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Ontology-Based Semantic Data Integration in the Domain of IT Benchmarking

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Abstract

Problem and Motivation: In the domain of IT Benchmarking (ITBM), a variety of data and information are collected. Although these data serve as the basis for business analyses, no unified semantic representation for such data yet exists. Consequently, data analysis across different distributed data sets and different benchmarks is almost impossible. Even setting aside the lack of a semantic representation for ITBM data, establishing a process for mapping databases to such a representation is one of the most cost-intensive tasks in the configuration of corresponding systems used for data integration. In response to these challenges, this dissertation proposes an approach for tool-based semantic data integration by grounding this type of performance measurement in a domain-specific ontology for ITBM. Thus, this dissertation contributes to the domain of ITBM by introducing a formal representation for relevant benchmarking data and by introducing a system for semantic database access based on this representation. Moreover, it contributes to the domain of Ontology Engineering (OE) by providing an approach for tool-supported ontology mapping.

Research Method: Following the design science paradigm this dissertation proposes a method for the semantic integration of data in the domain of ITBM. This research combines methodologies for ontology engineering with theory-driven design to develop concepts for tool-supported semantic data integration in this domain. The developed artifacts (i.e, concepts, approaches and software prototypes) are evaluated using several evaluation methods, including literature review, ontology evaluation, prototyping and scenarios.

Results: The first key result of this dissertation is the ITBM Ontology, a Semantic Web (SW)-based approach to the establishment of a common language to enable data analysis across different distributed data sets and different IT benchmarks as well as to foster interoperability among ITBM tools. The proposed ontology captures information relevant for specific benchmarks, such as information about the participants and their responses, and general information about specific indicators and their declaration. Thus, separation is achieved between the general time-related information regarding a benchmark, the structural information regarding the questionnaires used and the corresponding data that are associated with a specific indicator. The second key result of this dissertation is a system architecture for semantic data integration based on this domain-specific ontology, which provides a flexible means of linking various data sources without knowing the structures of previously attached sources. The third key result is a (semi-)automatic mapping recommender to support the mapping of ontology concepts to database tables. Finally, a web-based application has been implemented as a prototype combining all results. By using Natural Language Processing (NLP) techniques to translate natural

language inputs into Simple Protocol and RDF Query Language (SPARQL) queries, this application facilitates easy ontology-based access to ITBM data.

Research Implications: This work contributes to ITBM research by providing an ontological formalization of all relevant elements, attributes, and properties in this domain to enable the integration of various benchmarks together through a central platform to facilitate data access and performance comparisons across benchmarks. Furthermore, this work contributes to ontology engineering methodologies through the introduction of a (semi-)automatic recommender that directly supports the necessary mapping activities for linking an ontology to external databases. Additionally, this work contributes to theory-driven design by demonstrating how theories can be used to guide design decisions when building ontology-based applications, especially with regards to system architectures and the abstraction level of the applied ontology.

Practical Implications: In practice, the developed ontology for ITBM can function as a starting point for companies for the development of interoperable tool-based benchmarks and can enable them to more easily perform performance comparisons within their own organizations and across organizational boundaries. The system architecture and design principles developed in this dissertation can also guide future developments in provide tool-supported ITBM. Moreover, tool-based benchmarking-as-a-service could be offered by linking data sources to a benchmarking system that provides a standardized interface in the form of the ITBM ontology.

Limitations: This study has several limitations that warrant consideration. First, since the research was conducted over a period of five years and given the rapid pace of technological change, the data sources used for the development of the ontology might not cover all recent developments in IT. This is a common limitation in ITBM, as some period of time is needed to define new Key Performance Indicators (KPIs) for the evaluation of new technologies. Second, the implementation presupposes only connections to relational databases. This limitation will likely lead higher effort in attaching non-relational databases to the system and could be addressed in future research. Third, all users of the system are allowed to access all attached data sources. To address possible security issues that could arise if the system is used beyond company boundaries, more fine-grained access control could be implemented, with restrictions regarding the use of specific databases and specific data points within a single data source.

Originality: The main contribution of the ITBM ontology lies in the description of the technical architecture in which an ontology-based approach for data integration can be applied to achieve interoperability and reusability to structure an inherently unstructured field. Moreover, this approach demonstrates how tool-based benchmarking can be made easily accessible to users while including NLP technologies. In addition, a novel domain-independent approach for the tool-supported ontology mapping process during OE activities is presented.

Keywords: IT benchmarking, IT service management, performance measurement, semantic data integration, Semantic Web, ontology development, ontology engineering, system architecture, design science.

Zusammenfassung

Problemstellung und Motivation: Im Bereich des IT Benchmarking (ITBM) und ganz im speziellen während eines Benchmarks werden eine Vielzahl an verschiedensten Daten und Informationen gesammelt. Obwohl diese Daten als Basis für weiterführende Analysen dienen, existiert aktuell hiervon keine einheitliche semantische Repräsentation. In der Konsequenz ist es derzeit nicht, oder nur mit hohem manuellem Aufwand möglich Vergleiche und Analysen über die Grenzen einzelner Benchmarks und deren Datensätze hinweg durchzuführen. Zudem ist der Prozess des Mappings von einzelnen Datenbanken zu solch einer semantischen Repräsentation sehr zeit- und damit konstenaufwändig. Daher wird in dieser Forschungsarbeit ein Lösungsvorschlag für die semantische Integration von Datenquellen im Bereich des ITBM entworfen und prototypisch implementiert. Bisherige Ansätze der Leistungsmessung in dieser Domäne werden dabei in einer domänenspezifischen Ontologie verankert. Demzufolge liefert diese Arbeit einen Beitrag für den Bereich des ITBM, indem eine formale Repräsentation von Informationen und Benchmarking-Daten, also auch ein System für deren Zugriff entwickelt wurde. Zudem liefert diese Arbeit einen direkten Beitrag für die Domäne des Ontology Engineerings (OEs), indem ein toolbasierter Ansatz für die Aufgabe des Ontologie-Mappings entwickelt wurde.

Forschungsdesign und Methode: Dem Paradigma der gestaltungsorientierten Forschung folgend, entwickelt diese Arbeit eine toolbasierte Methode für die semantische Datenintegration im Bereich des ITBM. Dabei greift diese Arbeit auf Methoden und Ansätze aus theoriegetriebener Gestaltung, theoriebasierter Argumentation und dem Bereich des OE zurück, um Konzepte für solch ein semantisches System zu entwickeln. Die entwickelten Artefakte (u.a. Konzept, Ansätze und Software-Prototypen) werden dabei mittels verschiedenster Methoden evaluiert; Literaturanalyse, Ontologie-Evaluation, Prototypenentwicklung, sowie dessen Einsatz in entsprechenden Szenarien.

Ergebnisse: Ein Kernergebnis dieser Dissertation ist die ITBM Ontologie, ein Semantic Web (SW)-basierter Ansatz einer formalen und gemeinsamen Sprache, die den Informationsaustausch in dieser Domäne ermöglicht und zugleich die Interoperabilität verschiedenster Datenquellen und Informationswerkzeuge in diesem Bereich fördert. Dabei umfasst die vorgeschlagene Ontologie sowohl Informationen relevant für spezifische Benchmarks, bspw. Informationen über einzelne Teilnehmer und deren Antworten als auch deklarative Informationen zu einzelnen Messgrößen. Ein weiteres Kernergebnis ist die Systemarchitektur für die semantische Datenintegration, aufbauend auf der domänenspezifischen Ontologie und als flexible Möglichkeit Datenquellen zu verknüpfen, ohne die Strukturen der zuvor angebundenen Quellen kennen zu müssen. Als letztes Kernergebnis ist der semi-automatische Mapping-Recommender zu nennen, welcher das Mapping von Ontologiekonzepten zu Datenquellen direkt unterstützt. Sowohl die Ontologie als auch der Mapping-Recommender wurden prototypisch mittels einer web-basierten Anwendung implementiert. Unter Zuhilfenahme von Techniken der linguistischen Datenverarbeitung (LDV) bietet die hier

vorgestellte Anwendung die einfache Möglichkeit des natürlichsprachigen Zugriffs auf angeschlossene Datenbanken, indem Nutzeranfragen automatisch in Simple Protocol and RDF Query Language (SPARQL) Anfragen übersetzt werden.

Theoretischer Beitrag: Diese Arbeit trägt wesentlich zum Forschungsgebiet des ITBM bei, indem sie eine ontologische Formalisierung aller relevanten Elemente, Attribute und Eigenschaften bereitstellt, mit deren Hilfe bisherige individuell betrachteten Benchmarking Ansätze über einer zentralen Plattform semantisch zugreifbar gemacht werden. Dies ermöglicht neue Arten des Leistungsvergleichs über die bisherigen Grenzen eines einzelnen Benchmarks hinweg. Zudem leistet diese Arbeit einen entsprechenden Beitrag im Bereich des OE indem ein neuartiger Ansatz zur technischen Unterstützung des Ontologie-Mappings vorgestellt wird. Darüber hinaus wird in dieser Arbeit schrittweise aufgezeigt, wie theoriebasierte Entwicklung genutzt werden kann um Designentscheidungen ontologiebasierter Systeme zu lenken, um so bessere/einfachere Systeme zu entwickeln.

Praktischer Beitrag: Für die Praxis liefert die ITBM Ontologie die erste einheitliche, maschinenlesbare semantische Formalisierung von Informationen in diesem Bereich, mit deren Hilfe neuartige und interoperable toolbasierte Benchmarkingsysteme entwickelt werden können. Für Unternehmen bietet sich somit die Möglichkeit unternehmensweite und unternehmensübergreifende Benchmarks und entsprechende plattformbasierte Werkzeuge zu entwickeln. Darüber hinaus legt diese Arbeit den Grundstein um zukünftig toolbasiertes Benchmarking-as-a-Service, mittels der hier vorgestellten Ontologie als standardisierter Schnittstelle, zu betreiben bzw. anzubieten.

Limitationen: Einzelne Ergebnisse dieser Arbeit unterliegen Limitationen, die die Validität der gewonnenen Erkenntnisse beeinflussen bzw. deren direkte Anwendbarkeit mitunter beeinflussen können. Zunächst sei darauf hingewiesen, dass die Arbeit über einen Zeitraum von fünf Jahren entstand und so die für die Entwicklung der Ontologie verwendeten Datenquellen ggf. nicht alle jüngsten technologischen Entwicklungen in der IT abdecken. Dies ist eine generelle Herausforderung im ITBM, da eine gewisse Zeit benötigt wird, um neue Key Performance Indicators (KPIs) zu definieren, auf deren Basis entsprechende Technologien bewertet werden können. Des Weiteren sind derzeit lediglich relationale Datenbanken integrierbar. Diese Einschränkung kann dazu führen, dass bei der Anbindung von nicht-relationalen Datenbanken zusätzliche Aufwände entstehen. Weiterhin können derzeit alle Nutzer des Systems auf alle angeschlossenen Quellen zugreifen, eine Beschränkung auf einzelne Datenbanken oder spezifische Datenpunkte ist aktuell nicht vorgesehen. Zur Nutzung des Systems über Unternehmensgrenzen hinweg wäre daher eine feingranulare Zugriffskontrolle denkbar, um möglichen Sicherheitsanforderungen zu begegnen.

Originalität: Der spezifische Beitrag der ITBM Ontologie liegt in der Beschreibung der technischen Architektur, in der ein ontologiebasierter Ansatz für die Datenintegration Anwendung findet, um Interoperabilität, Wiederverwendung und Struktur eines inhärent unstrukturierten Feldes zu erreichen. Darüber hinaus zeigt dieser Ansatz, wie tool-basiertes Benchmarking für Benutzer leicht zugänglich gemacht werden kann, in dem Linguistische Datenverarbeitung (LDV)-Technologien für den Datenzugriff mit einbezogen wurden. Zudem beschreibt die Arbeit einen neuartigen, domänenunabhängigen Ansatz für werkzeuggestütztes Ontologie-Mapping, als Teil der OE-Aktivitäten.

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Lastly and most importantly, none of this would have been possible without the love, patience and continuous support of my family and my girlfriend Eva. Without you all, this work would not exist!

Munich, Germany, 29.09.2017 Matthias Pfaff

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List of Abbreviations and Acronyms

List of Symbols

$\circ$ Composition

$(\mathcal{D})$ Use of data type properties, data values or data types

$\mathcal{AL}$ Attributive language. This is the base language which allows:

- Atomic negation
- Concept intersection
- Universal restrictions
- Limited existential quantification

$\mathcal{C}$ Complex concept negation

$\mathcal{H}$ Role hierarchy

$\mathcal{I}$ Inverse properties

$\mathcal{N}$ Cardinality restrictions

$\mathcal{Q}$ Qualified cardinality restrictions

$\mathcal{R}$ Limited complex role inclusion axioms; reflexivity and irreflexivity; role disjointness

$\mathcal{S}$ An abbreviation for $\mathcal{ALC}$

$\subseteq$ A subset of

$\times$ Cartesian product

^{c} Class identifier

^{dp} Data property identifier

^{op} Object property identifier

A^{o} Set of axioms in Ontology (O)

C Zipf's law

$f(t)$ Frequency of term occurrence

S_{ik} Significance of term occurrence

Part A

Introduction to the Dissertation's Publications

Chapter A1

Introduction

A1.1 Motivation and Background

Benchmarking, the process of continuously measuring and comparing the performance of an organization against business leaders, has gained great popularity worldwide since the 1980s. One of the most cited pioneers in benchmarking practices is Xerox. In 1979, Xerox was facing tough competition from Japanese competitors. Robert C. Camp initiated an internal effort to compare the manufacturing costs and copier features of Xerox printers against the products of these competitors. From this comparison, he identified, inter alia, that it took Xerox twice as long as its competitors to bring a product to market, five times the number of engineers were needed, four times the number of design changes were required, and the design costs for Xerox were three times higher. Based on Camp's work, Xerox implemented a strategy called "leadership through quality" to recapture its leading position in the market (Airi/Leonard, 1994).

Camp (1989, 10) defined benchmarking as *"the continuous process of measuring products, services and practices against the toughest competitors or those companies recognized as industry leaders, (that is) ... the search for industry best practices that will lead to superior performance"*. Since then, benchmarking exercises have become very popular in all industries as one of the primary management tools (Bogetoft/Otto, 2011; Rigby/Bilodeau, 2015). In the course of such benchmarking exercises, not only specific products can be investigated; the processes and services of a company can also be in the focus of such a comparison. Thus, depending on the object of study, different types of benchmarks exist (Carpinetti/Oiko, 2008), including process, product, strategic, and internal benchmarks, to name but a few. The specification of questions that should be answered during a benchmark and the specification of corresponding indicators based on objective criteria are crucial steps of the benchmarking process (Camp, 1989). These concerns become increasingly important because of the continuous nature of benchmarks, since the quality of performance measurements of a specific object under investigation depends on a structured and well-described benchmarking process.

Currently, research in the field of benchmarking is focused on the development of specific measurement methods and the development of Key Performance Indicators (KPIs) for various domains, e.g., KPIs for the automotive industry (Smith, 2001), KPIs in the domain of business strategy management (Kaplan/Norton, 2001) and general KPIs in the balanced scorecard context (Parmenter, 2007). KPIs for measuring the performance of Information Systems (ISs) have also already been well described by numerous authors (cf. Slevin/Stieman/Boone, 1991; Smith/McKeen, 1996; Gacenga et al., 2011). To describe the service offerings of Information Technology (IT) departments, recent (research) activities have focused on structuring, standardizing and generalizing IT service catalogs which often form the basis for IT-related benchmarks (cf. Kütz, 2006; Riempp/Müller/Ahlemann, 2008; Rudolph, 2009; Nissen et al., 2014). In general, these service catalogs are based on a common vocabulary, such defined by IT Infrastructure Library (ITIL).

If one considers that poor data quality can have a severe impact on the overall effectiveness of an organization (Wand/Wang, 1996), a concept for uniform data description and data management in the IT Benchmarking (ITBM) domain is strongly recommended; however such a concept has not yet been considered (Wollersheim/Pfaff/Krcmar, 2014; Pfaff/Krcmar, 2015). Moreover, little work published to date in the IS literature has addressed the challenges of integrating data from different types of IT benchmarks. This lack of a uniform description of any arbitrary parameter that is measured during a benchmark and the relationships between such parameters limits the comparability of different types of benchmarks. For the linking of similar data (bases) in a semantic manner the use of ontologies has become popular in recent years, with a particular focus on the representation of business processes (Thomas/Fellmann, 2009; Garcia-Crespo et al., 2011), for the purpose of enterprise modeling (Uschold et al., 1998), in the sector of information management (Riedl et al., 2009; Müller, 2010; Cambria/Hussain/Eckl, 2011) or for the representation of the ITIL vocabulary (LinkedDataCenter, 2012) and its corresponding Configuration Management Database (CMDB) (Xin et al., 2010; Meier, 2011). In general, a domain-specific ontology can serve to ensure that the collected data are meaningful and to overcome recent limitations concerning data comparability in ITBM (Wand/Wang, 1996; Opdahl et al., 2012; Horkoff et al., 2012; Pfaff/Krcmar, 2014). To (semi-) automatically compare IT-related and business-related performance indicators across organizational boundaries, fine-grained conceptualization of such information is needed. Especially if an ontology is directly used to link and access external data sources (i.e., if ontology concepts are directly mapped to IT business-related KPIs) and to analyze organizational performance in terms of (IT) services, this conceptualization needs to be closer in structure to IT service catalogs than to an abstract description of organizational processes or IT resources.

This dissertation reports on the first search for a uniform data description in this domain, based on semantically representing relevant concepts by anchoring them in ontological foundations. This research has produced a domain-specific ontology and a software tool for ontology-based data integration in ITBM.

A1.2 Research Goal and Guiding Questions

To achieve a comparison across different kinds of benchmarks, a consistent semantic description of the collected data is essential. Thus, this dissertation presents an ontological formalization of all relevant elements, attributes, and properties in the domain of ITBM, following the description logic fragment of Web Ontology Language (OWL) 2 (Motik/Patel-Schneider/Parsia, 2012). Consequently, this work addresses the data comparability issue resulting from the lack of standardization by showing to which degree of abstraction the conceptualization of relevant concepts needs to be covered by an ontology in this domain and which basic relationships need to be modeled within the core ITBM ontology. Whereas the ITBM ontology provides a common understanding of concepts and relations within the domain of ITBM, a semantic foundation is achieved by grounding the ITBM ontology in an upper ontology, i.e., a foundational ontology. For this reason, the ITBM ontology is linked to Dolce UltraLite (DUL) (Gangemi, 2016b). By this means, the semantic interoperability of distinct conceptualizations among different (domain) ontologies is ensured (Guizzardi, 2005).

In light of the above, the purpose of this dissertation is to present a domain-specific ontology and to propose a conceptual model of a Semantic Web (SW)-driven ITBM data management system with the following key components: basic resources, metadata, ontology, and a user interfaces for querying external databases. Although the prototype implementation of the system architecture uses the ITBM ontology, the proposed concepts for data integration that are outlined in this dissertation are also applicable in other domains, especially the linkage between ontology concepts and external data sources.

The aim of this research is to develop a concept for tool-supported semantic data integration in the domain of ITBM and to ground this type of performance measurement in a domain-specific ontology.

To address the aforementioned challenges and to achieve the goals of this research, the following Research Questions (RQs) are addressed in this dissertation:

Research Question 1: What are the current challenges regarding data integration in the domain of ITBM?

The first RQ focuses on data integration challenges in the domain of ITBM. Answering this RQ requires generating an overview of the various ITBM approaches and the different data structures generated therefrom. Additionally, RQ1 is addressed through a literature review of benchmarking in general to ensure that the identified challenges have not already been solved within a broader benchmarking context. As a result, the identified challenges are described and discussed in detail, and they provide the basis for the evaluation of technologies in the context of RQ2.

Research Question 2: How can ITBM data be described and represented to build a foundation for subsequent, possibly computer-based, concepts and tools?

This RQ is answered by developing an ontological representation of ITBM data using recent SW technologies. RQ2 is addressed through the conceptual modeling of all relevant components for data integration in this domain. Given the importance of verifiable design decisions, this conceptual modeling is guided by a sound methodological framework for ontology engineering.

Research Question 3: How can a system be designed to integrate existing distributed data sources in ITBM using a domain-specific ontology?

In addition to the domain ontology constructed in response to RQ2, a system architecture for the integration of existing distributed data sources is developed, supported by theory-driven design. Because the ontology mapping procedure, which is generally performed manually, is one of the most cost-intensive tasks in the configuration of ontology-based systems for data access (Daraio et al., 2016), a semi-automatic mapping recommender is introduced to support this activity. To provide users with easy access to distributed data sources, Natural Language Processing (NLP) techniques are used to translate natural language requests into Simple Protocol and RDF Query Language (SPARQL) (Prud'hommeaux/Seaborne, 2008) queries. The system architecture follows a service-oriented design, encapsulating client (user)-side functionalities in a browser application and server-side functionalities in replaceable (service) components. Because ontologies are not static entities but evolve over time, the system is able to handle version changes of the ontology to safeguard the accessibility of the data from the attached data sources.

A1.3 Structure

This dissertation is structured in three parts (Part A: Introduction to the Dissertation's Publications, B: Publications, and C: Summary of Results and Discussion of Implications), as shown in Figure A1.1.

Part A: The first part of this dissertation begins by motivating the work and outlining the research objectives and the structure of this dissertation (current Chapter A1). Next, Chapter A2 provides an overview of the conceptual background and introduces basic terms relevant to the research context. Finally, the research design, the applied research methods and the included publications are outlined in Chapter A3.

Part B: The second part of this dissertation (Chapter B1 to Chapter B5) is composed of five publications (**P1 - P5**) produced as outcomes of the research performed by the author as part of this dissertation. A brief summary of each publication and its correspondence to the research questions outlined in the previous section can be found in Section A3.3.

Part C: The third part concludes this dissertation. First, the research results of the included publications are summarized (Chapter C1). Second, the contributions of this work to theory and practice and the limitations of the research results are outlined (Chapter C2). Finally, this part closes with a proposal of future research opportunities in Chapter C3.

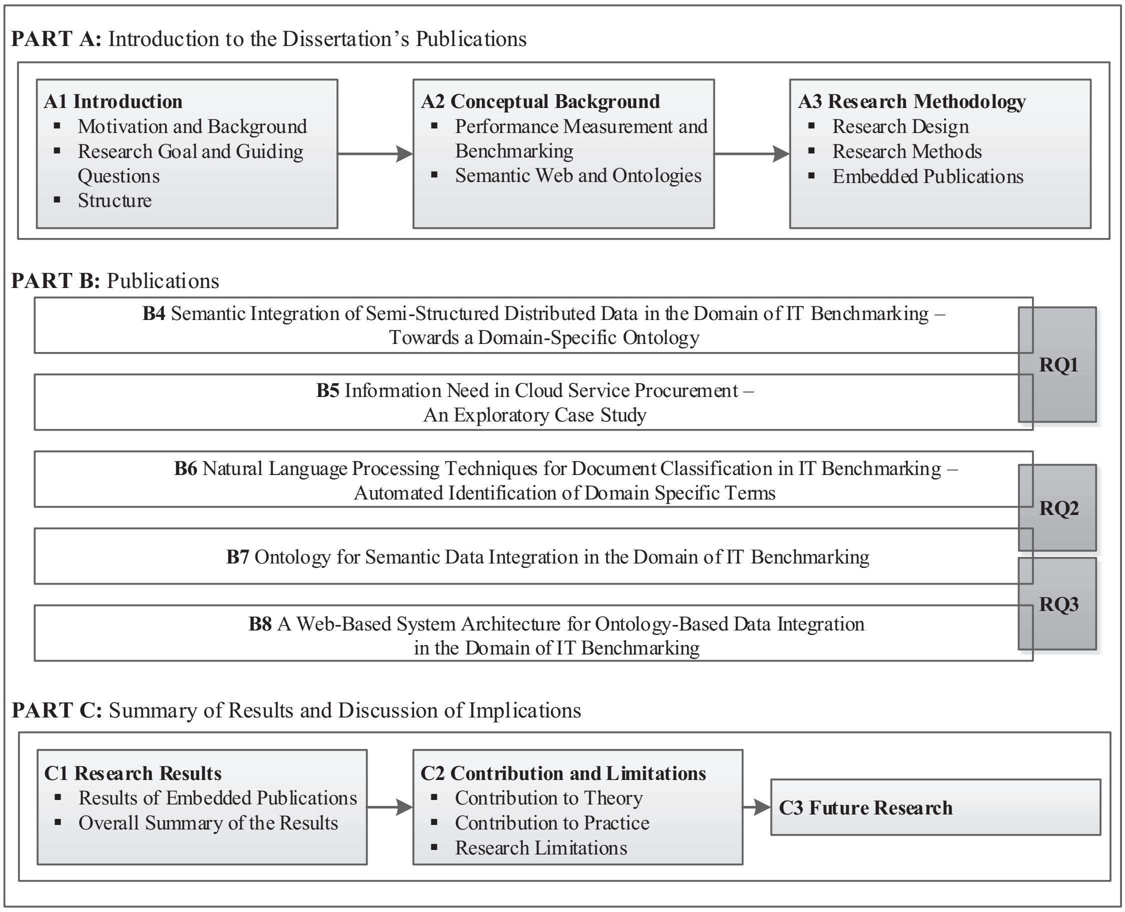

Figure A1.1: *Structure of this dissertation*

Chapter A2

Conceptual Background

THIS work is mainly influenced by two areas of research that are, at present, rarely considered in relation to each other, namely, performance measurement, specifically (IT) benchmarking, and Ontology Engineering (OE) in the context of the Semantic Web. Therefore, in the following, the basic concepts of these research areas are presented to lay the foundation for this dissertation.

A2.1 Performance Measurement and Benchmarking

The main methods of measuring business performance have been in place since 1910, when three Du Pont cousins consolidated and reorganized their small enterprises (Chandler, 1977). As a "basic management technique", performance measurement has recently become popular across all industries (Neely, 1999; Yadav/Sagar, 2013). During this time, various business improvement approaches and methodologies have been developed, all subsumed under the term Business Performance Measurement/Management (BPM). Moreover, as performance measurement has been increasingly recognized as a crucial factor in improving business performance (Eccles, 1991; Neely, 1999), these methods have continiously seen further developments, including measures of external success and internal performance (Bourne et al., 2000). As a consequence of the implementation of such performance measurement methods, searches for best practices for a product, service or process through external comparisons with competitors have been summarized under the term benchmarking (Camp, 1989). The differences between these two terms (performance measurement and benchmarking) are outlined in the following sections.

A2.1.1 Performance Measurement

The level of performance a business attains can be seen as a a function of the efficiency and effectiveness of certain actions it undertakes (Neely/Gregory/Platts, 1995), and descriptions of the assessment thereof can be subdivided into the following terms (Neely et al., 1994):

- *Performance measurement* can be defined as the process of quantifying the efficiency and effectiveness of an action.
- A *performance measure* can be defined as a metric used to quantify the efficiency and/or effectiveness of an action.
- A *Performance Measurement system (PMS)* can be defined as the set of metrics used to quantify both the efficiency and effectiveness of a set of actions.

As shown in Table A2.1, there are a variety of ways and dimensions in which performance measures can be categorized (Venkatraman/Ramanujam, 1986; Neely/Gregory/Platts, 1995). To summarize, performance measures can be related, among other things, to quality, time, cost or the flexibility of features, services, values or products.

Table A2.1: *Dimensions of performance measures, based on Neely* (1999)

Quality	Time	Flexibility	Cost
Performance	Manufacturing lead time	Material quality	Manufacturing cost
Features	Rate of product introduction	Output quality	Value added
Reliability	Delivery lead time	New product	Selling price
Conformance	Due-date performance	Modified product	Service cost
Technical durability		Volume	
Serviceability			
Value			

Traditionally, such measures were developed based on costing and accounting systems (Neely/Gregory/Platts, 1995) and supported by appropriate PMSs developed to support of measurement process. In general, a PMS can be seen as a balanced and dynamic system that is able to support decision-making processes through the collection, elaboration and analysis of (Neely/Adams/Kennerley, 2002). As one of the best known PMSs, the Balanced Scorecard (BSC) developed by Kaplan/Norton (1992) achieves a balance by considering measures of both external success and internal performance and provides an early indication of future business performance. By virtue of the combination of financial and non-financial perspectives, the introduction of the BSC led to improved operational efficiency and profitability for companies (Atkinson/Kaplan/Matsumura, 2012, 57).

Figure A2.1 presents the evolution of performance measurement that has occurred over the past decades. Beginning in 1900, early accounting standards did not trace the costs of products, activities, and processes and the cost of quality (Bititci, 1994). In 1914, the company Du Pont introduced the Return on Investment (ROI) calculation to measure the financial soundness of an organization. In the 1950s, the "Tableau de Bord" combined financial and non-financial measures to focus more on daily operations and less on strategic reflections (Epstein/Manzoni, 1997). Beyond financial considerations, various related approaches for the measurement of organizational demands were developed during this period, such as social accounting, a process of communicating social and environmental effects of an organization's economic actions to society (Gray/Owen/Maunders, 1987); strategic management accounting, a generic approach for strategic positioning (Simmonds, 1981); and activity-based costing, a process of determining the cost of a product or service on the basis of the activities required needed to produce and/or deliver it (Cooper/Kaplan, 1988)). Growing attention to performance measurement can also be seen, such as in the 1980s, when the European Foundation for Quality Management (EFQM) and several other quality and excellence awards were established to distinguish companies for their "contribution to quality and dependability of products" (Deming/Edwards, 1982). As previously stated, one of the main revolutions in performance measurement was initiated by Kaplan/Norton (1992), and the development of the BSC served as a complementary approach to financial measures through the integration of operational and strategic performance measurements. Thus, the integration of non-financial measures, such as quality, innovative capability, strategic considerations and business models, with financial measures can be seen as characterizing the main steps in the evolution of performance measurement up through the early 1990s.

From the end of the 1990s until early 2010s, the major efforts related to performance measurement focused on the development of PMSs to support the implementation of the BSC within companies, as nearly 70 percent of the initial implementations of the BSC failed due to inappropriate design and implementation failure (Neely/Bourne, 2000, 3). Thus, PMSs were developed to ensure consistent, integrated and dynamic performance measurement activities for enterprises. At the end of the decade, IT-based PMSs were being proposed as internal and external monitoring and measurement systems (Bititci/Turner/Begemann, 2000). By monitoring external factors relevant to the performance of an organization, such as multiple external stakeholders and competitors, PMSs shifted from being reactive to proactive systems. At the mid-2010s PMSs and the BSC approach began to be extended through the integration of simulation techniques and fuzzy logic to simulate the likely future of policy interventions and appropriately adjust the targets for (internal) performance measures (Yadav/Sagar, 2013).

In this work, performance measurement and benchmarks are so closely related that benchmarks are considered as the standards by which performance measurements are performed to identify performance gaps via comparative measurements. Thus, benchmarking is a process that enables the comparison of inputs, processes or outputs between organizations (or parts of organizations) or within a single organization over time.

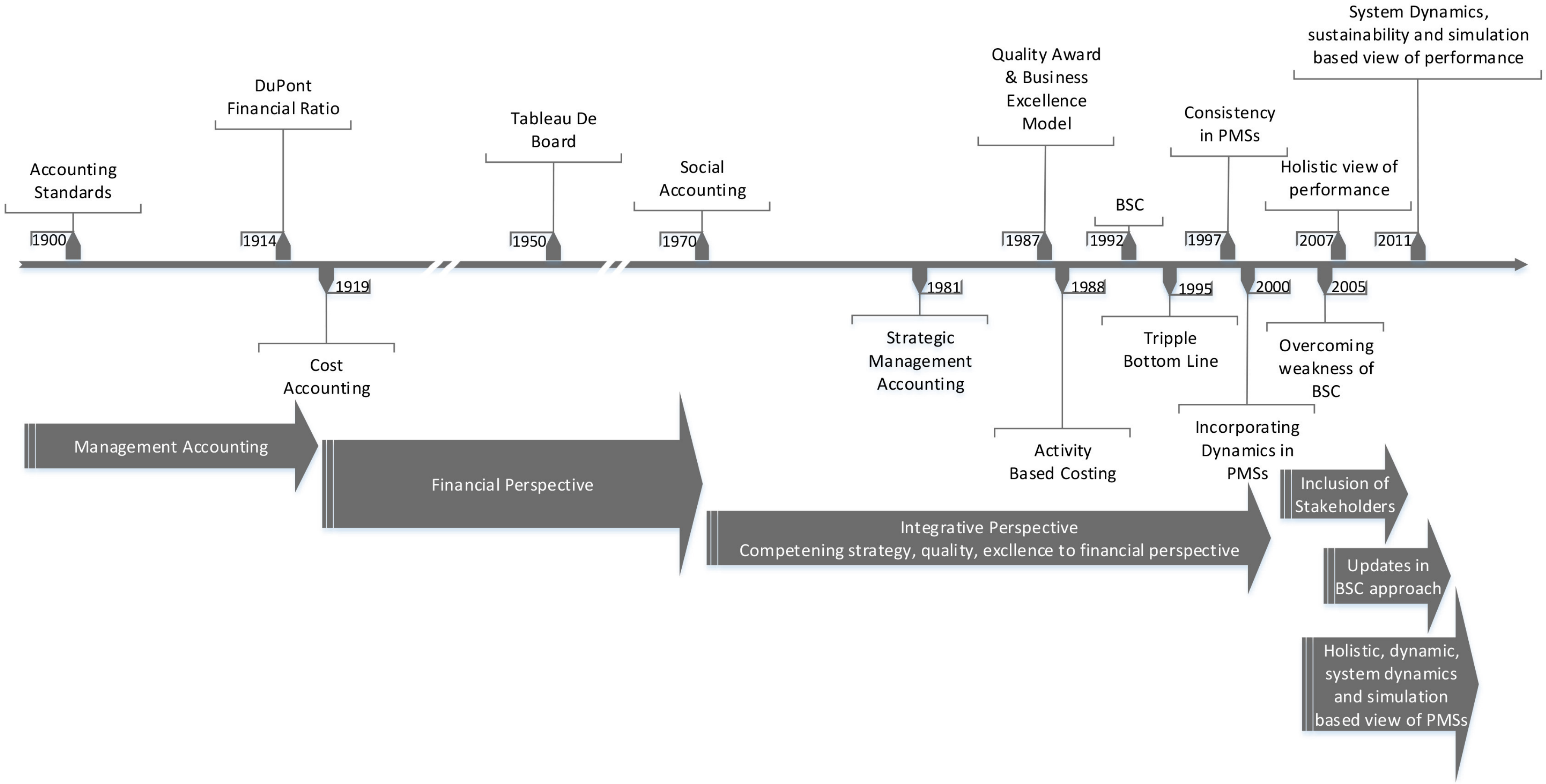

Figure A2.1: *Evolution of performance measurement, based on Yadav/Sagar* (2013)

A2.1.2 Benchmarking

Over time, several different benchmarking approaches have been developed (see Figure A2.2). Prior to Xerox's efforts, starting in the 1940s, the term "reverse engineering" subsumed several activities involved in a product-based comparison, including comparisons of product characteristics, functionality, and performance of competing offerings (Watson, 1993). The second generation of benchmarking expanded this product-centric view by including processes in comparisons with competitors and was mainly influenced by Camp (1989). The adoption of lessons learned from companies in different industries (i.e., outside competitive boundaries) and the sharing of information with others (non-competitive intelligence gathering) characterize third generation of benchmarking (Pryor, 1989). The fourth generation of benchmarking is referred to as "strategic benchmarking". It involves a systematic process for evaluating alternatives, implementing strategies and improving performance by understanding and adopting successful strategies from external partners (Watson, 1993). Starting in the mid-1990s, the fifth generation of benchmarking comprised global learning and required the bridging of cultural barriers and understanding international trade issues (Ahmed/Rafiq, 1998). In recent years, "competence" or "learning benchmarking" has been developed. It is based on the insight that organizations can improve their effectiveness by developing competences and skills and by learning how to change attitudes and practices (Freytag/Hollensen, 2001). Benchmarking within a networking environment for strategy development is the latest development in the area of benchmarking, combining global perspectives and interorganizational cooperation (Saunders/Mann/Smith, 2007; Quaglia et al., 2013; Bukh/Dietrichson, 2016).

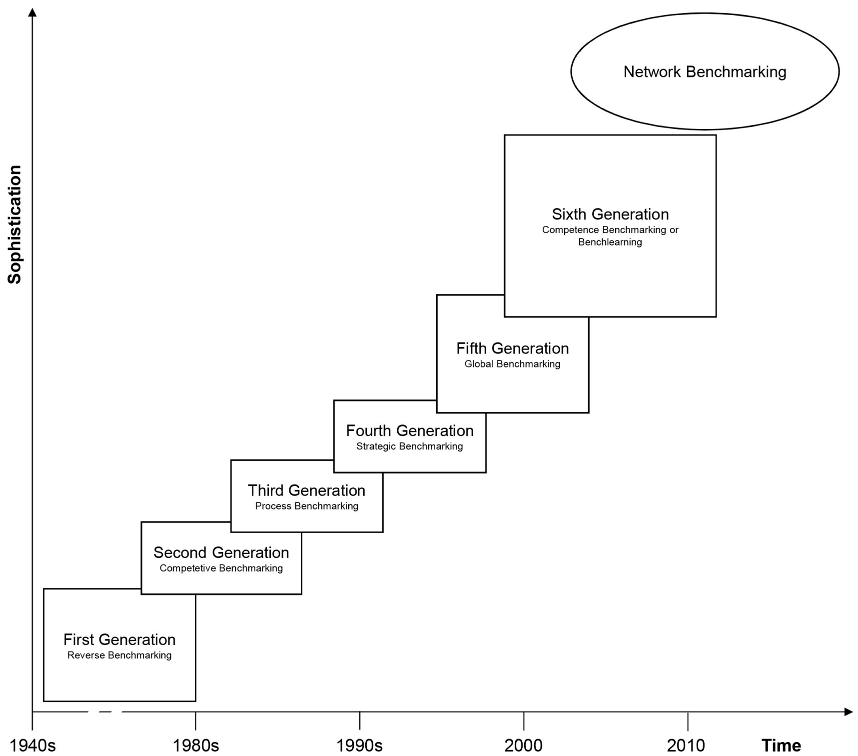

Figure A2.2: *Generations of benchmarking, based on Ahmed/Rafiq (1998, 288) and Kyrö (2003, 211)*

According to Watson (1993) the benchmarking procedure can be subdivided into several process phases following the Plan-Do-Check-Act (PDCA) Cycle, also called the Deming Cycle (Deming, 1986). First, the object of benchmarking and the organizations to be compared need to be identified and specified (Plan). Second, the actual benchmarking is performed (Do). Third, the benchmarking data are analyzed, and best practices are identified (Check). Finally, identified improvements for the organization are adopted (Act). Since benchmarking is a continuous process (McNair/Leibfried, 1992), upon the completion of the last process phase (Act), the next iteration of the benchmarking cycle begins all over again, probably with a different object of study. Notably, during each single benchmark, numerous data are collected for each benchmarking participant, which comprise both qualitative and quantitative statements.

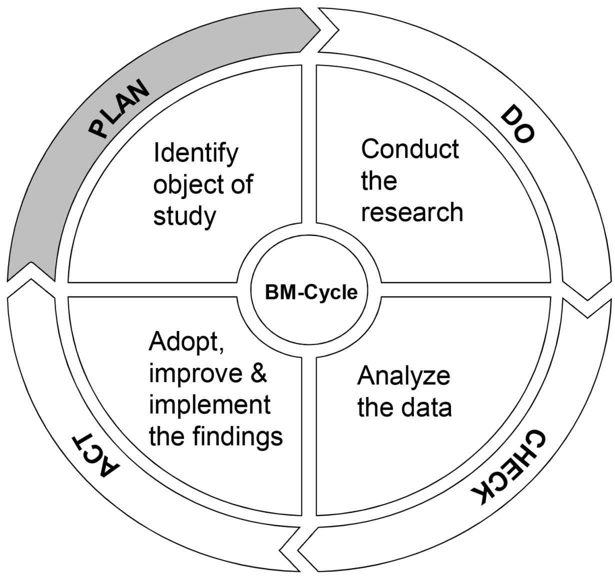

Figure A2.3: *The benchmarking process, based on Watson* (1993)

As previously stated, benchmarking has its origin in the context of management tools and was made popular in the 1980s by Camp (1989). In contrast to performance measurement, benchmarking requires comparisons to identify performance gaps within the one's organization (Manzoni/Islam, 2009, 22). Thus, benchmarking began to interface seamlessly with performance measurement at the time when performance measurement approaches also started to consider external aspects. As a systematic process for improving organizational performance, benchmarks can be classified according to their objects of study, e.g., processes, products, strategies or generic objects (Fong/Cheng/Ho, 1998; McNair/Leibfried, 1992; Carpinetti/Oiko, 2008). Furthermore, competitors within a benchmark may be units of the same organization, competitors in the same or different geographical markets or organizations in related or unrelated industries. Thus, a distinction is drawn between internal and external comparisons, where an internal performance measurement focuses on the operations of a single company, whereas an external performance measurement focuses on different companies. An overview of the different types of benchmarks is presented in Table A2.2.

Table A2.2: *Different types of benchmarks, based on Carpinetti/Oiko* (2008)

Type	**Description**
Process Benchmark	Compares operations, work practices or business processes
Product Benchmark	Compares products or services
Strategic Benchmark	Compares organizational structures, management practices and business strategies.
Internal Benchmark	Compares similar products or services of similar business units within a single organization
Competitive Benchmark	Compares performance with a direct competitor. The object of investigation may include products, services, technology, research and development, personnel policies, etc.
Functional Benchmark	Compares one or more non-competitive organizations in terms of particular business functions or processes
Generic Benchmark	Compares an organization or business unit with the best-performing comparable organization, regardless of the type of industry

In the context of this work, benchmarking is regarded as the basis for the identification of good and best practices, and therefore, this work focuses on improving formal comparative measurements by introducing a domain-specific ontology as foundation for such comparisons.

IT Benchmarking

Benchmarking in the IT context requires several prerequisites. For example, it is important to have a well-structured service-oriented IT department and consistent knowledge of IT services and their corresponding costs (Pfaff/Krcmar, 2014). Several approaches to IT management structures exist in literature (Ebner/Urbach/Mueller, 2016). These approaches generally focus on IT applications (Segars/Grover, 1998), IT infrastructure (Mocker/Teubner, 2005), or strategic and organizational aspects (Boddy/Boonstra/Kennedy, 2005). A Reference Framework (RF) for structuring an entire IT organization was introduced by Riempp/Müller/Ahlemann (2008) and implemented for Strategic IT Benchmarking (SITBM) by Ebner et al. (2012).

Figure A2.4 shows all dimensions covered by an ITBM approach. This RF has three main interfaces: (i) to the organization itself through its *business strategy*, with which the IT strategy needs to be aligned and against which financial aspects are to be evaluated; (ii) to internal and/or external customers, who order and consume the delivered products based on quality standards defined through Service Level Agreements (SLAs); and (iii) to suppliers, who provide specified services for the IT department based on quality standards defined through Underpinning Contracts (UCs). The core dimensions of the management of an IT department are project portfolio management, including program and individual project management; IT process and organization management, in accordance with the ITIL standard, for example; management of the application portfolio, which includes, among other aspects, the planning of the enterprise architecture and application integration; and management of the Information Communication Technol-

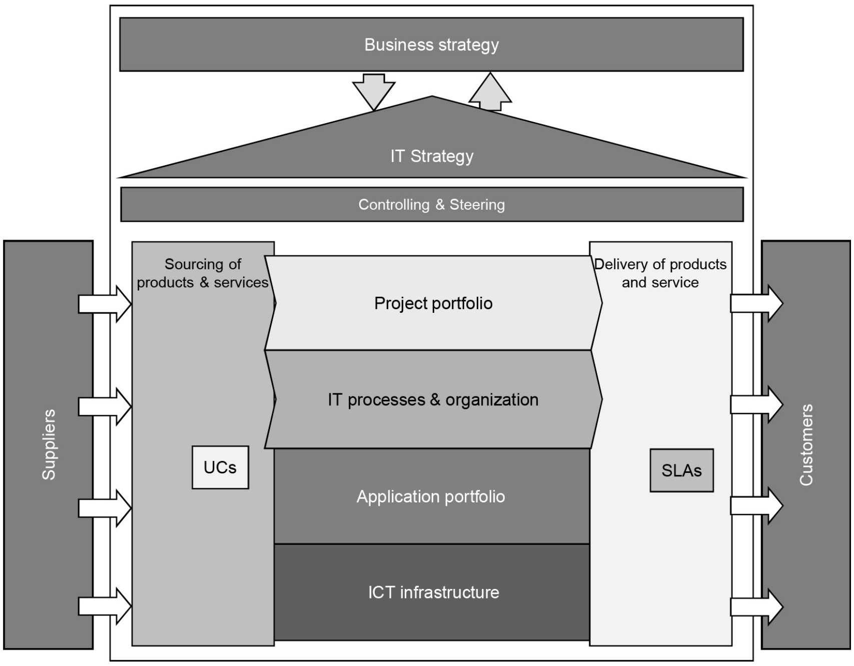

Figure A2.4: *Strategic ITBM reference framework, based on Riempp/Müller/Ahlemann (2008)*

ogy (ICT) infrastructure, comprising, among other components, networks, data centers, servers and client hardware.

In view of the above, organizations interested in IT benchmarking need to have valid definitions of the values and costs of the objects selected for benchmarking. In this regard, organizations benefit from the increasing industrialization, standardization, documentation and definition of IT services, which help them to measure the performance of IT-related objectives (Rudolph, 2009). To this end, IT service catalogs are appropriate instruments for captureing such service structures because they encompass certain aspects of deliverables and infrastructure components (Krcmar, 2015, 554).

Figure A2.5 shows the pattern structure of an IT service catalog as suggested by Rudolph (2008, 192). The structural layout of an IT service catalog can be generalized as a mono-hierarchical structure of IT services that are aligned with or used within specific business processes and those that are provided for cross-organizational services. In general, a service catalog provides some general information about the purpose of a service offering (for example, providing a mailbox or a print service) and detailed information about the performance and cost indicators that are used to measure the performance of this service. It is also possible that IT services may inherit indicators or values from basic organizational information (such as the total number of employees of an organization) to enable further calculations within a specific service based on such a basic indicator. For example, as shown in Figure A2.5, the general IT service “Mail” describes activities within an IT department that are related to this service offering, i.e., providing a mail account. In addition to service catalogs themselves, concepts regarding the identification of critical success factors for measuring the maturity level of service catalogs have already been developed by Kütz (2006) and Rudolph (2009).

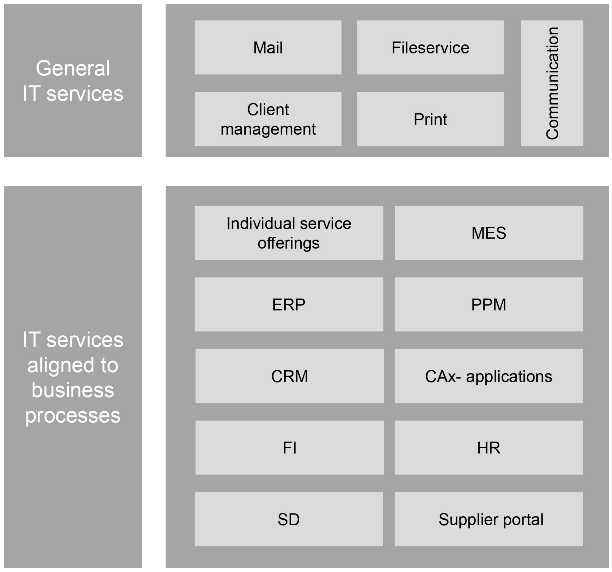

Figure A2.5: *Pattern structure of an IT service catalog, based on Rudolph (2008, 192)*[1]

A2.2 Semantic Web and Ontologies

> *"The Semantic Web is an extension of the current web in which information is given well-defined meaning, better enabling computers and people to work in cooperation."* (Berners-Lee et al., 2001)

The term "Semantic Web" has been disseminated by Berners-Lee et al. (2001) as referring to a vision of an intelligent web. The aim of research within the field of SW technologies is the development of methods of enriching the web with machine-processable information to enable web agents to "understand" these data (Berendt/Hotho/Stumme, 2002). The term most closely related to the development of the SW is "ontology". This is because ontologies, which are defined formally specified vocabularies of concepts and the axioms relating them, are seen as playing a key role in describing the "semantics" of the corresponding data. Thus, in the following sections, concepts relevant to SW and ontologies are outlined.

A2.2.1 Semantic Web

Tim Berners-Lee (2000), director of the World Wide Web Consortium (W3C), outlined his vision for the SW in his conference talk at the XML 2000. Moreover, he presented his plan for the SW architecture, often referred to as the Semantic Web Layer Cake (see Figure A2.6). In brief, in the first layer, Uniform Resource Identifiers (URIs) refer to entities.

[1]Enterprise Resource Planning (ERP), Financials (FI), Customer Relationship Management (CRM), Sales and Distribution (SD), Manufacturing Execution System (MES), Portfolio and Project Management (PPM), Computer-Aided (CAx) applications, Human Resource (HR).

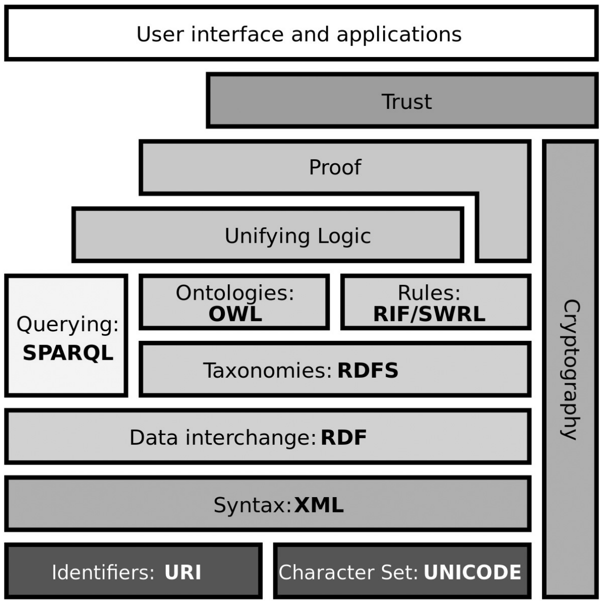

Figure A2.6: *Semantic Web stack, based on Berners-Lee* (2000)

Unicode is the standard for exchanging symbols. Extensible Markup Language (XML) is used to describe labeled trees and to define grammars for XML documents. The Resource Description Framework (RDF) is used for processing metadata by representing information about resources in graph form. An RDF description is based on triples specifying subject-predicate-object relations. To facilitate the standardized description of ontological constructs such as taxonomies, RDF Schema (RDFS) has been introduced. In more detail, ontologies can be created in OWL, which is syntactically embedded into RDF and is also a W3C standard (Calvanese/De Giacomo/Lenzerini, 2001; McGuinness/Van Harmelen, 2004). OWL can be further subdivided into OWL Lite, used for taxonomies and simple constraints; OWL-DL, for full description logic support; and OWL Full, for maximum expressiveness and syntactic freedom within RDF. Beyond the constructs provided by OWL, rule-based languages are also available, such as Rule Interchange Format (RIF) and Semantic Web Rule Language (SWRL). By means of RDF triples, SPARQL can be used to query RDF, RDFS and OWL and to access RDF data in a Structured Query Language (SQL)-like way. To ensure trustworthy results for any user and application, it is expected that all semantic results should be formally proofed and only provided in response to trusted inputs, verified some kind of cryptography (e.g., digital signatures).

Involving the handling of complex search queries, the combination of multiple resources for information integration and, finally, the understanding and interpretation of the meaning of search results, the definition from Berners-Lee et al. (2001) goes far beyond conventional web search engines:

> *"If the world's knowledge is to be found on the Web, then we should be able to use it to answer questions, retrieve facts, solve problems, and explore possibilities. This is qualitatively different than searching for documents and reading them, even though text search engines are getting better at helping people do these things. Many major scientific discoveries and breakthroughs have in-*

> *volved recognizing the connections across domains or integrating insights from several sources. These are not associations of words; they are deep insights that involve the actual subject matter of these domains. The Semantic Web has the machinery to help address interoperability of data from multiple sources."* (Gruber, 2008)

A2.2.2 Ontologies

Etymologically, the term "ontology" has its origins in the Greek language, from "ontos (ὄντος)", the Greek word for "being", and "logos (λόγος)", meaning "knowledge/discourse"; it and can be translated as *"the study of existence, of all the kinds of entities - abstract and concrete - that make up the world"* (Sowa, 2000, 51). Moreover, the term "ontology" has different meanings in different contexts. In philosophy, it is a branch of metaphysics and is the study of the kinds of things that exist (Hofweber, 2014). Thus, no universally accepted definition of ontology exists (Kuśnierczyk, 2006); however, in computer science, an ontology is typically defined as follows:

> *"An ontology is an explicit specification of a conceptualization."* (Gruber, 1993)

This definition was later updated by Studer/Benjamins/Fensel (1998).

> *"An ontology is a formal, explicit specification of a shared conceptualization."* (Studer/Benjamins/Fensel, 1998)

Based on these definitions, an ontology in computer science encompasses the structuring of knowledge within a specific domain. It is used as a form of representation for knowledge about the world or about only a certain a part of the world. It can be seen as a kind of data model representing a specific domain. Moreover, it is used to reason about the entities in that domain and the relationships between them. The central concepts of the definitions given above are *conceptualization*, *explicit specification*, *formal* and *shared*. A *conceptualization* maps a given (real-world) phenomenon to an abstract representation of its relevant concepts, relations, axioms and constraints. The term *explicit* refers to the explicit definition of types of concepts and relations along with their axioms and constraints. The term *formal* implies that an ontology should be machine-readable and, therefore, described using mathematical or formal notation. The term *shared* indicates that an ontology conceptualizes a common and non-exclusive understanding of knowledge in a specific domain.

The relations between a representation (language), a concept and a thing (referent) in reality can be visualized in the well-known form of Ullmann's triangle (Ullmann, 1962, 57), as shown in Figure A2.7. Here, a symbol represents a concept, which is an abstraction of a thing in the real world, and the symbol stands for this thing corresponding thing in the real world.

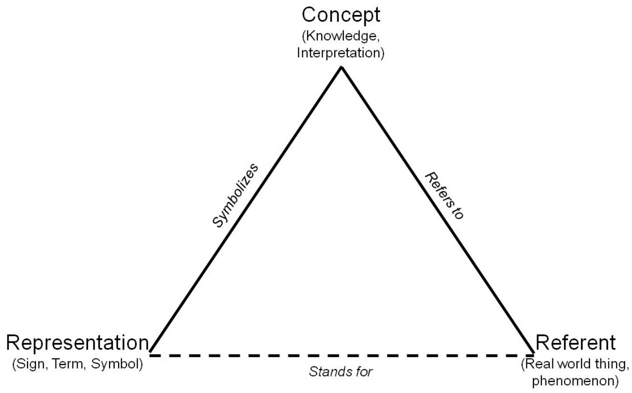

Figure A2.7: *Ullmann's triangle, based on Ullmann (1962, 57)*

According to Maedche/Staab (2001), an ontological structure (explicit specification of the conceptualization of a specific domain) is formally defined as follows:

Definition A2.2.1. *An ontological structure O is defined as*

$$O = \{C,\ R,\ A^o\}, \tag{A2.1}$$

where;

- *C is a set of elements called concepts,*
- *$R \subseteq C \times C$ is called the set of relations between concepts and contains the existing inherent hierarchical structure among the concepts in C (hierarchical taxonomy), and*
- *A^o is the set of axioms in O.*

The common vocabulary regarding such a conceptualization O (ontological structure) is specified by the corresponding lexicon (language) L which is defined as follows:

Definition A2.2.2. *Let L be the lexicon for ontological structure O:*

$$L = \{L^C, L^R, F, G\}, \tag{A2.2}$$

where

- *L^C is a set of elements called the lexical entries of concepts;*
- *L^R is a set of elements called the lexical entries of relationships;*
- *$F \subseteq L^C \times C$ is a set of references to concepts, each linking a concept with a lexical entry: and*
- *$G \subseteq L^R \times R$ is a set of references to relationships, each linking a relationship with a lexical entry.*

From the previous definitions (Definition A2.2.1 and Definition A2.2.2), an ontology can be formally defined, in short, as a structure of the form $\langle O,\ L \rangle$, where O is an ontological structure and L is the corresponding lexicon.
Because the purpose of authoring an ontology is to enable the reuse of knowledge regarding a specific domain, it should be applicable across different applications (Neches et al., 1991). Figure A2.8 shows the classification of ontologies according to their application scopes as proposed by Guarino et al. (1998).

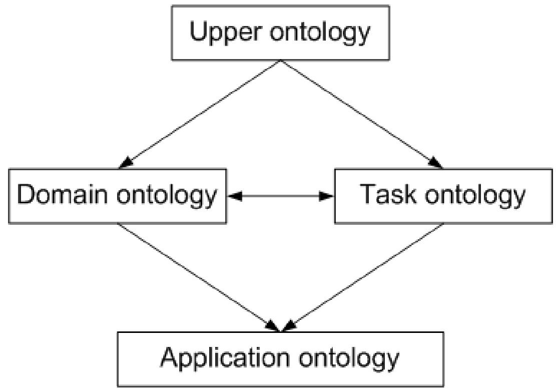

Figure A2.8: *Types of ontologies, based on Guarino* et al. (1998)

- *Top-level ontologies* (also upper or generic ontologies) describe general knowledge or general concepts, independent of any specific domain.
- *Domain ontologies* describe knowledge from a specific domain, such as the biomedical or pharmaceutical domain.
- *Task ontologies* are used to describe domain-independent knowledge related to a specific task.
- *Application ontologies* are developed to describe a specific application for a specific domain and task.

The ontology introduced in this work is a domain ontology for the domain of ITBM. It describes concepts regarding general tasks within a benchmark, specific service-dependent information and structural information regarding specific service catalogs.

Ontology Engineering

The term Ontology Engineering (OE) encompasses methods and tools for the development and maintenance of ontologies (Sure/Staab/Studer, 2009). Table A2.3 provides an overview of the most relevant Ontology Engineering Methodologies (OEMs) based on Iqbal et al. (2013). Following this reference, these methodologies are differentiated on the basis of (i) whether the OEM offers a clear life cycle model, (ii) whether the proposed activities provide detailed guidelines and (iii) whether the OEM is sufficiently general to be used in arbitrary domains. A cell marked with *"X"* indicates the availability of the corresponding property. In addition to the methodologies reviewed in Iqbal et al. (2013), this list has been extended with more recent methodologies, such as DILIGENT (Pinto/Tempich/Staab, 2009) and NeOn (Suárez-Figueroa, 2010).

Because all activities within the NeOn OE process are highly dependable from the perspective of the resulting ontology and the underlying OEM, a short overview of the main activities within the NeOn framework is given. Note that NeOn core scenarios were used for the construction of the ITBM ontology. As introduced by Suárez-Figueroa (2010), the NeOn framework for ontology engineering comprises 59 elementary activities and comprehensive guidelines (see Figure A2.9). These activities are grouped into nine scenarios described below.

Table A2.3: *Chronological overview and evaluation of ontology engineering methodologies, based on Iqbal* et al. (2013)

Official Release	Ontology Engineering Methodology	Life Cycle	Details	Generality
1990	Cyc Methodology (Lenat/Guha, 1990)		X	X
1994	IDEF5 (Benjamin et al., 1994)		X	X
1994	Plinius (van der Vet/Speel/Mars, 1994)		X	X
1995	TOVE (Grüninger/Fox, 1995)		X	X
1995	Enterprise Model Approach (Uschold/King, 1995)		X	X
1996	SENSUS (Swartout et al., 1996)		X	X
1997	METHONTOLOGY (Fernandez-Lopez/Gomez-Perez/Juristo, 1997)	X	X	X
2001	Ontology 101 (Noy/McGuinness, 2001)		X	X
2003	On-To-Knowledge (Sure/Staab/Studer, 2004)	X	X	X
2004	DILIGENT (Pinto/Tempich/Staab, 2009)	X	X	X
2005	UPON (Nicola/Missikoff/Navigli, 2005)	X	X	X
2010	NeOn Methodology (Suárez-Figueroa, 2010)	X	X	X

Scenario 1 - From specification to implementation: An ontology is developed without the reuse of already existing resources. Here, the ontology developers specify requirements (based on comprehensive guidelines) first, before potential resources for reuse are identified. Ontology engineering activities are scheduled afterward.

Scenario 2 - Reusing and re-engineering Non-Ontological Resources (NORs): NORs to be used for ontology engineering are identified in accordance with previously specified requirements. Through support from further guidelines, these NORs are re-engineered into an ontology.

Scenario 3 - Reusing ontological resources: An ontology network is built by developers based on ontological resources (complete ontologies, ontology modules, and/or ontology statements).

Scenario 4 - Reusing and re-engineering ontological resources: This scenario covers reuse and re-engineering activities of ontological resources.

Scenario 5 - Reusing and merging ontological resources: This scenario covers the development of a new ontological resource through the combination and reuse of ontological resources in the same domain.

Scenario 6 - Reusing, merging and re-engineering ontological resources: The core activities in this scenario are similar to those in scenario 5 but with a focus on the re-engineering of the set of merged resources.

Scenario 7 - Reusing Ontology Design Patterns (ODPs): The use of ODPs is covered by this scenario.

Scenario 8 - Restructuring ontological resources: This scenario covers all activities related to the restructuring of ontological resources to integrate them into an ontology network.

Scenario 9 - Localizing ontological resources: This scenario covers activities performed to adapt an ontology to other languages and culture communities to provide a multilingual ontology.

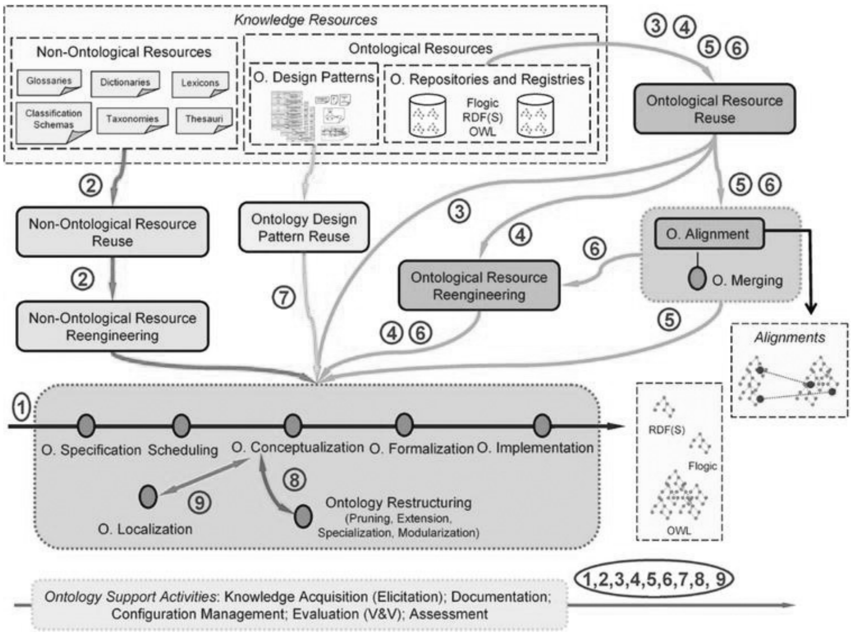

Figure A2.9: *NeOn scenarios for building ontologies and ontology networks, based on Suárez-Figueroa* (2010)

In addition to the previously described scenarios, the NeOn core scenario (see Figure A2.9 (1)) includes the following activities: (i) *specification*, referring to collecting requirements; (ii) *scheduling*, referring to deciding which scenario/activities are to be performed and when; (iii) *conceptualization*, referring to building a conceptual model of the domain; (iv) *formalization*, referring to formalizing the model using a description-logic-level representation; and (v) *implementation*, referring to converting the formal model into a computable ontology language. Moreover, this core scenario comprises a set of ontology support activities, namely, (i) *knowledge acquisition*, referring to the collection of knowledge for a specific domain; (ii) *documentation*, referring to documentation activities related to any design decision; (iii) *configuration management*, referring to activities for the handling of ontology versions and the control of activities of the process itself; (iv) *evaluation*, referring to the validation and verification of the implemented ontology; and (v) *assessment*, referring the evaluation of the ontology with respect to the qualitative expectations of users. These scenarios are mapped to the phases of an underlying life cycle model for ontology engineering within NeOn. Two life cycle models are supported: a waterfall model with a variable number of phases (depending on the scenario to be conducted) and an iterative-incremental model. The iterative-incremental model combines sequences of waterfall models based on different scenarios. Each activity is described using a certain glossary of term with the aim of providing commonly accepted definitions for certain activities. Most activities come with a set of comprehensive descriptions comprising functional descriptions (e.g., definitions, goals, input/output) provided within the scope of a filling card as well as procedural descriptions offering step-by-step guidelines.

In addition to the previously mentioned types of ontologies, several types of ontology development strategies exist in the academic literature. Wache et al. (2001) distinguishes between three main types of ontologies (see Figure A2.10). A *single ontology* uses a shared vocabulary to provide semantic descriptions of data (cf. Figure A2.10(a)). The main advantage of this approach is its rapid development process. The need to manage a single

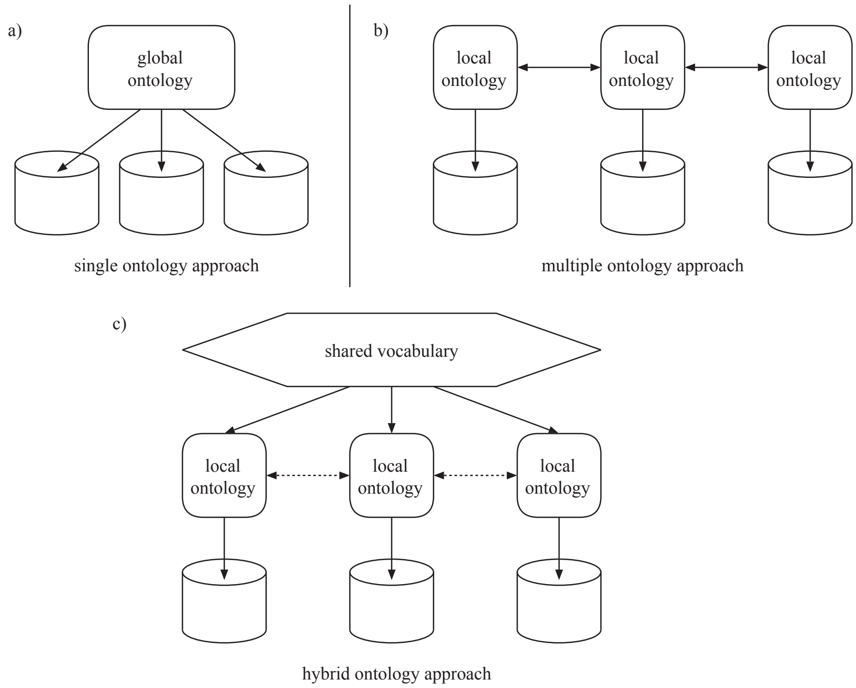

Figure A2.10: *Development strategies for ontologies, based on Wache* et al. (2001)

large, complex ontology is one of the main disadvantages, as every change can generate potentially ontology-wide inconsistencies. *Multiple ontologies* are based on several ontologies that are built independently for every source of information (cf. Figure A2.10(b)). The complexity of each single ontology depends only on its corresponding data source and therefore, such ontologies are, in general, less complex. One major disadvantage of this approach is the lack of a shared vocabulary for comparisons among these ontologies. To achieve such comparisons, *hybrid ontologies* are used (cf. Figure A2.10(c)). An ontology of this kind uses a shared vocabulary with basic terms based on the domain-related information captured within its local ontologies.

As previously stated, to allow ontologies to be machine-processable, they are often modeled in OWL. As an extension of RDF and RDFS, OWL ensures smooth technical exchanges of information among applications within the context of the SW as well as business modeling frameworks (e.g., Business Process Model and Notation (BPMN)) that also use XML as their interchange syntax. An OWL ontology comprises (i) classes, as sets of individuals; (ii) individuals, as instances of classes (i.e., real-world objects in the domain); and (iii) properties, as binary relations between individuals. In addition to the implementation of domain knowledge, it is possible to define cardinality ranges and reasoning rules within an ontology. Several reasoning engines (e.g., Pellet Pellet (2015)) exist that can be used to infer additional knowledge explicitly included in an OWL ontology (e.g., class equivalence checks). An OWL ontology can be modeled using open-source ontology editors such as Protégé (Protégé, 2014), which is one of the most common tools for ontology development (Khondoker/Mueller, 2010) and was also used for the development of the ITBM ontology.

Chapter A3

Research Methodology

A3.1 Research Design

This dissertation follows the Design Science Research (DSR) paradigm, as conceptualized by Simon (1996). According to March/Smith (1995) the goal of DSR is the creation of new *"things that serve human purposes"*. As outlined by March/ Smith (1995), the DSR framework distinguishes between research activities and research outputs. Research outputs encompass constructs, models, methods, and instantiations, whereas research activities comprise building, evaluating, theorizing on, and justifying artifacts. In the context of this dissertation, DSR is understood as follows:

> *"The objective of design science research is to develop technology-based solutions to important and relevant business problems"* (Hevner et al., 2004).

Because the DSR framework of Hevner et al. (2004) does not provide an explicit process description, this works adopts the Design Science Research Methodology (DSRM) for Information Systems Research introduced by Peffers et al. (2007), in which the required activities are categorized into the following six steps:

1. **Problem identification and motivation:** In this activity the specific research problem is defined and the benefits of a solution are presented. Moreover, the state of the art in research and available solutions must be evaluated.

2. **Definition of the objectives for a solution:** The objectives for a solution are inferred from the problem definition and from knowledge of what is possible and feasible. The objectives should be inferred rationally from the problem specifications.

3. **Design and development:** In this activity, artifact(s) are created, and their planned functionalities are determined.

4. **Demonstration:** The use of the created artifacts to solve one or more of the described problems is demonstrated. For this purpose, experiments, simulations, case studies, proofs, or any other appropriate activity can be used.

5. **Evaluation:** This activity involves observing and measuring how well each artifact supports a solution to the problem of interest. Depending on the nature of the problem this evaluation can be done performed in various ways, from quantitative performance measures to conceptual comparisons. The purpose of this activity is to evaluate the quality of the solution in order to decide whether to return to step three to attempt to improve the effectiveness of the artifact or to continue on to the communication step.

6. **Communication:** In the case of a sound solution, this activity involves presenting the problem and its importance, as well as the artifact and its utility, the rigor of its design, and its effectiveness to researchers and other relevant audiences, such as practicing professionals.

With regard to the DSRM activities described above, Section A1.1 motivates the research problem of this dissertation, in accordance with the first step in the DSRM. The objectives of this dissertation and the guiding research questions are described in Section A1.2, in accordance with the second step of the DSRM. The design and development step, demonstration and evaluation of the solution are addressed in the publications section (Part B of this dissertation), which also represents the communication step of the DSRM.

The development of the benchmarking ontology and the benchmarking system as well as the arguments for the utility, quality, and efficacy of the chosen approach are based on the research methods summarized in Table A3.1, which will be described in greater detail in the following section.

Table A3.1: *Research questions and the methods to answer them*

Research Question	*Research Method*	*Outcome*
RQ1	• *Literature review*	Conceptual foundations Research gap and contributions Criteria for a solution
RQ2	• Empirical analysis / document analysis • *Ontology engineering* • Conceptual modeling	Benchmarking ontology
RQ3	• Theory-driven design • *Prototyping / system development* • *Scenarios* • *Architectural analysis* • *Informed argument*	System design Implementation Evaluation

A3.2 Research Methods

Because a brief discussion of methods is an important aspect of scientific research (Popper, 2002), and because research on information systems is inherently multidisciplinary and, in general, based on various research methods (Palvia et al., 2004; Becker/Niehaves, 2007), this section outlines the relevant aspects of the methods on which this dissertation is based. Mainly, these methods follow Hevner et al. (2004) for DSR, supplemented by methods for OE following Sure/Staab/Studer (2009).

Literature Review In accordance with the DSRM based on Peffers et al. (2007), as the first step, an overview of the existing scholarship and literature relevant to this research needs to be compiled. The RQs can be evaluated against this body of knowledge to prove the existence of a gap in the research to be addressed by research proposal. In the context of this work, the literature has been continuously reviewed to ensure that the introduced ontological concepts and the proposed system architecture for data integration are novel and add to the body of knowledge in the domains of ITBM and OE.

During work on each publication produced in the context of this dissertation, a literature review was conducted, focusing on related work and already available tools relevant to the research objective. Based on suitable keywords, scholarly databases were *searched forward and backward*, as proposed by Webster/Watson (2002).

Starting with the identification of suitable keywords with which to query scholarly databases the process of working *backward* through the initially identified literature can be further subdivided into a *backward reference search*, a *backward author search* and a search for *previously used keywords* (Levy/Ellis, 2006). The *backward reference search* refers to reviewing the references of the articles obtained in the keyword search mentioned above, whereas the *backward author search* refers to reviewing what the authors of each article under investigation have published prior to that article. The search for *"previously used keywords"* refers to reviewing the keywords specified in the articles obtained in the previous keyword search; thus, the backward search is an iterative process.

The *forward search* can be subdivided into a *forward reference search* and a *forward author search* (Levy/Ellis, 2006). The *forward reference search* refers to reviewing additional articles that have cited a specific article previously identified as relevant within the research context. The *forward author search* refers to reviewing what the authors of a specific article have published following that article. The relevance of each publication is identified on the basis of its title, keywords, and abstract. The keywords used here for the identification of relevant literature in the domains of ITBM, BPM, PMS, OE, OEM, and OWL are *benchmark**, *IT service**, *performance management*, *performance measurement*, *semantic data integration*, *domain ontology*, *ontology engineering*, *ontology mapping*, *data modeling*, *data integration*, *information retrieval*, *knowledge representation*, *OWL* and various combinations and modifications thereof.

The most important scholarly databases considered in this dissertation are listed below:

1. Association for Computing Machinery (ACM)[2]
2. Association for Information Systems Electronic Library (AISeL)[3]
3. EBSCOHost[4]
4. IEEE[5]
5. Springer[6]

The most important conference and journals considered in this work are listed below:

1. Benchmarking: An International Journal
2. Communications of the Association for Information Systems
3. Enterprise Information Systems
4. Journal of the ACM
5. Journal of Web Semantics
6. International Conference on Enterprise Information Systems (ICEIS)
7. International Conference on Information Systems (ICIS)
8. International Journal of Accounting Information Systems
9. Knowledge-Based Systems
10. The Semantic Web journal

For the identification of relevant ontologies in the context of ITBM and related fields of research, the following databases and ontology search engines have been used in this work:

1. Watson[7]
2. Swoogle[8]
3. Linked Open Vocabularies (LOV)[9]
4. FalconS[10]
5. vocab.cc[11]

[2] http://dl.acm.org/
[3] http://aisel.aisnet.org
[4] http://search.ebscohost.com
[5] http://ieeexplore.ieee.org/Xplore/home.jsp
[6] http://www.springer.com/de/
[7] http://watson.kmi.open.ac.uk/
[8] http://swoogle.umbc.edu/
[9] http://lov.okfn.org/
[10] http://ws.nju.edu.cn/falcons/
[11] http://vocab.cc/

6. SemanticOverflow[12]

Ontology engineering Within the scope of OE, principles, methods and tools for assisting in the process of developing and maintaining ontologies are investigated (Sure/Staab/Studer, 2009). On this basis, OEMs have been introduced to implement the guidelines developed through OE approaches. The use of an OEM is especially suitable in larger, more complex ontology projects (Simperl et al., 2009). Because ontology engineering is a core method used in the work presented in this dissertation, various activities within the engineering process are described in the different publications presented in Section A3.3. Based on the NeOn framework for ontology engineering, these activities include, among others, *knowledge acquisition*, *ontology requirement specification*, *ontology conceptualization*, *ontology reuse and alignment*, *ontology implementation*, *ontology annotation*, and *ontology evaluation*.

Prototyping / system development Because a prototype implementation provides proof by construction (Nunamaker/Chen/Purdin, 1990; Hevner et al., 2004), a prototype for data access and data linkage has been developed, using the benchmarking ontology as a single point of semantic data access. The developed prototype is flexible in its use, permitting the integration of different ontologies or ontology versions to expand its applicability over the various scenarios considered in this dissertation. Moreover, it demonstrates that an ontology-based benchmarking system can be constructed and used to link already existing databases. Furthermore, it shows how mapping between the data fields in different databases and the benchmarking ontology can be supported.

Scenarios According to Hevner et al. (2004), scenarios are used to demonstrate the applicability of the developed artifacts in information systems. To this end, the benchmarking ontology has been applied to a concrete scenario for data access derived from typical research and project activities in ITBM. Based on this real-world scenario and real-world data, the necessity of a structured benchmarking process utilizing a benchmarking ontology is demonstrated.

Architectural analysis An architectural analysis is used to study the compatibility of the developed artifact with the technical architecture. By referring to the OEM throughout the ontology design section and by referring to a service-oriented architecture for a web-based system, arguments are developed to support the claim that the technical representation of the benchmarking ontology is compatible with the technical architecture and overall system design.

Informed argument An informed argument provides a line of reasoning arguing that a created artifact is able to solve the problem in question and fulfills the defined requirements on the basis of an ex ante evaluation (Johannesson/Perjons, 2014, 147). To this end, publications **P1**, **P4** and **P5** present arguments as to why the approach is promising and useful on the basis of the derived requirements for the ITBM ontology and the system architecture.

[12] `http://answers.semanticweb.com/`

A3.3 Included Publications

As stated in the introduction, Part B of this dissertation is composed of five publications that have been (co-)authored by the author of this work. An overview of all publications of relevance within this context is given in Table A3.2. This table includes the publication number, the authors, the title and the outlet of each publication.

In the following, a brief summery of each publication and its correspondence to the RQs outlined in Section A1.2 is given.

Publication **P1** motivates and discusses research activities in the domains of ITBM and ontology engineering. It also describes the problem that previous work on ITBM has neglected aspects of data quality, in terms of lacking solutions for semantic data integration. Thus, it provides an answer to the first RQ, namely, *"What are the current challenges regarding data integration in the domain of ITBM?"*, and motivates why an ontology is required for the ITBM domain.

Publication **P2** highlights the need for further research on service description languages and ontologies in domains closely related to ITBM. The outlined findings provide a conceptualizing overview of the (cloud) service properties that need to be covered by such domain ontologies.

Through the use of NLP techniques, an automated approach for the extraction of terms from ITBM data is presented in publication **P3**. The results of this work are used to identify the requirements posed by semi-structured and unstructured benchmarking data for the development of a domain ontology in this context. Thus, it presents an answer to the question of how domain-specific terms can be automatically identified from domain-specific documents. Because these terms are representative of each document, describing the purpose and content of each file, they serve as the basis for the subsequent ontology development process.

By integrating methods and results from publication **P3**, publication **P4** presents the design of the ITBM ontology and describes the development of all of its main components. Moreover, a description of its alignment with the DUL foundational ontology for ontology reuse and activities for the evaluation of the presented ontology are presented. Thus, these two publications together provide an answer to RQ2: *"How can ITBM data be described and represented to build a foundation for subsequent, possibly computer-based, concepts and tools?"*

Publication **P5** addresses the third RQ: *"How can a system be designed to integrate existing distributed data sources in ITBM using a domain-specific ontology?"* It integrates methods and results from previous publications (**P3** and **P4**) and presents a system architecture prototype implementation for the integrated data management of distributed databases based on a domain-specific ontology. To preserve the semantic meaning of the data, this domain ontology is linked to the data sources and functions as the central framework for database access. In addition, the web-based system supports the process of mapping ontology concepts to external databases by providing semi-automatic mapping recommender and by visualizing possible mapping candidates. The system also provides a natural language interface that can be used to easily query linked databases in order to address the previously identified usage scenario for data access.

Table A3.2: *Publications included in this dissertation*

No.	Authors	Title	Outlet	Type	Rank/Impact
P1	**Pfaff**, Krcmar	Semantic Integration of Semi-Structured Distributed Data in the Domain of IT Benchmarking - Towards a Domain Specific Ontology DOI: 10.5220/0004969303200324	ICEIS 2014, Lisbon, Portugal ISBN: 978-989-758-027-7	C	h5 Index[13]: 13
P2	Wollersheim, **Pfaff**, Krcmar	Information Need in Cloud Service Procurement - An Exploratory Case Study DOI: 10.1007/978-3-319-10491-1_3	EC-Web 2014, Munich, Germany ISSN: 1865-1356	C	Rank[14]: B
P3	**Pfaff**, Krcmar	Natural Language Processing Techniques for Document Classification in IT Benchmarking - Automated Identification of Domain Specific Terms DOI: 10.5220/0005462303600366	ICEIS 2015, Barcelona, Spain ISBN: 978-989-758-096-3	C	h5 Index[13]: 13
P4	**Pfaff**, Neubig, Krcmar	Ontology for Semantic Data Integration in the Domain of IT Benchmarking DOI: 10.1007/s13740-017-0084-9	JoDS ISSN: 1861-2040	J	h5 Index[15]: 17 H Index[16]: 7
P5	**Pfaff**, Krcmar	A Web-Based System Architecture for Ontology-Based Data Integration in the Domain of IT Benchmarking DOI: 10.1080/17517575.2017.1329552	EIS ISSN: 1751-7583	J	Impact Factor[17]: 2.269 H Index[18]: 34

Notes. P: Paper; ICEIS: International Conference on Enterprise Information Systems; EC-Web: International Conference on Electronic Commerce and Web Technologies; JoDS: Journal on Data Semantics; EIS: Enterprise Information Systems: C: Conference; J: Journal

[13]Google's h5 Index 2015, `http://scholar.google.de`
[14]CORE Rank 2017, `http://portal.core.edu.au/conf-ranks/1007/`
[15]Google's h5 Index 2015, `http://www.springer.com/journal/13740/about`
[16]SCImago, `http://www.scimagojr.com/journalsearch.php?q=21100466219&tip=sid&clean=0`
[17]Thomson Reuters Journal Citation Reports 2016, `https://jcr.incites.thomsonreuters.com`
[18]SCImago, `http://www.scimagojr.com/journalsearch.php?q=10900153330&tip=sid&clean=0`

Part B

Publications*

*In this part, the original publications are slightly modified, including the unification of format and reference styles, the correction of spelling errors, and minor orthographic and grammatical revisions. Furthermore, the references included in each research study have been integrated and are presented at the end of this dissertation. The published version of the included publications can be found in the appendix.

Chapter B1

Semantic Integration of Semi-Structured Distributed Data in the Domain of IT Benchmarking - Towards a Domain-Specific Ontology

Authors	Pfaff, Matthias[1] (pfaff@fortiss.org) Krcmar, Helmut[2] (krcmar@in.tum.de) [1]fortiss GmbH, Guerickestraße 25, 80805 München, Germany [2]Technical University of Munich (TUM), Boltzmannstraße 3, 85748 Garching, Germany
Outlet	International Conference on Enterprise Information Systems (ICEIS) 2014, Lisbon, Portugal
Type	Conference and Proceedings
Publisher	Scitepress, Portugal
Ranking	Google's h5 Index[19] 2015: 13
Status	Published
How to Cite	Pfaff M. and Krcmar H. (2014). Semantic Integration of Semi-Structured Distributed Data in the Domain of IT Benchmarking - Towards a Domain Specific Ontology. In *Proceedings of the 16th International Conference on Enterprise Information Systems*, ISBN 978-989-758-027-7, pages 320-324. DOI: 10.5220/0004969303200324
Keywords	IT Benchmarking, Distributed Data Sources, Heterogeneous Data, Semantic Data Integration, Ontologies.
Individual Contribution	Content and scope definition, construction of conceptual framework, manuscript writing, and manuscript editing

Table B1.1: *Bibliographic details for P1*

[19]http://scholar.google.de

Semantic Integration of Semi-Structured Distributed Data in the Domain of IT Benchmarking - Towards a Domain-Specific Ontology

Abstract In the domain of ITBM a variety of data and information are collected. The collection of this heterogeneous data is usually done in the course of specific benchmarks (e.g., focusing on IT Service Management (ITSM) topics). This collected knowledge needs to be formalized previous to any data integration, in order to ensure interoperability of different and/or distributed data sources. Even though these data are the basis to identify potentials for IT cost reductions or IT service improvements, a concept for semantic data integration is missing. Building on previous research in ITBM we emphasise the importance of further research in data integration methods. Before we describe why the next step of research needs to focus on the semantic integration of data that typically resides in ITBM, the evolution of ITBM is outlined first. In particular, we motivate why an ontology is required for the domain of ITBM.

B1.1 Introduction

Benchmarking as a systematic process for improving organizational performance has gained great popularity worldwide since the 1980s. It is based on the insight that observing organizations and analyzing their acting and (measure) their performance is a powerful way to transform the own organization. This transformation is usually done by applying lessons learned from a benchmark (Camp, 1989; Peters, 1994). Moreover, benchmarking can help explaining value or cost aspects to stakeholders within the company while comparing for example their (IT) unit or only certain services of the IT with competitors (Spendolini, 1992).

Recent research in the IS (e.g., Slevin/Stieman/Boone (1991); Smith/McKeen (1996); Myers/Kappelman/Prybutok (1997); Gacenga et al. (2011)) focuses on the analysis and evaluation of performance measurement. Performance measurement in the IT context requires several prerequisites. Having a well-structured service oriented IT department and a consistent knowledge of IT services and their corresponding costs are, for example, important.

Additionally these are basic requirements for circular comparisons and subsequently for improvements based on data analysis. Companies that are interested in benchmarking need to have valid definitions of the value and the costs for the objects selected to benchmark. Rudolph/Krcmar (2009) argues, that throughout increasing IT industrialization the standardization, documentation and definition of IT services are gaining more importance. They state, that IT service catalogues are an appropriate instrument to picture such a service structure. In addition, concepts for the identification of critical success factors for measuring the maturity level of service catalogues are developed by Kütz (2006) and Rudolph/Krcmar (2009). In detail, each IT service (object of IT benchmark) should encompass certain parts of deliverables and infrastructure components (Krcmar, 2010). Many of these studies omit facts such as data quality and data integration. Yet, in spite of this new interest, little work published in IS literature addresses the problem of data integration across different kind of IT benchmarks.

One difficulty in making data of different types of benchmarks comparable with each other is a result from the lack of an uniform description of any parameter that is measured. Moreover, a description of the relation in between two of such parameters is missing. This is not a particular issue in the domain of ITBM. Other fields of research are facing similar challenges in data integration, provided with some promising and practical approaches to solve them (Leser/Naumann, 2007). Thus, research on data integration methods for the specific field of ITBM and its vocabulary should be intensified. Especially given the rising research in big data analysis, results from ITBM should not be discarded because of an inadequate data management. A promising approach for data management lies in the use of a domain specific ontology, in order to make these kind of data meaningful (Uschold/Gruninger, 2004; Horkoff et al., 2012).

The next section gives an overview of benchmarking in general and data integration challenges in the domain of IT benchmarking in specific. Following Section B1.2 further research areas in semantic integration of IT benchmarking data are presented and discussed in Section B1.3. Furthermore, a first iterative approach for integrating data from different ITBM initiatives is introduced in Section B1.3.

B1.2 Background

Most of the current research in ITBM and the practical literature on this topic is only related to the implementation of IT benchmarks (e.g., Dattakumar/Jagadeesh (2003); Jakob/Pfaff/Reidt (2013)). All of these approaches have one thing in common: Neglecting the need for a sustainable semantic data integration and a unified structure for data management is left out of scope. Thereby most IT benchmarking initiatives are damned to exist side on side in siloed data storages. Consequently, they are incapable to be used a second time or in a different benchmarking context, except they have been collected for.

B1.2.1 Benchmarking

In academic research benchmarking can be classified according to the nature of the object of study and according to the benchmarking type (e.g., process benchmarking, product benchmarking, and strategic benchmarking or generic benchmarking) (Carpinetti/Oiko, 2008). Benchmarking partners may include other units of the same organization, competitors in the same or different geographical markets and organizations in related or unrelated industries, in the same or different countries. So, a differentiation is made between internal and external comparisons of such a performance measurement.

Internal performance measurement focuses on the operations of a single company whereas external looks outside the firm's industry. Nevertheless, both of them have a common foundation. An overview on the different types of benchmarks is given in Table B1.2.

Table B1.2: *Types of benchmarks, based on Carpinetti/Oiko* (2008).

Type	Description
Process Benchmark	Compares operations, work practices or business processes
Product Benchmark	Compares products or services
Strategic Benchmark	Compares organizational structures, management practices and business strategies.
Internal Benchmark	Compares similar products or services of similar business units within a single organization
Competitive Benchmark	Compares performance with a direct competitor. The object of investigation may include products, services, technology, research and development, personnel policies, etc.
Functional Benchmark	Compares one or more non-competitive organizations in terms of particular business functions or processes
Generic Benchmark	Compares an organization or business unit with the best-performing organization, irrespective of the type of industry

An IT benchmark can be considered as passing through several phases. Starting with the initial conception by describing the object to investigate, up to optimizing and reorganizing internal (business) processes (cf. Figure B1.1). For each of these phases of a benchmark numerous data get collected in various data formats. The substance of these data are qualitative, as well as quantitative statements collected over the complete benchmarking cycle in every single benchmark. Furthermore these data get collected for every single participating company of a benchmark.

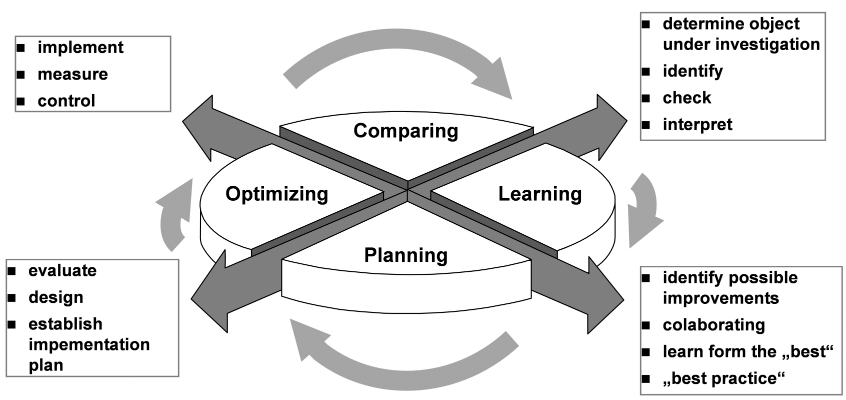

Figure B1.1: *Phases of a benchmark, based on Watson* (1993)

B1.2.2 Data Integration

As has already been presented by Ziaie et al. (2013) and structural described by Riempp/ Müller/Ahlemann (2008) tool based data collecting is quiet common in the domain for ITBM. Even if different benchmark types measure the same object from different perspectives a direct link in between these collected data is difficult to establish.

Next to various formats the data are stored no semantic information are machine readable persisted. But, in order to make the captured data comparable between different benchmarking approaches a semantic integration in a machine readable data format is crucial. Since concepts of such data integration methods are missing, most of the gathered data during a benchmark will stay only applicable for this specific one time performance measurement in its specific domain focus (e.g., cluster benchmarking by Carpinetti/Oiko (2008)). In other words, comparability of benchmarking data beyond the specific context of one specific benchmark is left out of research focus and actually impossible because of data separation.

Figure B1.2 shows the different scopes of data storing in benchmarking. Companies can participate on a specific benchmark (*Benchmark 1..n*) in a specific year. In other words, data storing is done yearly per participant. In addition, a benchmark itself can consist of several services (*Service A..n*) or specific strategic questions. Even if such benchmarks do have the same object of observation (f.i. same service or same product), no direct semantic information of these data are stored. Therefore, this kind of siloed storing information do inhibit further comprehensive analysis.

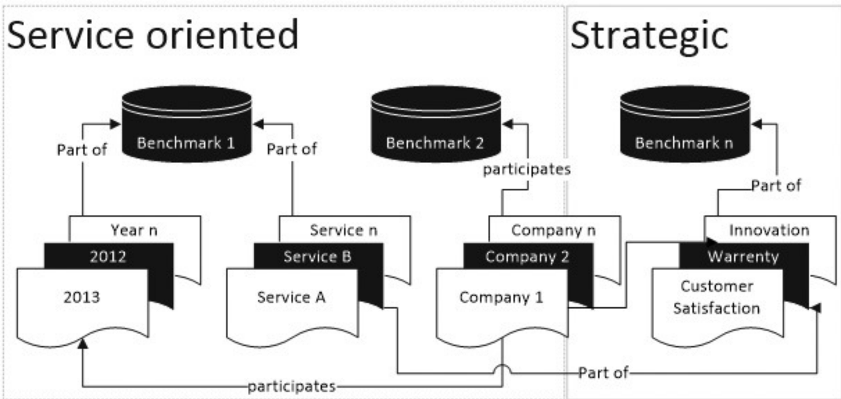

Figure B1.2: *Data dispersion in benchmarking*

In the context of data integration particular requirements are demanded from the use of distributed context sensitive (i.e., heterogeneous) data. Since these are usually not solely for one field of research (e.g., ITBM), approaches and methods to organize information are already applied in related fields of research. Ontologies which, by definition convey electronic or ßemantic meaningäre already used to structure unstructured data (e.g., Cambria/Hussain/Eckl (2011)) in the medical or in the information management sector (Riedl et al., 2009; Müller, 2010; Cambria/Hussain/Eckl, 2011). Thus, representing semantic knowledge with formal ontologies, as proposed by Guarino (1995) and Brewster/ O'Hara (2007), seem to provide promising approaches for data integration techniques in the domain of ITBM.

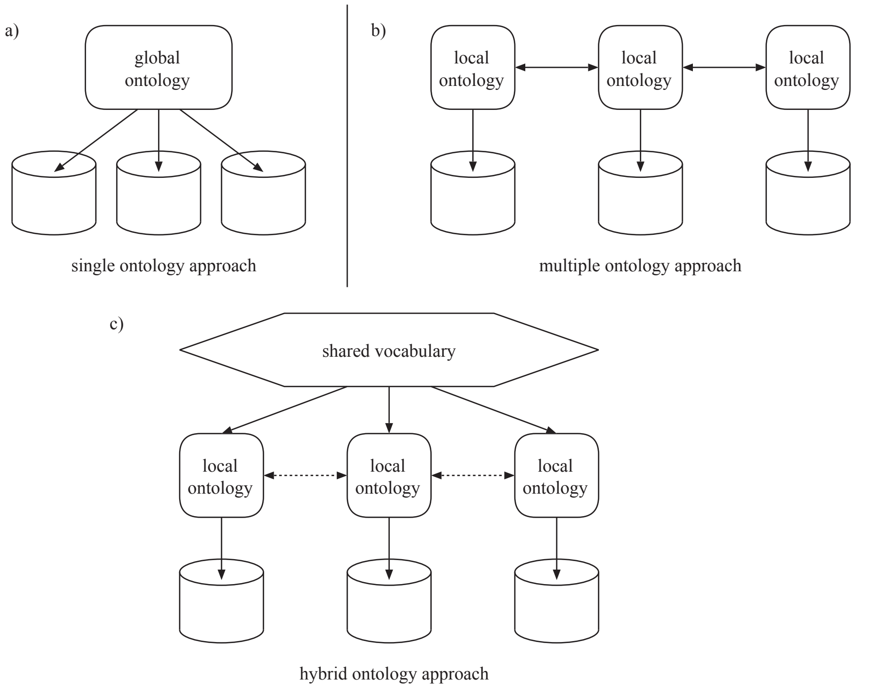

Figure B1.3: *Types of ontologies, based on Wache* et al. (2001)

There exist several types of ontology development strategies in the academic literature. Wache et al. (2001) distinguishes between three main types of ontologies (cf. Figure B1.3). A *single ontology* (Figure B1.3(a)) uses a shared vocabulary for describing the semantic information of data . The main advantages of this approach is its quick development process. Managing a single complex and large ontology is one of the main disadvantages, while every change is generating potentially sweeping ontology-wide inconsistencies. *Multiple ontologies* (Figure B1.3(b)) are based on several independently build ontologies for every source of information. The complexity of a single ontology is only dependant from its corresponding data source and therefore in general less complex. One major disadvantage is the lack of a shared vocabulary when comparing these ontologies. In order to achieve such comparisons *hybrid ontologies* (Figure B1.3(c)) are used. This kind of ontologies use a shared vocabulary with basic terms of the domain related information of its local ontologies.

On the basis of the existing data of ITBM collected within the last four years, it has to be checked first which type of ontology being the most likely to leverage data integration. Particularly bearing in mind that most of the collected data during an IT benchmark were only meant to be used in their single case of measurement. Thus, existing data form questionnaires presented by Ebner et al. (2012) and Ziaie et al. (2013) are used to identify possible starting points for a benchmarking ontology.

B1.3 Conclusion

Identifying potential performance improvements within organisations by the use of IT benchmarks suffers from the quality of the collected data. This quality of data is strongly dependent on a precise specification of every single key performance indicator. There is not only a demand of a precise description of these indicators on the questionnaires side, the underlying contextual connection should be taken into account for data management. This is especially important when trying to analyse benchmarking data beyond the specific scope they were collected for. In order to achieve a comparison across different kinds of benchmarks a consistent semantic description of the collected data is essential. Consequently, future research on semantic data integration should be conducted for the domain ofITBM.

For the development of a suitable solution for the data integration in ITBM, already available data and service descriptions of different IT benchmarks serve as sources. These data were collected from 25 large and medium size companies during strategic and service oriented IT benchmarks over the last years. Previously implemented online ITBM systems (cf. Ziaie et al., 2013) and frameworks to structure and asses strategic IT/IS management (cf. Riempp/Müller/Ahlemann, 2008) are used for the data acquisition. Building up on these data the specific requirements that need to be met by a concept for data integration are identified. Using a common vocabulary, such as based on ITIL (2013) might ensure broad acceptance of different domains of benchmarking or ITSM. Derived from this, a domain specific ontology for ITBM will be developed iteratively according to Noy/ McGuinness (2001).

In a next step, a concept of a system to re-integrate and organize benchmarking data needs to be developed and prototypical implemented. To this end, the previously used data and service descriptions of a strategic and service oriented benchmark can be restructured according to the previous elaborated ontology. This in turn allows a direct inclusion of the ontology and the restructured data into the existing capturing mechanisms for the data collection process during an IT benchmark. Therewith, not only an ontology for IT benchmarking is elaborated but also the seamlessly fit into the existing benchmarking tools is pointed out, with all its added value in terms of comparability of data collected. Moreover, already existing benchmarking data become significantly enhanced by establishing a link across boards of different benchmarking initiatives.

At least the collected data become comparable and integrable across different benchmarking domains. This enables the development of new assistance system and further statistical analysis on such structured IT benchmarking data. In addition, already existing data sets can be integrated into a uniform data representation structure and thus be used for further statistical analysis which is actually not possible.

Chapter B2

Information Need in Cloud Service Procurement – An Exploratory Case Study

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Outlet	International Conference on Electronic Commerce and Web Technologies (EC-Web) 2014, Munich, Germany
Type	Conference and Proceedings
Publisher	Springer, Cham
Ranking	CORE[20] Rank 2017: B
Status	Published
How to Cite	Wollersheim J., Pfaff M., Krcmar H. (2014) Information Need in Cloud Service Procurement – An Exploratory Case Study. In: Hepp M., Hoffner Y. (eds) E-Commerce and Web Technologies. EC-Web 2014. Lecture Notes in Business Information Processing, vol 188. Springer, Cham, ISBN 978-3-319-10491-1, pages 26-33. DOI: 10.1007/978-3-319-10491-1_3
Keywords	Cloud Service, Service Description, Case Study
Individual Contribution	Problem and scope definition, construction of the conceptual approach, interpretation of results, manuscript writing, and manuscript editing

Table B2.1: *Bibliographic details for P2*

[20]http://portal.core.edu.au/conf-ranks/1007/

Information Need in Cloud Service Procurement – An Exploratory Case Study

Abstract Cloud computing enables the on-demand self-service procurement of standardized IT services over the internet. However, to efficiently use electronic markets and platforms for exchanging cloud services, a common understanding of the service to be exchanged is required between the organizations providing and the organizations in need of the service. Currently, only a few rather specific criteria catalogues are available to address this need, only focusing on certain types or specific aspects of cloud services. It remains unclear upon which general characteristics organizations require information when procuring cloud services. To identify this broad set of information, we conducted 16 interviews with small-to-large organizations. Combining the responses with literature-based findings, we identified a set of 39 items that form the essential set of characteristics required by an organization when procuring cloud services. This set provides a starting point for the development of a domain-specific vocabulary, service descriptions, and supports the decision-making process of procuring organizations.

B2.1 Introduction

Traditionally, IT outsourcing providers try to engage in long-term relationships with their clients, providing them with customized IT services. Clients rely on the expertise and detailed solution descriptions offered by potential service providers to specify their individual service demand. Typically, an initial Request for Information (RFI) is sent out to providers describing an approximate demand while asking for a detailed solution specification. The client expects the service provider to present bite-sized information. Subsequently, the client may use this information as a blueprint for a more detailed demand specification, distributed among multiple vendors in a second step of the procurement process. In contrast to those iteratively and individually specified services, cloud computing services are rather standardized offerings. Cloud services, by definition, are designed to be purchased, integrated and used with minimal provider interaction (Mell/Grance, 2010), rendering individual requests, such as RFIs, inapplicable (Wollersheim/Krcmar, 2013). The industrialized IT-delivery model of cloud services is defined as "enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources that can be rapidly provisioned and released with minimal management effort or service provider interaction" (Mell/Grance, 2010). Consequently, in the cloud computing market, prospective service customers must independently gather all relevant information regarding an offered service (Wollersheim/Hoberg/Krcmar, 2013). In turn, procuring organizations need to specify their service demand, and providers need to specify their service offerings, in every detail, to enable any matching of supply and demand. However, customers struggle to specify their demand, and providers struggle to identify the essential elements of cloud service descriptions - those service characteristics for which almost every customer will ask. First catalogues of cloud service characteristics emerged in academia and corporate practice, investigating specific aspects, but the following still remains unclear:

> *What is the essential set of service characteristics that describes the information needed by organizations when procuring cloud services?*

To answer this research question, we first review the academic and practitioner-oriented literature, followed by an empirical analysis of requirements of small to large organizations towards cloud service descriptions, addressing the gaps identified in current literature.

B2.2 Related Work

Academic research investigating the set of information important to organizations when in the process of procuring cloud services is scarce and addresses different foci (Hoberg/Wollersheim/Krcmar, 2012). Repschläger et al. (2012) and Binz et al. (2012) focus on rather specific, technical aspects such as the design and functionality of the interface used to manage and port soft-ware packages from one service provider to another. In corporate practice, first sets of such criteria focus on aspects such as security (BSI, 2012; CSA, 2009) or specific service functionalities (Youseff/Butrico/Da Silva, 2008). As cloud services may be traded on electronic markets, ontologies provide a way to describe this type of IT service (Pfaff/Krcmar, 2014). For example, the GoodRelations Ontology (Hepp, 2008) could be of use to describe specific aspects, such as provider and payment details. To address and structure the full range of information demands of organizations, the quality models defined by the international standard Systems and soft-ware Quality Requirements and Evaluation (SQuaRE)" (ISO/IEC, 2010) can be used. This standard sets forth the following:

1. "A quality in use model composed of five characteristics [...] that relate to the outcome of interaction when a product is used in a particular context of use." (ISO/IEC, 2010)
2. "A product quality model composed of eight characteristics [...] that relate to static properties of software and dynamic properties of the computer system." (ISO/IEC, 2010)

The norm SQuaRE provides a list of quality characteristics that are important when determining quality needs throughout the procurement. Moreover, it provides a list of characteristics when measuring the quality of the service received throughout operations (ISO/IEC, 2010). As the quality the customer will receive during service operations is rather unknown at the time of procurement, proxy values might be of use. As suggested by Grönroos (2007), characteristics of a provider's image could be used in this sense as a filter or proxy for unknown quality characteristics. Furthermore, as SQuaRE is designed for IT services, in general, some of the more cloud-specific aspects outlined in the research by Repschlaeger et al. (2013) or Hoberg/Wollersheim/Krcmar (2012) are not addressed in such detail. However, to enable a more efficient procurement process of cloud services for small and mid-sized organizations, sets of service properties are required that focus on the most important criteria while omitting security specifics or technical interfaces, which become more important in certain procurement settings only. Adding up all characteristics, vocabularies, ontologies, etc., means a high number of items to be considered when procuring. This high number of items would undermine one of the cloud service advantages - the ability to focus on the needs of agile organizations (Willcocks/Venters/Whitley, 2013).

B2.3 Research Approach

To answer the previously formulated research questions and to identify the essential set of information that small- and medium-sized companies need during the procurement process, the remainder of this paper has been organized as follows. We first introduce a case study we performed to gather the needed empirical data. Before analyzing the requirements of organizations with respect to cloud service descriptions, an overview of the research approach is provided. Subsequently, we present and discuss our empirical research results. Finally, we present the essential set of information organizations require when procuring cloud services. This set is derived from explorative group interviews with representatives of small-, medium- and large-sized organizations that have at least limited experience in procuring cloud services.

To gather the needed insights into this contemporary and complex sourcing model within a real-life context, we chose an exploratory case study approach (cf. Yin, 2013) following the guidelines of Pare (2004). In general, the unit of analysis is the process executed by an organization when specifying a cloud service demand. Specifically, we aim at the identification of the particular set of characteristics an organization uses to characterize its cloud service demand. Within each organization investigated, the list of requirements, agreed upon by the procurement team, forms the cornerstone for all following processes within the procuring organization. At the same time, the list of requirements represents the essential set of information this organization requests when in search for cloud services, e.g., on electronic service markets.

To gather in-sights on procurement processes in corporate practice, while accounting for extraneous variations regarding the set of information identified, we selected interview participants that met the following criteria: (i) represented a large-, medium or small-sized

(ii) private sector organization that (iii) successfully executed a procurement process for at least one cloud service. As proposed by (cf. European Commission, 2013), we included organizations of varying sizes. Moreover, the focus on private sector organizations is driven by specific restrictions applying exclusively to public sector organizations (e.g., the Federal Information Security Management Act of 2002; Title 44 United States Code § 3541, et seq.). We identified 4 interview partners who were involved in the procurement of cloud services at large organizations, and 12 who were involved in the procurement at medium- or small-sized organizations. In addition to the interviews, additional feedback was collected by follow-up emails. For greater richness of detail and to increase the validity of our findings, each interview was attended by at least two researchers - one leading the interview and discussion and the second researcher taking notes and asking follow-up questions. In total, we completed three semi-structured group inter-views with representatives of large organizations and two interviews with representatives of small- and medium-sized organizations. Table B2.2 provides an overview of our interview partners, the type of organization to which their answers refer and the position of the interviewee within the organization.

All four interviewees involved in cloud service procurement at large organizations were interviewed in 3 group-interview sessions, each lasting between 60 and 120 minutes. The 12 remaining interviewees were questioned in 2 sessions, each lasting 120 minutes. To provide a focused discussion on a specific and structured purpose, we chose group interviews as our interview technique as proposed in (Morgan/Scannell, 1998; Frey/Fontana, 1991). Moreover, this technique allowed us to collect the information an organization perceives when procuring cloud services. To structure the interviews and discussions, an inter-view guideline was used. First, the interview participants described themselves and briefly described their general experience with the procurement of cloud services. Next, the participants were asked to recall the set of information they used in their previous cloud sourcing activities and to report on single characteristics and lists of characteristics

Table B2.2: *Overview of interviewees*

ID	Type of Company	Position of Interview Participant within Organization	
1	Large	Middle Management	Procurement
2	Large	Senior Corporate Counsel	Legal
3	Large	External	Consultant
4	Large	External	Senior Consultant
5	Medium	Team Lead	IT Department
6	Medium	Team Lead	IT Department
7	Small	Executive	Business Department
8	Medium	Founder	Chief Executive Officer (CEO)
9	Small	External	Consultant
10	Medium	Team Lead	IT Department
11	Small	Staff	IT Department
12	Small	Founder	CEO
13	Small	External	Consultant
14	Medium	Team Lead	Business Department
15	Small	Staff	IT Department
16	Small	Founder	CEO

they used. Subsequently, lists of characteristics were presented based on the academic and practitioner-oriented literature review and the initial feedback from the group. Moreover, collected data were enriched with contextual information derived from the group discussions. Based on the responses and suggestions through-out the discussion, a catalogue of service properties representing the information need was collected at the end of each session. In a subsequent interview-session, this list of characteristics collected was presented to the participants for respondent validation (Yin, 2013), followed by a renewed discussion of the characteristics included and excluded. Based on notes taken in this subsequent discussion, a refined set of characteristics was collected and supplemented with a short summary of the researchers (Pare, 2004).

B2.4 Information Needs of Cloud Service Buyers

Table B2.3 shows the set of information gathered, structured according to the dimensions used in SQuaRE (ISO/IEC, 2010) and expanded by the image dimension being a proxy for unknown quality-in-use characteristics (Grönroos, 2007). The SQuaRE dimensions cover functional suitability, performance, compatibility, usability, reliability, security, maintainability and portability. Functional suitability addresses a service's functional completeness, correctness and appropriateness (ISO/IEC, 2010). Performance addresses a service's time behavior and capacity. Compatibility addresses the degree to which a service can exchange information with other products or services. A service's usability addresses aspects such as the learnability and operability of the service. Reliability addresses a service's maturity. Security addresses aspects such as confidentiality and data integrity. Maintainability addresses the degree of effectiveness and efficiency with which a product or system can be modified by the intended maintainers. Portability addresses the replace-ability of the service.

B2.5 Conclusion

The diverse positions and departmental backgrounds of our interviewees within their organizations show that stakeholders of multiple departments engage in the procurement of cloud services. The interviewees reported that some of the departments involved emphasize distinct information needs and try to push specific lists of characteristics, either self-initiated or derived, from lists set up by associations of professionals or consultants. Summed up, the interviewees agreed upon the listed criteria shown in Table B2.3 as being a comprehensive set to be used at the start of the procurement process. Depending upon individual needs within the organization procuring cloud services, the importance of specific criteria might vary. This needs to be reflected when weighting criteria to personal needs in common decision support methods that help to solve multi-criteria decision problems, such as the Analytic Hierarchy Process (AHP) or utility value analysis.

Table B2.3: *Information need when procuring a cloud service*

Dimension	Information need
Func. suitability	Type of functionality the service is offering (IaaS & PaaS or SaaS)[21]
Func. suitability	Support obligations (scope and response-times)
Func. suitability	Internationality of support
Func. suitability	Communication channels for customer queries
Performance	Guaranteed availability of service
Performance	Guaranteed throughput of service (parallel users supported)
Performance	Network bandwidth and redundancy
Performance	Initial provisioning time (hours until initial service use possible)
Performance	Elasticity supported (provisioning time (hours) after scaling-request)
Compatibility	Supported interfaces to application services
Compatibility	Supported interfaces to other platform- or infrastructure services
Compatibility	Supported Interfaces (interoperability to 3rd party applications).
Usability	Amount of factors determining a service's fee (cost transparency)
Usability	Possibilities to configure using options and rules
Usability	Supported techniques to authenticate users
Usability	Offered tutorials, demos and trainings for users and administrators
Reliability	Liability and compensation for SLA-violation
Reliability	Naming of (sub-)contractors involved
Security	Guaranteed data separation (Multi-tenancy)
Security	Security measures - Organization and Staff
Security	Security measures – Infrastructure and Technical
Security	Possibilities to audit provider/sub-contractors
Security	Degree of protection sufficient to process personal data (§9 BDSG)[22]
Maintainability	Minimum contract duration and extensions
Maintainability	Self Service Possibilities to scale up/down
Maintainability	Backup and Recovery Possibilities
Maintainability	Update-Management Possibilities
Maintainability	SLA-Monitoring Possibilities
Maintainability	Handling of emergencies - Response times
Maintainability	Response times upon customer requests
Portability	Possibilities to export data stored with the service
Portability	Full data deletion upon contract termination
Image	Name and address of provider
Image	Stability of provider (years since foundation)
Image	Place of service provision (place where data are processed & stored)
Image	Duration provider offers a service (months)
Image	Reference customer(s), incl. phone numbers
Image	Service assessments by experts or customers

[21]Infrastructure as a Service (IaaS), Platform as a Service (PaaS), Software as a Service (SaaS)
[22]Bundesdatenschutzgesetz (BDSG)

The need to potentially add more criteria during the procurement process was emphasized by those interviewees representing large organizations. All of the large organizations structure and classify their data and data sources existing within the organization according to a predefined set of protection classes. This protection class, in turn, defines the security measures to which a service storing or processing these data must comply (see BSI (2011) for the detailed approach). In addition to information needed to analyze and assess a service's characteristics, organizations require information on the quality they can expect when using the service. The interviewees would like to know whether they can expect a service to always be up and running and to be provided by a supportive and professional organization. Information provided by other organizations or the duration of a service that is already being offered are some of the proxy values organizations use to gather information on the quality they can expect. Furthermore, all of the interviewees state that the agile cloud market and its quickly emerging and vanishing service offers require agile and lean procurement processes, especially as the frequency of procurement and termination increases. However, the interviewees reported unclear formulated and incomplete service descriptions. This lack of clarity, in turn, requires manual requests for further information throughout the service procurement process. Reducing the current mismatch of information provided by service vendors and the set of information demanded by service-using organizations might not only enable automated searches for required services, it might be one of the next steps towards an agile and lean cloud service procurement.

Even if organizations need to comply with certain rules and regulations that re-quire extending this set, the 39 items identified form the underlying basis. We, thereby, contribute to the sparse empirical research on cloud service procurement. Our findings form a starting point for further research and can be used by service providers to be able to develop meaningful and comprehensive service descriptions for prospective customers. Furthermore, this paper highlights the need for further research in service description languages and ontologies in the domain of cloud services. Thus, the outlined findings provide a conceptualizing overview of service properties to be covered by ontologies and vocabulary for the domain of cloud services.

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Chapter B3

Natural Language Processing Techniques for Document Classification in IT Benchmarking - Automated Identification of Domain Specific Terms

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Individual Contribution	Problem and scope definition, development of the conceptual approach, prototype development, experiment design, execution and result analysis, manuscript writing, and manuscript editing

Table B3.1: *Bibliographic details for P3*

[23]`http://scholar.google.de`

Natural Language Processing Techniques for Document Classification in IT Benchmarking - Automated Identification of Domain Specific Terms

Abstract In the domain of IT benchmarking collected data are often stored in natural language text and therefore intrinsically unstructured. To ease data analysis and data evaluations across different types of IT benchmarking approaches a semantic representation of this information is crucial. Thus, the identification of conceptual (semantical) similarities is the first step in the development of an integrative data management in this domain. As an ontology is a specification of such a conceptualization an association of terms, relations between terms and related instances must be developed. Building on previous research we present an approach for an automated term extraction by the use of NLP techniques. Terms are automatically extracted out of existing IT benchmarking documents leading to a domain specific dictionary. These extracted terms are representative for each document and describe the purpose and content of each file and server as a basis for the ontology development process in the domain of IT benchmarking.

B3.1 Introduction

Benchmarking as a systematic process for improving organizational performance has gained great popularity worldwide since the 1980s (Camp, 1989). It is based on the insight that analyzing the acting and performance of organizations is a powerful way to transform the own organization. This is done by applying lessons learned for the own organization derived by these observations (Peters, 1994; Camp, 1995). Moreover, this performance measurement (equiv. benchmarking) can help to explain value or cost aspects to stakeholders (Spendolini, 1992). Thus, the analysis and evaluation of such performance measurement approaches is subject of manifold studies (cf. Slevin/Stieman/Boone, 1991; Smith/McKeen, 1996; Gacenga et al., 2011).

The research focus of attention is on structuring, standardize and generalize IT service catalogues (cf. Kütz, 2006; Rudolph/Krcmar, 2009; Nissen et al., 2014). Usually, in order to model internally provided (IT) services in a standardized manner. However, since (IT) service catalogues are commonly designed for internal or individual purposes only comparability is difficult to reach, especially across different (IT) organizations. At present, most of research in (IT) benchmarking is focusing on how benchmarking can be done or in how a successfully performed benchmark should be performed (Jakob/Pfaff/Reidt, 2013). In other words, current research on (IT) benchmarking generally focuses on designing service catalogues or designing benchmarks on various kinds of subjects. Due to the nature of the subject, the information collected during a benchmark is generally done by the use of questionnaires. This leads to a variety of different kind of data getting collected withing a single benchmark (such as cost of employee, software licensing costs, quantities of hardware etc.). All of these approaches have one thing in common: A common concept for data management is left out of scope, even though it is strongly recommended (cf. Pfaff/Krcmar, 2014; Wollersheim/Pfaff/Krcmar, 2014). Moreover, little work published in IS literature addresses the problem of data integration across different kind of IT benchmarks, yet. So, they omit facts of data quality and data integration.

Today, one difficulty in making data of different types of benchmarking comparable with each other is a result from the lack of a uniform description of any parameter measured. Their relation in between is not formalized too. Following Pfaff/Krcmar (2014) the conceptual level of the different benchmarking approaches needs to be analyzed, to identify first similarities in a logical manner. To do so, already existing service description as well as questionnaires of different benchmarking approaches are used for examination. These data were collected over the last seven years within different benchmarking approaches supervised and evaluated. Encompassing data from strategic and consortial IT benchmarks, reflecting a broad range of numerous small to medium sized enterprises as well as large-scale enterprises.

By the identification of domain specific terms elaborating the specific structural characteristics from different benchmarking approaches, this work addresses the following question: How can the domain specific terms in IT benchmarking be automatically identified out of unstructured data? Subsequently, the results of this work are used to identify the requirements semi-structured and unstructured benchmarking data pose for the use of ontology.

To ensure maximum re-usability and to speed up the document classification process these benchmarking data are analyzed by the use of NLP techniques. Resulting in a domain specific dictionary as a basis for a domain specific ontology for IT benchmarking, in order to make these kind of data meaningful (Uschold/Gruninger, 2004; Horkoff et al., 2012).

First, an overview of benchmarking in general and data integration challenges in the domain of IT benchmarking in specific is given. Second, the used method and the quality of the previously mentioned approach is described in the following sections. Thus, in this paper the first step in the ontology engineering process is addressed by the use of NLP techniques.

B3.2 Related Work

Today, there exist a broad range of different approaches for structuring service catalogues (cf. Rudolph/Krcmar, 2009). A short overview of these approaches is given by Nissen et al. (2014). Next to IT service catalogues the structure of IT benchmarks follow the abstraction of IT departments proposed by Riempp/Müller/Ahlemann (2008). Thus, data management in IT benchmarking needs to cover a broad range of different characteristics (e.g., different views on supplier or provider of services, different level of abstraction of a service or various types of cost accounting). Especially where IT-based solutions become more and more used for the data collecting process in the domain for IT benchmarking, such as presented by Ziaie et al. (2013) and structural described by Riempp/Müller/Ahlemann (2008). Although such benchmarks do have the same object of observation (f.i. same service or same product), no direct semantic information are stored to identify this similarity, which is inhibiting further comprehensive analysis (Pfaff/Krcmar, 2014).

In related fields of research there already do exist several approaches to organise and integrate such kind of semantically identical information. Ontologies which, by definition, convey electronic or "semantic meaning" are used to structure such kind of unstructured data in the medical sector (Cambria/Hussain/Eckl, 2011) or in the sector of information management (cf. Riedl et al., 2009; Müller, 2010). To address this lack of appropriate data management concept in the domain of IT benchmarking onotlogies are already proposed by Pfaff/Krcmar (2014), following Guarino/Giaretta (1995) and Brewster/O'Hara (2007).

There exist several types of ontology development strategies in academic literature (cf. Wache et al., 2001). A *single ontology* uses a shared vocabulary for describing the semantic information of data. *Multiple ontologies* are based on several independently build ontologies for every source of information. The lack of a shared vocabulary across these ontologies is one major disadvantage. *Hybrid ontologies* use a shared vocabulary with basic terms of the domain related information. But, to our knowledge no ontology exists for ITBM or ITSM.

B3.3 Methods

Since NLP driven ontology development has become more and more common over the last years (cf. Lame, 2005; Maynard/Li/Peters, 2008; Karanikolas/Skourlas, 2010; Witte/Khamis/Rilling, 2010; Ray/Chandra, 2012; Alatrish/Tosic/Milenkovic, 2014), these techniques are used to develop a domain specific ontology for IT benchmarking. Focusing on the first phase of ontology development, such as term extrusion and dictionary development.

B3.3.1 Ontology Development

Ontologies aim to capture static domain knowledge in a generic way and can be used and shared across applications and groups (Chandrasekaran/Josephson/Benjamins, 1999). Thus, one can define an ontology as a shared specification of a conceptualization. Following Noy/McGuinness (2001) and Pinto/Martins (2004) Figure B3.1 shows the schematic procedure of the ontology creating process.

First, already existing repositories of information, such as documents, are used to identify and extract characteristic terms within the specific domain. Second, these terms are conceptualized according to Fernandez-Lopez/Gomez-Perez/Juristo (1997). In a third step, the conceptualization is evaluated and revised to map the requirements previously identified. Supporting the construction of ontologies and populating them with instantiations of both concepts and relations, commonly referred to as ontology learning.

Next to a manual extraction of terms out of documents there exist several semi-automatic approaches. In general, these are NLP or Machine Learning (ML) techniques which speed up the initial process of the ontology engineering.

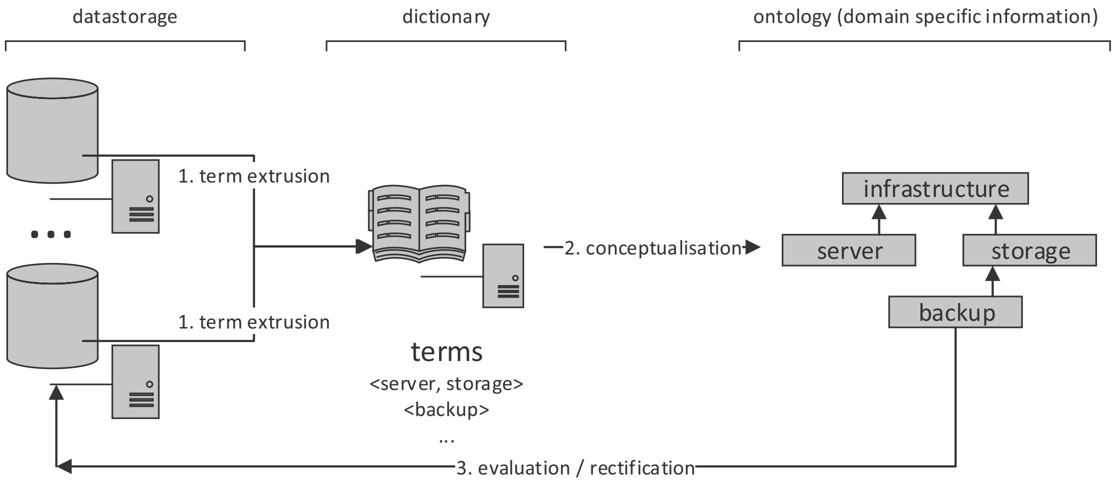

Figure B3.1: *Ontology engineering steps, adapted from Sack* (2008)

B3.3.2 Natural Language Processing

Based on already existing documents (i.e., service descriptions and benchmarking results of the last seven years) an automatic extraction of terms is performed. All of the documents stored in various data formats are converted into a new data format, commonly referred to as data stream (raw text). This raw text is the input for the NLP algorithm. Figure B3.2 illustrates the pipeline architecture for an information extraction system apart from technical details.

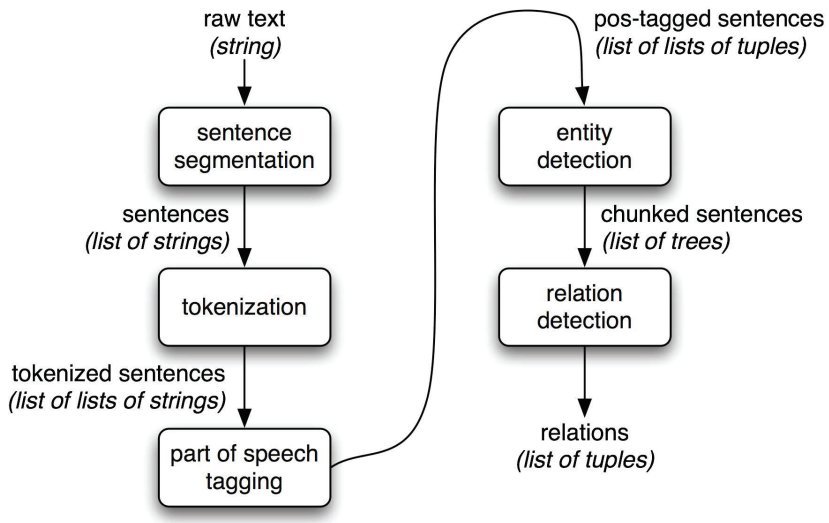

Figure B3.2: *Pipeline Architecture for an information extraction system, based on Bird/ Klein/Loper (2009)*

The complexity of the NLP analysis can be reduced since all documents are related to topics in the domain of IT benchmarking. It can therefore be assumed that these documents are based on a reduced set of vocabularies. Thus, a dictionary with commonly used terms in this domain supports the NLP process. Using this dictionary a pre-classification of the documents can be made according to the initial set of terms. But, as it cannot be assumed that the initial generated dictionary is completely sound, this dictionary has to be iteratively adjusted or extended with the automatically identified terms of the analyzed the documents. As a result a representative set of terms for the domain of IT benchmarking is acquired.

On the pre-processing side of NLP the documents are parsed and transferred into a raw data format which is needed for *tokenization*, *division in sentences*, *lemmatization* and *lexical analysis*. As *tokenization* identifies each single term of a sentence *division in sentences* organizes these terms by grouping them into sentences. The reduction of each term to its basic form is called *lemmatization* (e.g., employees is reduced to employee). In a last step *lexical analysis* aims at the identification of grammatical classes for each term selected in the tokenization process.

Following Salton (1989), all words are analyzed and count according to their frequency of use within the existing documents first. The term frequency (t) within on single document (d) is brought into relation of all documents where (t) is used. This is called *Inverse Document Frequency (IDF).*

$$IDF(t) = \frac{FREQ_{td}}{DOCFREQ_t} \tag{B3.1}$$

Thus, in a collection of (n) documents the significance (S_{ik}) for one term (t) in document (d) can be described by:

$$S_{ik} = C * \frac{n}{DOCFREQ_t} * FREQ_{td} \tag{B3.2}$$

Where (C) is known as *Zipf's law* (Zipf, 1949), approximating the rank-frequency relationship where (r) is the rank of a term, (f) is the frequency of occurrence of the term, and (c) is a constant, dependent on the number of terms in a document.

$$C = r * f \tag{B3.3}$$

This approach has its weaknesses in small to mid size documents with less different terms. In this case the documents get probably not identified by the most representative term if only the most weighted terms get saved. This will lead to an incomplete list of index terms an therefore inadequate for the building of a base dictionary for IT benchmarking. Consequently, terms of small an mid size documents are parsed last and compared with the dictionary entries created out of larger data sets. In case of new index terms, these terms are included into to dictionary. In case of a document with equivocal results concerning the representative term all terms are stored and associated with this document. This is done in order to prevent incomplete set of dictionary terms as well as incomplete result sets if searched for a specific term and its corresponding documents.

Before measuring the quality and effectiveness of the implemented automated document indexation it is necessary to specify the requirements the implementation has to full fill. In our case these are:

- All relevant information are extracted.
- Less irrelevant information are stored.

Thus, effectiveness reflects the amount of correct identified documents with less false positive results. Moreover, the list of documents identified correct should be nearly complete and the amount of documents not relevant for a specific search term should be small.

The four categories a document can be assigned to is shown in Figure B3.3. According to the definition of information retrieval systems, an information can be retrieved and be relevant (true positive) or retrieved and irrelevant (false positive). In contrast, the information not received can be irrelevant (false negative) or relevant (true negative).

To measure the effectiveness, two key performance indicator are used, *recall* and *precision* Nohr (2003). *Recall* and *precision* are defined as follows:

$$Recall(r) = \frac{Number\ of\ relevant\ documents\ retrieved}{Total\ number\ of\ relevantdocuments} \tag{B3.4}$$

$$Precision(p) = \frac{Number\ of\ relevant\ documents\ retrieved}{Total\ number\ of\ documents\ retrieved} \tag{B3.5}$$

	retrieved	not retrieved
irrelevant	retrieved & irrelevant	Not retrieved & irrelevant
relevant	retrieved & relevant	not retrieved but relevant

Figure B3.3: *Segmentation of a collection of documents according to four types of classes of belonging, based on Nohr* (2003)

By definition, a high value of *recall* describes a set of documents where all relevant documents are identified, with its drawback, that this set may also contain irrelevant documents. Such high values of *recall* is desired if it is important to identify all documents related to a specific search term. In contrast, a high value of *precision* describes a set of documents with many relevant documents are identified correctly and the amount of irrelevant documents is comparatively low. Thus, a high value of *precision* is desired whenever relevant documents need to be identified only, at the expense of completeness.

B3.4 Methodology

As already mentioned, it can be assumed, that most of the documents consist of a reduced set of vocabulary, as all of them are related to specific topics out of IT benchmarking. Thus, they describe technical and economic aspects such as IT costs or the number of employees. This constraint allows us to group data objects into subsets based on their relation, i.e., objects with similar information are grouped together.

The reduction to primary words is done by the help of LemmaGen (Juršic et al., 2010; LemmaGen, 2011), a lexical database that contains approximately 23385 natural language terms and about 10655 primary words.

B3.4.1 Prototype

Figure B3.4 shows the schematic workflow of the implemented prototype. First a set of documents is analyzed according to the previously described NLP methods and transferred into raw data formats. Second, the shared terms of the different documents are identified, building the underlying dictionary of the domain. Therefore LemmaGen (Juršic et al., 2010) and the Stop Word (Savoy, 2014) identifier are used. This shared dictionary is used

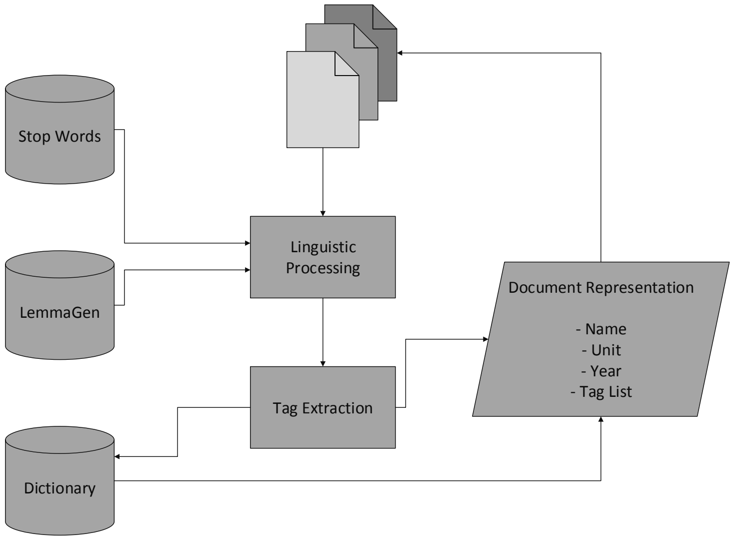

Figure B3.4: *Schematic workflow of the prototype for document indexing*

to identify each single document in a last step (e.g., by name, unit, year and representative tag).

The implementation of this prototype is done in Java. The documents are read in by the use of the Apache POI Application Programming Interface (API) (Foundation, 2014). This is to transform each document into a string-array, split into paragraphs for term identification. At last, each document gets tagged by its most representative term or list of terms.

B3.4.2 Evaluation

According to this schematic workflow the prototype is tested on a set of documents out of different benchmarking approaches, mainly based on *.doc(x), *.xls as well as *.pdf documents, resulting in 1084 unique files. These files were previously categorized by hand, to identify relevant documents with potential terms for ontology building. Moreover, this is done to measure *recall* and *precision*, as the document distribution needs to be known (e.g., documents related to personal costs). This leads to a distribution of documents shown in Table B3.2.

Table B3.2: *Documents under examination*

Total Number of Documents	1084
Number of relevant Documents	404

At first, the quality of document identification has been tested. Thus, it is evaluated if all relevant documents are found. The results are shown in Table B3.3.

26 documents could not be identified, as these missed some relevant information needed, such as the name of performance indicator that should be described by this document.

Table B3.3: *Accuracy of document identification*

Number of relevant documents	404
Number of identified documents	378
Accuracy	93.3%

In a next step a subset of manually categorized documents were tested to measure the *precision* and *recall*, while focusing on a high *recall* value. This is due to the fact, that in case of IT benchmarking and especially for the development of an ontology nearly all relevant information/documents should be identified. This means, that false positive identified documents are allowed to occur in the result set. An overview on used search terms is given in Table B3.4.

Table B3.4: *Recall and precision for the test data set*

Search term	Recall	Precision
Supported Devices	0.2	1.0
Personnel costs	0.57	0.8
Number of client devices	0.63	1.0
Total cost of IT	0.65	0.92

At last, it is tested whether all units of the indicators are identified correctly. The Result of this test is shown in Table B3.5. Five units could not be identified because of major typing errors within these documents.

Table B3.5: *Identification of units*

Number of search documents	36
Identified Units	31
Accuracy	86%

B3.5 Discussion & Future Work

This work transfers NLP and ML techniques into the domain of ITBM, as basis for ontology creation processes in the future. It is its first step towards an ontology in this domain. By automating the term extrusion out of benchmarking documents the development of this ontology is accelerated. This acceleration is even more important on maintaining an ontology. As the initial development of such an ontology is only the first step, extension and maintenance processes are activities which also get supported by the automated term extrusion. This is especially useful if new domain specific terms need to be identified out of new documents, such as service descriptions (e.g., related to topics like cloud computing).

Future work will focus on step two/three, shown in Figure B3.1. As it is shown, the conceptualization of terms leads, in general, to a cyclically adjustment of the initial developed ontology. As this process needs to be supervised by a domain expert only a semi- automation of this step is possible yet. Nevertheless this semi-automation will be developed. To support the domain expert during this step, the differences between two ontology versions (before and after the automatic term extrusion) will be identified and presented to him. Moreover this kind of versioning helps to comprehend the development process of the whole ontology.

In a last step, already existing output data will be linked to the domain ontology, such as, cost or performance values collected from different companies since the last seven years and persisted in various databases (e.g., MySQL or Access Database (DB)). Thus, the conceptualization of logical structures in this domain, is used to get access to benchmarking data. Without the need of the development of a unified database schema. Therefore new databases can be linked to already existing ones by the use of an abstraction layer, so called ontology.

Chapter B4

Ontology for Semantic Data Integration in the Domain of IT Benchmarking

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Table B4.1: *Bibliographic details for P4*

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Ontology for Semantic Data Integration in the Domain of IT Benchmarking

Abstract

A domain-specific ontology for IT benchmarking has been developed to bridge the gap between a systematic characterization of IT services and their data-based valuation. Since information is generally collected during a benchmark exercise using questionnaires on a broad range of topics, such as employee costs, software licensing costs, and quantities of hardware, it is commonly stored as natural language text; thus, this information is stored in an intrinsically unstructured form. Although these data form the basis for identifying potentials for IT cost reductions, neither a uniform description of any measured parameters nor the relationship between such parameters exists. Hence, this work proposes an ontology for the domain of IT benchmarking, available at `https://w3id.org/bmontology`. The design of this ontology is based on requirements mainly elicited from a domain analysis, which considers analyzing documents and interviews with representatives from Small and Medium-Sized Enterprises (SMEs) and Information and ICT companies over the last eight years. The development of the ontology and its main concepts is described in detail (i.e., the conceptualization of benchmarking events, questionnaires, IT services, indicators and their values) together with its alignment with the DOLCE-UltraLite (DUL) foundational ontology.

B4.1 Introduction

IT benchmarking is based on the insight that by observing organizations and analyzing their performance, an organization can transform the way it conducts business (Camp, 1989). Such a transformation is usually achieved by applying lessons learned from benchmarking results to their own organization (Peters, 1994; Camp, 1995). Information is generally collected during a benchmark exercise using questionnaires on a broad range of topics, such as employee costs, software licensing costs, and quantities of hardware or software. Moreover, there are different types of benchmarks that generally focus on the same subject from different points of view, especially in the domain of IT benchmarking. Although the different benchmark types measure the same object from different perspectives, a direct link is often difficult to establish between these collected data.

Research in the field of IT benchmarking typically focuses on structuring, standardizing and generalizing IT service catalogs and their implementation within companies (Kütz, 2006; Ebner/Urbach/Mueller, 2016) to model internally provided IT services in a standardized manner. Because IT service catalogs are commonly designed for internal or individual purposes only, they are often not directly comparable, especially when attempting to compare the across organizational boundaries. This is because the concept of a uniform data description and data management is not considered even though it is strongly recommended for such measurement problems in the domain of IT benchmarking (Pfaff/Krcmar, 2014; Wollersheim/Pfaff/Krcmar, 2014).

Currently, the number of studies in the IS literature addressing these data integration challenges across different types of IT benchmarks is limited and most literature sources omit facts related to the data quality, the data integration and the comparability of different types of benchmarks. This is because of the lack of a uniform description of any arbitrary performance parameter and KPI that is measured during a benchmark and because of the lack of a uniform description of the relationships between these parameters (Pfaff/Krcmar, 2015) relevant for comparability. However, a domain-specific ontology my represent a solution to ensure that the collected data are meaningful and to overcome these limitations of data comparability (Uschold/Gruninger, 2004; Horkoff et al., 2012). Similar ontology-based approaches for enhancing the data quality have been successfully implemented in related fields of research, for example, for linking IT infrastructure and business elements (cf. vom Brocke et al., 2014).

Since there are numerous challenges related to data integration specific to not only the domain of IT benchmarking but also related fields, such as ITSM, in this work, we describe an IT benchmarking ontology, an ontological formalization of all relevant elements, attributes, and properties in this domain, following the description logic fragment of the OWL 2 language (Motik/Patel-Schneider/Parsia, 2012). Thus, this work contributes to the data comparability problem because of the lack of standardization by showing to which degree of abstraction the conceptualization of relevant concepts needs to be covered by an ontology in the domain of IT benchmarking and what basic relationships need to be modeled within the core ITBM ontology . While the ITBM ontology provides the common understanding of concepts and relations within the domain of IT benchmarking the semantic foundation is achieved by grounding the ITBM ontology in an upper ontology, a “foundational ontology”. For this reason, the ITBM ontology is linked to DUL (Gangemi, 2016b). Grounding in a foundational ontology ensures the semantic interoperability of distinct conceptualizations from different (domain) ontologies (Guizzardi, 2005).

The paper is organized as follows: Section B4.2 provides an overview of the relevant literature on IT benchmarking/service management, foundational ontologies, and ontologies in related domains. The methodology for the development of the ITBM ontology is described in Section B4.4. Section 4 introduces the proposed ITBM ontology and gives an overview of the document structure used to build the domain ontology. Section B4.5 outlines the application and use case of the ITBM ontology. Finally, Section B4.6 provides the conclusion and perspectives for future in terms of ontology extension.

The paper is organized as follows: Section B4.2 provides an overview of the relevant literature on IT benchmarking/service management and ontologies in related domains. Section B4.4 introduces the proposed ITBM ontology and gives an overview of the document structure used to build the domain ontology. Section B4.5 offers the use-case and application of the ontology. Finally, Section B4.6 provides some perspectives for the future in terms of ontology extension.

B4.2 Background

B4.2.1 The Domain of IT Benchmarking

As a systematic process for improving organizational performance, benchmarks can be classified according to the type of study (e.g., processes, products, strategies or generic objects) (cf. Carpinetti/Oiko, 2008). Benchmarking partners may be units of the same organization, competitors in the same or different geographical markets or organizations in related or unrelated industries. Thus, a distinction is drawn between internal and external comparisons of these performance measurements. Whereas an internal performance measurement focuses on the operation of a single company, an external performance measurement focuses on different companies. An overview of the different types of benchmarks is presented in Table B4.2 .

A benchmark can be subdivided into several process phases, beginning with the initial conception which describes the object of investigation and ending with optimizing and reorganizing internal (business) processes. In each of these phases of a benchmark numerous data (KPI) are collected in various data formats or data structures. These data consists of both qualitative and quantitative statements and are (recurrently) collected through the entire benchmarking cycle for every benchmark. Furthermore, they are collected for

Table B4.2: *Different types of benchmarks, based on Carpinetti/Oiko* (2008)

Type	**Description**
Process Benchmark	Compares operations, work practices or business processes
Product Benchmark	Compares products or services
Strategic Benchmark	Compares organizational structures, management practices and business strategies.
Internal Benchmark	Compares similar products or services of similar business units within a single organization
Competitive Benchmark	Compares performance with a direct competitor. The object of investigation may include products, services, technology, research and development, personnel policies, etc.
Functional Benchmark	Compares one or more non-competitive organizations in terms of particular business functions or processes
Generic Benchmark	Compares an organization or business unit with the best-performing organization, irrespective of the type of industry

every benchmarking participant. In IT benchmarking, the scope of the collected data is generally limited to IT-related performance indicators, regardless of whether they were collected within a strategic or generic benchmark. Thus, these data (indicators) are similar in a semantic manner, as they are related to specific IT aspects, even if acquired within different types of benchmarks. More generally, different IT benchmarks often measure the same IT objectives from different vantage points. Therefore, such collected data are semantically related to each other for this specific objective which was measured within different benchmarks.

The structural layout of an IT service catalogs can be generalized to (i) basic organizational information (such as the number of employees or revenue), subsequently referred to as basic data services, and (ii) 20 additional IT services, describing more specific aspects of IT offerings (cf. Figure B4.1). These IT services provide some general information about what the service offering is about (for example, providing a mailbox or a virtual machine/server) and detailed information about performance and cost indicators that are used to measure the performance of this service. Note that calculations of indicators may be dependent on different services. For example, a storage service contains all costs associated with disk storage in a data center; however, some of those storage-specific costs are also required within a more general IT service such as in the context of server costs (as disk storage is associated with servers in general). Additionally, costs originally related to the database service are based on both the general server costs as part of the infrastructure component and the more specific disk storage costs. Again, some cost in-

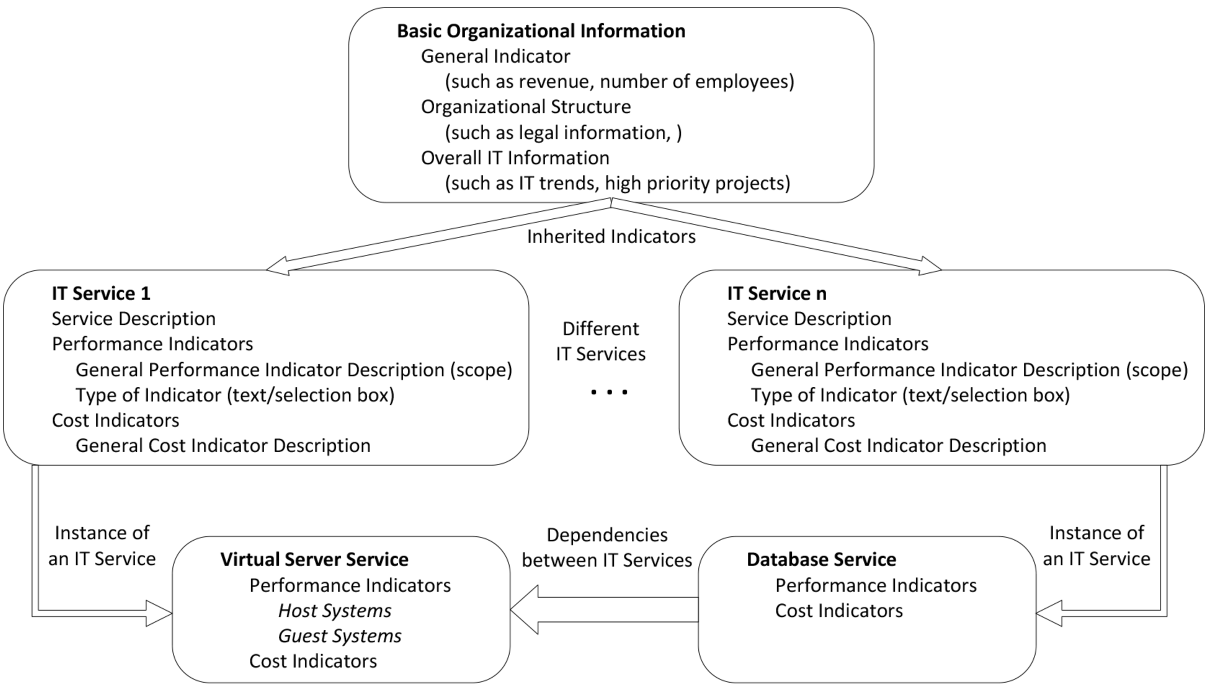

Figure B4.1: *Structural overview of the IT service catalogs used to build the ontology. Services are segmented first (e.g., cost or performance indicator) and optionally further split into indicator groups (e.g., host systems). Services may include the costs of other services (e.g., a database service includes the cost also specified in a virtual server service) (based on Pfaff/Krcmar (2018)).*

dicators of the database service depend on the performance indicators of the server and data storage service. It is also possible that IT services could inherit indicators or values from the basic organizational information (such as the total number of employees of an organization) to perform further calculations within a specific service based on such a basic indicator. Figure B4.1 shows the structural layout of the IT service catalogs and IT service descriptions used to build the ontology.

In short, IT services are mono-hierarchically structured. Each top-level service consists of a set of subordinated service segments and, optionally, additional indicator groups. As shown in Figure B4.1, the basic data service's segments correspond to general organizational information (e.g., organizational structure and IT costs), and the remaining IT services are segmented by whether they are cost or performance indicators and, optionally, grouped into smaller logical units (for example, the host or guest systems in the context of the virtual server service).

B4.2.2 Foundational Ontologies and Ontologies in related Domains of ITBM

To link data (bases), that are similar in a semantic manner, the use of ontologies has become popular in recent years, with a particular focus on the representation of business processes (cf. Thomas/Fellmann, 2009; Garcia-Crespo et al., 2011) or for the purpose of enterprise modeling (cf. Uschold et al., 1998). By nature, when an ontology is built with a focus on business processes or enterprise modeling, it lacks the information needed to shift the focus to financial aspects, which are of crucial importance in the domain of IT benchmarking. Although, such ontologies, such as the Edinburgh Enterprise Ontology (EEO) by Uschold et al. (1998), the TOronto Virtual Enterprise (TOVE) by Fox/Grüninger (1998) and the Engineering Methodology for Organizations (DEMOs) by Dietz/Hoogervorst (2008), are used for enterprise modeling, they differ in the meaning of key terms, as they are not grounded in a foundational ontology. Further, aside from the lack of a shared understanding of equal concepts in these ontologies, they do not address IT infrastructure and IT costs nor do they focus on IT-comparable IT services in general across company boundaries, which is crucial for the domain of ITBM. This situation holds true for ontologies in the context of ITSM (Freitas/Correia/Abreu, 2008; Valiente/Garcia-Barriocanal/Sicilia, 2012)), for ontologies and IT governance frameworks in the context of ITIL (2011) and for related ontologies such as the GoodRelations ontology (Hepp, 2008) and the Financial Industry Business Ontology (FIBO) (Council, 2016). Whereas the Business Model Ontology (BMO) (Osterwalder/Pigneur/Tucci, 2005) only focuses on the conceptualization of economic aspects within a single enterprise, the e^3-value ontology (Gordijn/Akkermans, 2001) only focuses on the conceptualization of economic aspects within a network of enterprises. Other, more domain-specific ontologies focus on the modeling of the aspects of an enterprise's accounting aspects, such as the Resource-Agent-Event (RAE) ontology (Geerts/McCarthy, 2002), which is used to define the architecture of an Accounting Information System (AIS). Since the RAE ontology is not grounded in a foundational ontology, it is unclear what is meant by an economic event.

One initial approach for measuring the impact of IT infrastructure changes on business processes and vice versa by an ontology was introduced by vom Brocke et al. (2014). The focus of this study is the linkage of (inner) organizational process levels to their IT-resource level. However, to (semi-) automatically compare IT-related and business-related performance indicators across organizational boundaries, a more fine-grained conceptualization of such information is needed. Especially if the ontology is directly used to link and access external data sources (i.e., directly map ontology concepts to IT business-related KPIs) to analyze the organizational performance of (IT) services, the conceptualization needs to be closer to the structure of IT service catalogs than to the abstract description of organizational processes or IT resources.

As previously stated, upper ontologies, or "foundational ontologies", are used to ensure the semantic interoperability of distinct conceptualizations from different domains (Guizzardi, 2005). Thus, several of these foundational ontologies have been recently developed. The Suggested Upper Merged Ontology (SUMO) (Niles/Pease, 2001), the Basic Formal Ontology (BFO) (Smith/Grenon, 2002), the Descriptive Ontology for Linguistic and Cognitive Engineering (DOLCE) (Gangemi et al., 2002), the Unified Foundational Ontology (UFO) initially presented by Guizzardi/Wagner (2004), and the General Formal Ontology (GFO) proposed by Herre (2010) are some prominent examples of this type of ontology. The BFO was developed for the support of information retrieval, analysis and integration in scientific and other domains. It was developed to be very generic and to incorporate both three-dimensionalist and four-dimensionalist perspectives on reality. In contrast to BFO, DOLCE captures ontological categories underlying natural language and human commonsense (López-Gil/Gil/García, 2016). As a descriptive ontology, DOLCE distinguishes between things and events, which correspond to organizations (things) and benchmarks (events) in the domain of ITBM. In DOLCE, the differences between these entities is related to their behavior in time, and they are linked by participation relations (similar to a participation within a benchmark), whereas in BFO (as a realist ontology), such branches are completely independent of each other. Thus, DOLCE offers a better support for representing temporal qualities (e.g., a benchmark as a time-specific event) and properties (e.g., a specific type of benchmark) and values (e.g., a particular benchmark of a specific type). Since a lightweight version of DOLCE is provided with DUL (Gangemi, 2016b), being sufficient in terms of expressiveness and complexity, DUL was used for grounding the ITBM ontology. Note that for grounding the ITBM ontology in a foundational ontology, GFO and SUMO would also have been appropriate, as they also provide sufficient temporal conceptualizations. However, since no lightweight version of GFO exists and since the extensive and detailed taxonomy of SUMO is not needed, the ITBM ontology is grounded in DUL to provide a lightweight solution. In contrast to the previously mentioned foundational ontologies, which are based on OWL, UFO is based upon OntoUML (Guizzardi, 2005). As a result, and since the ITBM ontology was implemented in OWL, UFO and its extensions (UFO-A, UFO-B, UFO-C and UFO-S) were not considered further in the investigation. OWL was chosen for the development of the ITBM ontology to ensure further linkage possibilities to the previously mentioned domain ontologies (such as FIBO and BMO).

B4.3 Methodology

For the development of the ITBM ontology, we implemented a customized process based on the NeOn framework for ontology engineering (Suárez-Figueroa/Gómez-Pérez/Fernández López, 2012). NeOn offers nine different scenarios consisting of 59 activities. The basic activities for each ontology development process are bundled in the NeOn core scenario. To perform a certain scenario, the scenario is mapped to the phases of an underlying life cycle model. Two life cycle models are supported; a waterfall model with a variable number of phases (depending on the scenario to be performed) and an iterative and incremental model. The iterative and incremental model is a sequence of subsequently performed waterfall models (i.e., iterations), each of which may be based on a different scenario; the chosen scenario defines the different phases to be performed during a specific iteration. Activities are described in a glossary of terms, aiming to give commonly accepted definitions for certain activities. Most activities come with a set of comprehensive descriptions consisting of functional descriptions (e.g., definition, goals, and input/output).

The IT benchmarking ontology as presented in this work is the result of a number of iterations of the overall ontology engineering process, which is based on an iterative and incremental life cycle model. So far, both the NeOn core scenario as well as the NeOn scenario for the reuse of ontological resources have been used. In addition to this customization, we further adapted some of the NeOn activities to fit our needs therein keeping the engineering process as lightweight as possible. In the following, subsequently performed activities are described in more detail in the order or their execution.

Knowledge Acquisition. According to the NeOn specification for the knowledge acquisition process three different activities were performed: (i) ontology elicitation to acquire conceptual structures and their instances by domain experts; (ii) ontology learning to (semi-)automatically transform unstructured, semi-structured and structured data sources into conceptual structures; and (iii) ontology population to (semi-)automatically transform unstructured, semi-structured and structured data sources into instance data. Within the ITBM ontology engineering process, the ontology population activity is not performed during the ontology design phase, as the ITBM benchmarking ontology solely contains conceptual knowledge. Analogously, knowledge elicitation is limited to gathering conceptual knowledge. Ontology learning was conducted to support the domain experts in performing the ontology elicitation activity; here, existing service catalogs and databases were analyzed using Natural Language Processing NLP techniques to extract the most important concepts, as described in detail in (Pfaff/Krcmar, 2015).

Ontology Requirements Specification. The main challenge during the specification activity was to identify a set of appropriate Competency Questions (CQs) to describe the requirements to be fulfilled by the final ontology as the ontology is used for accessing external data sources. Thus, the CQs are questions the ontology should be capable of answering, based on the results of the external attached data sources. Following the NeOn guidelines, Table B4.3 shows the categorized and prioritized CQs for the ITBM ontology and the corresponding query-style answers.

Table B4.3: *Extract of competency questions created during the Specification activity, grouped by pre-established categories as suggested by NeOn: (i) Indicator Structure, (ii) Individual Benchmarks, and (iii) Participants and Values. Square brackets indicate lists of values.*

Group	Competency Question (CQ1-CQ20)	Exemplary Answer
Indicator Structure (CQ1-CQ6)	What performance indicators do exist?	[NumberOfUsers]
	What performance indicators are contained in the BENCHMARK_NAME in YEAR?	[NumberOfUsers]
	Regarding BENCHMARK_NAME of YEAR, how many cost indicators have been answered by all participants?	NUMBER
	What IT services are of interest (i.e., have had values provided for) for the ORGANIZATION_NAME ?	[BasicDataIndicator]
	How frequent is the revenue indicator queried within the existing benchmarks?	NUMBER
	How many values have been provided for the revenue indicator of the SERVICE_NAME in total?	NUMBER
Individual Benchmarks (CQ7-CQ11)	How many benchmarks exist?	NUMBER
	In which years was the BENCHMARK_NAME conducted?	[YEAR]
	Which indicators have been queried in at least two benchmarks?	[HardwareCost]
	How many values have been provided for the number of employees indicator in total?	NUMBER
	Which organizations have participated in which benchmarks?	[(ORGANIZATION_NAME, BENCHMARK_NAME, YEAR)]
Participants and Values (CQ12-CQ20)	How many organizations do exist?	NUMBER
	How many organizations have participated in at least one benchmark?	NUMBER
	Does ORGANIZATION_NAME participate in at least one benchmark called BENCHMARK_NAME?	YES/NO
	What is the yearly revenue of ORGANIZATION_NAME?	[(YEAR, NUMBER)]
	What was the average hardware costs for BlackBerry devices in YEAR?	NUMBER
	What was the greatest value of hardware costs for BlackBerry devices provided in YEAR?	NUMBER
	What are the hardware cost for BlackBerry devices in YEAR by ORGANIZATION_NAME?	[(ORGANIZATION_NAME, NUMBER)]
	Regarding YEAR, what was the average number of employees of all organizations having a revenue between $NUMBER_1 and $NUMBER_2?	NUMBER
	Regarding YEAR, what was the minimum number of employees of organizations having a revenue between $NUMBER_1 and $NUMBER_2?	NUMBER

Ontology Conceptualization. To organize data and information according to the specified requirements in the domain of ITBM, we created a conceptual domain representation as proposed by NeOn, which was stepwise refined. Starting with a list of terms obtained from the ontology requirements (i.e., extracted from the CQs) and deriving concepts from those terms, we enhanced this domain representation until reaching a semi-formal, graphical model of the intended ontology. Moreover, to enhance the general quality of the final model and to specify concepts in more detail, we used existing data sources (such as service catalogs and related databases (cf. Section B4.4) for the conceptualization, and additionally utilized the NeOn framework for ontology engineering (Suárez-Figueroa/Gómez-Pérez/Fernández López, 2012)).

Ontology Reuse and Aligning. Existing (non-)ontological resources are used for the development of the ITBM ontology. These resources encompass ITBM data collected over the last eight years in the context of research activities on ITBM at the research institute fortiss and the Technische Universität München (TUM). Moreover, existing domain ontologies in related domains are identified and evaluated for their suitability in the context of ITBM (for additional details see Section B4.2.2). By grounding the ITBM ontology in the upper ontology DUL, the semantic foundation of the ITBM ontology is achieved. To achieve this, relevant concepts in acDUL and the ITBM are identified and linked (see Section B4.4).

Ontology Implementation. Within the scope of ontology implementation, the conceptual model obtained during the conceptualization activity is implemented using OWL 2 DL (Motik/Patel-Schneider/Parsia, 2012). Note that the expressiveness of OWL 2 entailment is required to formally represent more complex properties, especially property chains, that is, inferring a new property between two concepts based on a chain of existing properties already linking them (complex role inclusion) (Grau et al., 2008). With regard to the huge number of indicators, the implementation process is supported by (semi-)automatic tools (i.e., a software script) that generate concepts of the ontology from previously extracted term lists derived from the existing databases.

Ontology Annotation. To keep the ontology readable for humans, we conduct an activity for annotating the ontology. In addition to general information (e.g., the ontology version), concepts and properties are annotated using *rdfs:label* and *rdfs:comment*. In the same way as the implementation activity, this activity is (semi-)automatically supported by the use of existing databases in this domain.

Ontology Evaluation. Before the ontology is published, ontology evaluation is performed. Here, the final ontology is first evaluated against the CQ listed during the specification activity. Then, different tools (i.e., the HermiT reasoner (Glimm et al., 2014) and the OntOlogy Pitfall Scanner (OOPS) (Poveda-Villalón/Suárez-Figueroa, 2009)) are applied to ensure both that the ontology is consistent as well as its general quality.

In addition to the subsequent activities as described above, the IT benchmarking ontology engineering process is supported by a number of side activities as also suggested by NeOn. Those activities are described in the following.

Ontology Quality Assurance and Control. The control activity refers to process monitoring and ensures that the subsequent activities described above are performed and completed correctly. The ontology quality assurance activity ensure the quality of the ontology implementation process and its artifacts. During the development of the IT benchmarking ontology, the process was monitored and controlled constantly using checklists.

Ontology Documentation. While developing the IT benchmarking ontology, the utilized and created documents and artifacts (e.g., including reasoning of design decisions and code fragments) were collected and ordered for documentation purposes.

As stated before, to allow the ITBM ontology to be machine-processable, it is implemented in OWL (more specifically, following the OWL 2 Description Logic (DL) fragment (Motik/Patel-Schneider/Parsia, 2012)), a W3C standard (Calvanese/De Giacomo/Lenzerini, 2001; McGuinness/Van Harmelen, 2004). Thus, the OWL ontology consists of the following: (i) classes as sets of individuals, (ii) individuals as instances of classes (i.e., real-world objects in the domain), and (iii) properties as binary relations between individuals. In addition to the implementation of the domain knowledge, it is possible to define cardinality ranges and other constructs (e.g., taxonomies) allowing inference within an ontology. Moreover, a reasoning engine was used during the development process to avoid inconsistencies in the specifications of the ontology classes and properties. The corresponding ITBM ontology was modeled using the open-source ontology editor Protégé (2014), as it is one of the most common tools for ontology development (Khondoker/Mueller, 2010).

B4.4 IT Benchmarking Ontology

The ITBM ontology was initially built based on already-existing IT service descriptions and catalogs of numerous small to medium-sized enterprises and several questionnaires from different IT benchmarking approaches. As previously stated, these data were collected over the last eight years in the context of research activities and were supervised and evaluated within different benchmarking approaches (cf. Rudolph, 2008; Pfaff/Krcmar, 2015). These data encompass results from strategic and consortial IT benchmarks. Subsequently, as a result of the different data acquisition channels of on-line web platforms, Excel questionnaires and other sources (cf. Ziaie et al., 2013; Ebner et al., 2016), different distributed data sources were used to derive the concepts of the ITBM ontology. The database consists of 1007 unique descriptions of key performance indicators, which are composed of 25 service catalogs from individual companies. In addition, the underlying data for the ontology development consist of 708 data sets from consortial IT benchmarks. These data sets encompass questions on 15 IT services answered for 10 companies as an yearly average over the last six years. Furthermore, IT benchmarking results from 112 different companies were used to extend the database for the ontology development. These data were acquired over the last eight years within a strategic benchmark based on(Riempp/Müller/Ahlemann, 2008), and each data set consists of 1,612 quantitative and qualitative data points of a single organization. As previously stated, the existing service catalogs and databases were analyzed using NLP techniques to extract the most important concepts and terms relevant to building the ontology (for more details on NLP, see Pfaff/Krcmar (2015)).

As described before, the ontology was implemented following the OWL 2 DL fragment (Motik/Patel-Schneider/Parsia, 2012) and using the common vocabularies based on ITIL (ITIL, 2011). Moreover, the alignment to DUL (Gangemi, 2016b) was added to make the ontological commitments explicit and to specify the intended meaning of the introduced concepts (Guarino et al., 1998).

B4.4.1 Top-Level Description

Starting with the top-level description of the proposed benchmarking ontology, the ontology can be divided into the following three sections: *Individual Benchmarks* (equivalent to one specific benchmark), *Participants and Values* and the *General Indicator Declaration.* The *Individual Benchmarks* section introduces concepts to describe, processes relying on different IT service descriptions or questionnaires, including a customizable structure of selectable indicators (measured within a benchmark). Participants (viz. organizations) and their values, which may be instantiated based on these concepts, are described in the *Participants and Values* section. The indicators themselves and their hierarchical and intermediate relationships are organized in a three-layer taxonomy referred to as the *General Indicator Declaration* section. The *General Indicator Declaration* is described in

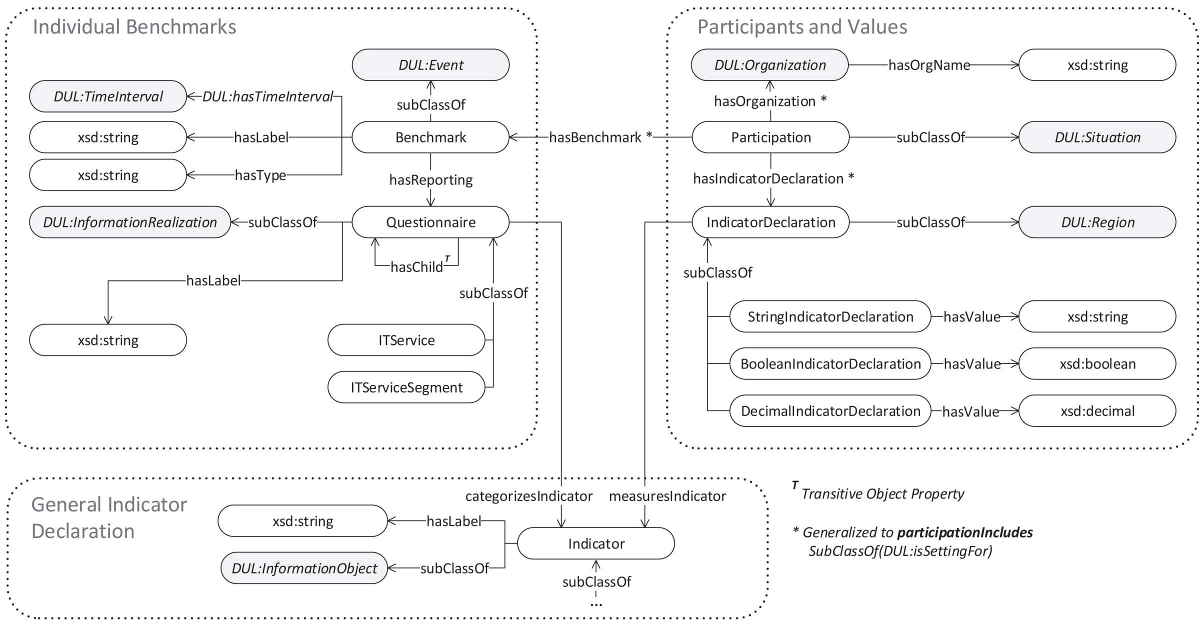

Figure B4.2: *IT benchmarking ontology consisting of three different sections: (i) Individual Benchmarks, (ii) Participants and Values and (iii) General Indicator Declaration. Solid arrows indicate data or object properties, with their direction being defined by rdfs:domain and rdfs:range, according to Brickley/Guha* (2016).

more detail in Section B4.4.2 because of its complexity. Figure B4.2 provides a conceptual overview of the three ontology sections and the relations in between. Gray nodes indicate inheritances from DUL concepts and properties. The nodes of the graph illustrated in Figure B4.2 refer to *concepts* (i.e., classes) or *datatypes* (Motik/Patel-Schneider/Parsia, 2012) of the ontology, whereas the edges refer to *properties* provided by the ontology.

B4.4.1.1 Individual Benchmarks

An IT benchmark is identified by a specific name. As described in Section B4.2, a benchmark may be conducted once or several times within various time periods. In the following, an *individual benchmark* refers to a single conduction of a benchmark that a company is participating in (i.e., an instantiation of the Benchmark class), whereas the benchmarking specification in general refers to a concept of a benchmark that is performed numerous times in different capture or time periods. In other words, two individual benchmarks can be conducted based on two different indicator structures and indicators, or these individual benchmarks can differ in the year of being conducted. In both cases, these benchmarks are represented as a delimited instance within the ontology to uniquely identify individual benchmarks.

As already mentioned in Section B4.2, indicators may be captured in different contexts. For example, whereas an individual benchmark may be based on specific questionnaires (i.e., indicators are grouped in arbitrary categories), the indicator structure of another benchmark may be completely based on a traditional service catalog (i.e., indicators are grouped by the IT service that they belong to). To represent and distinguish the contexts a specific indicator is captured within individual benchmarks, different concepts have been introduced to represent an indicator structure (i.e., *Questionnaire*, *ITService* and *ITServiceSegment*).

In the following, the concepts that an *Individual Benchmark* consists of are described in more detail:

Benchmark. A benchmark can be seen as a time-specific event for the conduction of a benchmark. Thus, the Benchmark class is grounded in the *DUL:Event* concept. An instance must have at least one label, containing the benchmark's name, a type and its specific time interval of conduction. Such a *TimeInterval* is defined for events within DUL and may be freely specified by utilizing the *DUL:hasTimeInterval* property. The *hasType* property refers to the set of benchmark types as described in Table B4.2 and is therefore limited to those values. Each benchmark has to be assigned to one or two of these benchmarking types. The labels of a benchmark are represented by arbitrary strings, referring to benchmark names, for example expressed in one or multiple languages. For connecting to DOLCE, both *hasLabel* and *hasType* have been defined as a sub-property of *DUL:hasDataValue*.

Questionnaire. During a benchmark event, indicator values are reported by utilizing exactly one previously specified questionnaire that defines a structure for capturing these data of the KPIs. These questionnaires are connected to a benchmark instance using the *hasReporting* property. Within the ITBM ontology, a questionnaire refers to a physical object (e.g., paper sheets), is grounded in *DUL:InformationRealization* and is labeled by at least one headline (e.g., multiple headlines for multiple languages). Indicators are more abstract information objects and are linked to a questionnaire using the *categorizesIndicator* property, which is a sub-property of *DUL:realizes*. A questionnaire or a group of questionnaires consists of different indicators focusing on different aspects or activities within an IT department, such as general service offerings or more generic questions. For more details on the structure of a non-service-based ITBM see Riempp/Müller/Ahlemann (2008). A questionnaire can be further nested into sub-questionnaires coupling questions to a specific topic of interest to compare through the benchmark. This results in a mono-hierarchical structure that can be realized using the transitive *hasChild* property, which is a sub-property of *DUL:hasPart* and defines a questionnaire to be a part of another questionnaire.

ITService. An IT service consists of a set of different activities to be performed by an IT department to meet specific business or IT demands. Thus, as the structure of an individual benchmark is based on IT service catalogs, describing the parts of this service in natural language and based on indicators for the measurement of the service KPIs, this structural information is represented by the ITService concept. In other words, an ITService is a specialization of the more general questionnaire consisting of KPIs that are directly linked to IT service activities and their organizational resources (such as costs or human resource). Once an IT service is defined, it can also be further divided into sub-services.

ServiceSegment. It is also possible to structure an IT service in more fine grained ways. Thus, an IT service can be divided into a set of smaller service segments. For example, an indicator set of a service could be divided into indicators referring to mobile and stationary IT systems in accordance with the description of the underlying IT service catalog structure. Moreover, a service segment may be further divided into smaller segments if necessary to maintain the structural information of this service.

B4.4.1.2 Participants and Values

In the domain of IT benchmarking, a participant represents an organization contributing values of benchmarking indicators (answering questions) specific to an individual benchmark. In the ontology, this organization is represented as a class (i.e., Organization) and connected to an individual benchmark (i.e., Benchmark). The contributed values are indicated by the use of the Participation and IndicatorDeclaration classes. The description of these classes is as follows:

Organization. A participant represents an organization participating in specific benchmarks (minimum of one) and is identified by its name. To foster reuse, it refers to the *DUL:Organization* concept provided by the DUL ontology.

Participation. According to the IT benchmarking process an organization contributes its KPIs (alues) while participating in a specific benchmark. In DUL, such participations are usually represented by *DUL:involvesAgent* and the *DUL:isAgentInvolvedIn* properties, established between an event and its participants. However, this approach is insufficient, as a single property cannot represent the ternary relation of a benchmark and the participant in combination with the contributed values (cf. Noy et al., 2016). Therefore the participation has been implemented based on the Nary Participation ontology design pattern (Gangemi, 2016a), which specifies a reified participation concept and a *participationIncludes* property to link participation with (i) at least one event (e.g., the benchmark), (ii) at least one object (e.g., the participant and its values), and (iii) at least one time interval to describe when the participation in the event occurred. Regarding the ITBM ontology, however, the time index of the participation (iii) was removed as we are only interested in the time span for which collected values are valid (i.e., given by the benchmark event) rather than the time span in which values were collected. Moreover, to further specify the role of a certain entity during one participation, additional properties (i.e., *hasBenchmark*, *hasOrganization* and *hasIndicatorDeclaration*) inheriting from *participationIncludes* have been introduced.

IndicatorDeclaration. For each indicator value, provided by a specific organization, an *IndicatorDeclaration* (grounded in the *DUL:Region* concept) is instantiated. This is included in one participation and represents the measures of exactly one specific indicator. An IndicatorDeclaration has one or multiple values attached to it. Currently, these values can be in the format of strings, booleans or decimals, represented by the corresponding subclasses. For each pair consisting of a participation and an indicator, only one IndicatorDeclaration is instantiated. Thus, using a subclass referring to a specific unit type, instead of the more abstract IndicatorDeclaration, an indicator can only be described by a single type of unit at one time, even if more values are attached to it (e.g., a list of values).

StringIndicatorDeclaration. A *StringIndicatorDeclaration* refers to indicator values that are described in string format. Suitable indicators include qualitative indicators such as descriptions of service level agreements.

BooleanIndicatorDeclaration. A *BooleanIndicatorDeclaration* refers to indicator values that are described in boolean format, that is, indicators having binary values assigned (e.g., yes/no). For example, such indicators refer to the question of whether a certain technology is used within an organization.

DecimalIndicatorDeclaration. A *DecimalIndicatorDeclaration* refers to indicator values that are described in decimal format. It represents, for example, quantitative performance indicators, such as the number of workplaces, as well as cost indicators.

One of the most important relations within the concepts described above is the relation between the Benchmark and its associated participation and the involved Organizations. The Participation concept is only required to model the ternary relation between a benchmark, its participants and their provided values. This, however, comes at the cost of a more complicated ontology usage, as this intermediate concept has to be considered for related queries. Moreover, using DUL, one would usually expect that for participation relations, a *DUL:involvesAgent* and/or its inverse *DUL:isAgentInvolvedIn* is specified. Unfortunately, the Nary Participation pattern does not include statements to establish such a relation. This issue is addressed by utilizing complex role inclusion (Horrocks/Kutz/Sattler, 2006). Thus, to define the original *DUL:involvesAgent* property (which also implies its inverse), a property chain consisting of the inverse of *hasBenchmark* ($hasBM^{-1}$) and the *hasOrganization* (*hasOrg*) property has been specified to imply the *DUL:involvesAgent* property and is formally represented as

$$hasBM^{-1} \circ hasOrg \sqsubseteq involvesAgent. \tag{B4.1}$$

As mentioned before, indicators of a specific benchmark (i.e., their instantiation) are linked to a single category using the *categorizesIndicator* object property. If, for example, category A nests category B, which already nests category $($C), category $($A) also nests category $($C) and is referred to as a transitive relation of categories. This transitiveness does not apply to indicators linked by *categorizesIndicator*. To ensure that category A also includes all indicators that are categorized by one of its sub-categories, the following needs to be introduced:

$$hasChild \circ categorizesIndicator \sqsubseteq categorizesIndictor \tag{B4.2}$$

B4.4.2 General Indicator Declaration

The General Indicator Declaration section (cf. Figure B4.3) introduces a taxonomic description of the indicators used in IT benchmarks. This starts from the top level with the general Indicator class and moves on to the more specific concept of an indicator (for example, the MobileDevicesIndicator in Figure B4.3) that refers to indicators that are instantiated by an individual benchmark. In other words, instances of indicators form the entities that are linked to a benchmark structure described in Section B4.4.1.1. The most specific classes, which contain the subset of indicator instances, refer to the same (specific) indicator, as they are included in different individual benchmarks.

The taxonomy is implemented in three different layers (L1 to L3). Except for the first layer, layers 2 and 3 consist of a large set of classes partitioning the set of available indicators by different characteristics using *subClassOf* definitions. Due to the large number of indicators, in the following, we refer to a complete layer, rather than to a single concept, to provide a more coarse-grained description instead of describing each concept individually.

L1: General Concept. The top layer of the taxonomy only consists of the root concept of the taxonomy: the *Indicator* class. This class constitutes the set of all instantiated indicators and is grounded in the *DUL:InformationObject* class to describe more abstract pieces of information to be realized by a questionnaire. Furthermore, the elementary data property *hasLabel* is defined and used by indicator instances to specify at least one label used as an indicator name within a specific benchmark (equivalent to an individual benchmark).

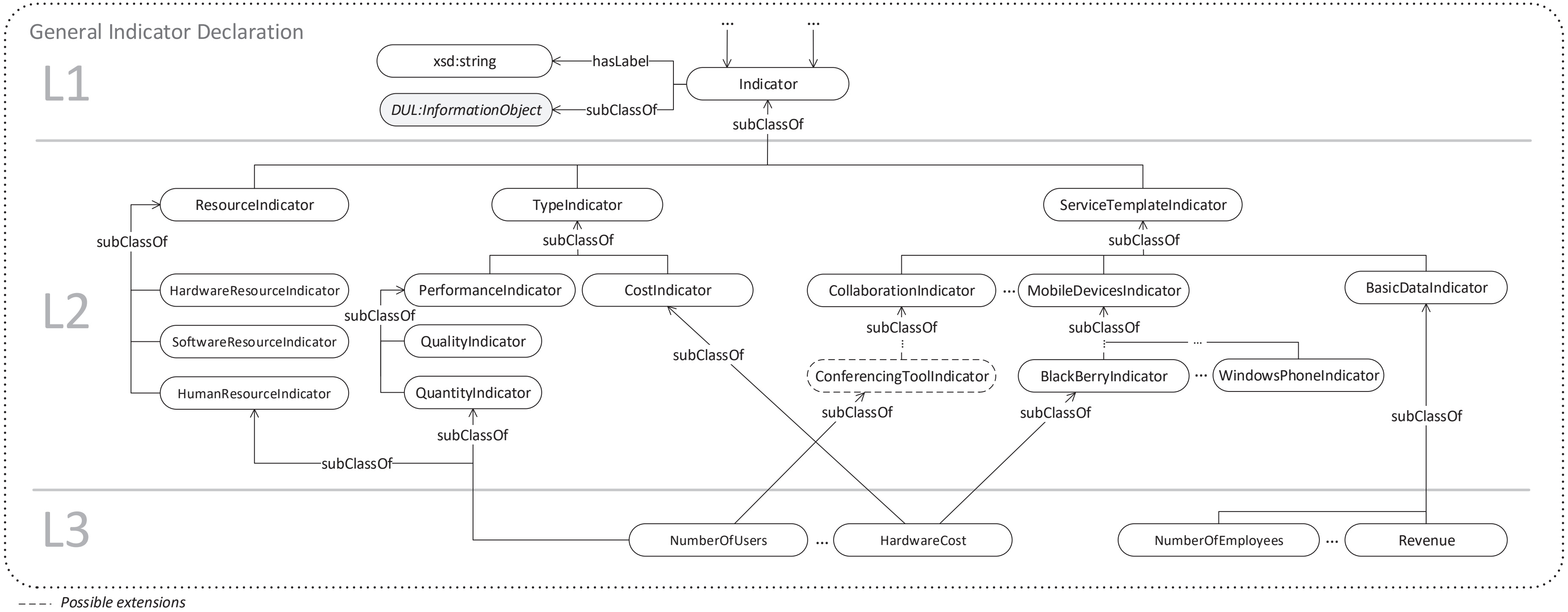

Figure B4.3: *General Indicator Declaration including exemplary indicators. Solid arrows indicate taxonomic relationships, and concepts with dashed borders indicate examples of more fine-grained extensions of the service template. Statements of disjoint classes are omitted to improve readability.*

L2: Indicator Dimensions. Indicators may be classified using different dimensions. In the current ontology version, we introduced dimensions for (i) the (IT) service that is measured according to a service template for the structure of an IT service based on recent research activities (Riempp/Müller/Ahlemann, 2008; Rudolph, 2008), (ii) the specific type of questions to which an indicator is assigned (i.e., whether it is a cost or performance indicator) and (iii) the type of resource (i.e., hardware, software, or human resource) to which the indicator refers.

There is no natural order for performing hierarchical splits among the different dimensions; thus, all possible splits are performed in parallel in the intermediate layer of the taxonomy. One dimension subdivides the set of all indicators into smaller (sub-)sets. These subsets of indicators belong to a certain service or a certain type of indicator.

Concepts within the same dimension and the same hierarchical level are pairwise disjoint. Specifically, an indicator (L3) may only be of one type for each dimension. Moreover, except for the service template dimension, a dimension does not necessarily need to cover all indicators. Thus, it is possible to specify indicators that are neither cost nor performance indicators and/or do not imply a resource type.

Indicators belonging to the basic data service template (represented by the BasicDataIndicator class) describe the core data of participating organizations (e.g., the yearly revenue), the number of employees, and structural information about the organization among others. Most indicators are neither performance nor cost indicators and therefore are separated in this basic data service. The remaining services refer to more specific IT services, such as those regarding user collaboration or IT infrastructure.

The resource dimension refers to the resources described by a specific indicator. Possible resources include hardware, software and human resources. Performance indicators may be further split into quality (e.g., referring to service level agreements) and quantity indicators. There are, however, performance indicators that are neither quality nor quantity indicators.

Dimensions can have their own intrinsic hierarchy, describing the different concepts they consist of in different granularities. For example, as shown in Figure B4.3, the collaboration indicators are additionally specified by the ConferencingToolIndicator class in the service template dimension. Another example at a more specific level includes indicators to be further split according to different quality or hardware standards that they describe, such as BlackBerry or WindowsPhones within the MobileDevices service template.

In contrast to the introduced intermediate abstraction levels shown in Figure B4.3, the current implementation of the ontology contains two levels of abstraction within the service template dimension (additional splits are marked as possible extensions). The first abstraction refers to the service name, and the second abstraction refers to an additional sub-classification, for example as, currently implemented for the MobileDevices service. In contrast to the service template dimension, descriptions of other dimensions are expected to remain more constant.

L3: Indicators and Relationships. The bottom layer of the indicator taxonomy consists of the most specific indicator descriptions, referring to a single indicator instantiated by individual benchmarks rather than to an indicator categorization. As explained above, such indicators are classified in one or multiple dimensions (using *subClassOf* definitions) but are only covered completely within the service template dimension.

B4.4.3 Ontology Summary

At present, the IT benchmarking ontology consists of a number of statements, which are summarized in Table B4.4. The number of classes corresponds to the concepts described in the previous sections, including the 20 top-level service classes (one of which is the basic data service), corresponding to IT services that are commonly measured within an IT benchmark, and the 1,064 L3 indicator classes, corresponding to key performance indicators that are measured during an IT benchmark. Entities of the indicator taxonomy do not have their own properties defined but rather inherit the *hasLabel* property from their *Indicator* base class. Therefore, only a small set of object and data properties need to be additionally defined, and they are shown in Figure B4.2. Currently, the majority of axioms refer to the number of *SubClassOf* definitions. However, axioms on the domain and range of object properties and statements relevant to the characterization of disjoint classes also exist. The number of annotations includes bilingual (viz. English and German) *rdfs:label* and *rdfs:comment* for all classes. The description logic expressiveness for the benchmarking ontology is $\mathcal{SRIQ}(\mathcal{D})$.

Table B4.4: *Number of classes, properties, axioms and annotations in the ITBM ontology V1.4*

Ontology Metric	#	Ontology Metric	#
Classes	1,192	Logical Axioms	3,287
Object Properties	123	Annotations	5,264
Data Properties	9		

B4.5 Application and Use Case of the ITBM Ontology

B4.5.1 System Architecture

Because the ITBM ontology is built for the purpose of data access in the domain of IT benchmarking and is based on research activities on strategic and service-oriented IT benchmarking initiatives, the application of the ITBM ontology within a web-based system architecture for data access will be described in the following. The main focus of the presented prototype is on (i) accessing data from external databases through the use of natural language queries and (ii) supporting the (semi-)automatic mapping of concepts of the ontology with data points of the attached databases.

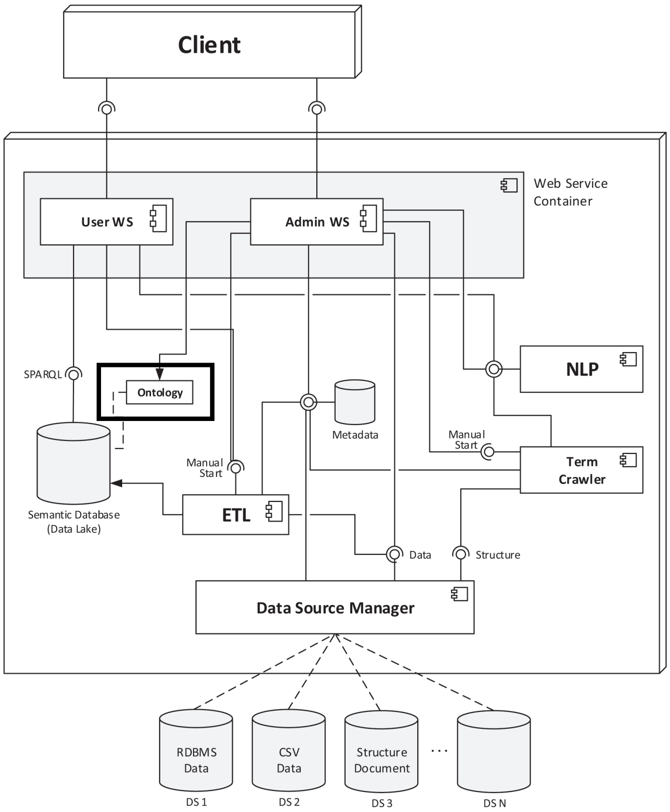

Figure B4.4: *System architecture for ontology-based data integration, based on Pfaff/ Krcmar* (2018)

The complete system architecture is described in more detail in Pfaff/Krcmar (2018). Figure B4.4 illustrates the complete system architecture. A black border highlights the implementation of the ontology within the system. The connection of external data sources is configured through the use of the data source manager. The data source manager ensures the correct mapping of the relational structure of the attached databases to the corresponding ontology by detecting changes in the relational scheme. These changes are reflected in a new version number for the data source.

The Extract, Transform, Load (ETL) module is implemented for the data integration task (see below). This process is based on a two-fold mapping of the metadata stored in the metadata repository. The first part (part 1) specifies a set of transformation rules to transform external data models (i.e., a database scheme) into a virtual model, where each virtual table (i.e., SQL queries, referred to as *Generators*) corresponds to an ontological concept. The specification in the second part (part 2) utilizes this virtual model to map table instances (i.e., rows) to instances of the corresponding concepts. Examples of those metadata are provided in Listing B4.1. A *generator* created on top of the organization table of an external database is specified (part 1) and mapped to the *DUL:Organization* concept of the ontology (part 2). To keep the example simple, both further transformations (e.g., filters) and specifications of links to other generators (i.e., foreign keys) have been omitted.

```
<generator name="gen_organization" baseTable="organization">
   <primary-keys>
      <column>id</column>
   </primary-keys>
</generator>

<mapping class="DUL:Organization" generator="gen_organization">
   <data-property name="bm:hasOrgName" value="#{name}" />
</mapping>
```

Listing B4.1: *Exemplary mapping metadata.*

Creating such mappings for all tables/concepts is a tedious process; thus, to support the mapping of database contents to ontology concepts (i.e., creating the second part of metadata), a (semi-)automatic mapping recommender is implemented. Here, "(semi-)automatic" refers to the fact that mappings are initially recommended by the system but not applied automatically so that human interaction is needed to confirm recommended mappings for the purpose of quality assurance. The system supports two different types of mapping recommendations. The first type of recommendation assumes that a whole database table corresponds to an existing ontology concept and the second type of recommendation that each database table record is mapped to a different ontology concept. Additional details are provided as follows:

- *Mapping (virtual) tables to ontology concepts:* Often, a (physical) table from the original database schema directly corresponds to a concept defined in the ontology. In this case, all records of this table are converted to instances of this concept. Note that if concepts in the ontology are specified on a more fine- or coarse-grained level of abstraction, such a table may still be constructed virtually using appropriate SQL statements (e.g., JOINs); within the scope of the system, this type of table has been referred to as *Generators*. For example, consider the database table *"organization"*, which contains all the organization names of the participants for a specific benchmark. Thus, the rows of this table directly reflect the instances of the *DUL:Organization* concept that need to be integrated. The matching of database table names to the concepts of the ontology is based on different similarity metrics. This mapping is realized by the mapping recommender. For quality assurance, the mapping candidates are presented to the user for confirmation. An example of such a mapping is given in Listing B4.1. In this example, the mapping process for two organizations, named *Organization 1* and *Organization 2* (cf. the name column of the organization table), results in the corresponding triples, which are shown in the following Listing B4.2.

```
:org1   rdf:type       DUL:Organization;
        bm:hasOrgName  "Organization␣1"^^xsd:string.
:org2   rdf:type       DUL:Organization;
        bm:hasOrgName  "Organization␣2"^^xsd:string.
```

Listing B4.2: *Result of an exemplary table-concept mapping.*

- *Mapping (virtual) table records to ontology concepts:* Sometimes records are not meant to be converted to instances of the same concept but rather are partitioned to different concepts. In this case, a specific table is chosen, and each of its records is converted to one instance of a specific concept of the ontology. For example, a database table of *indicators* may consist of the different indicators that are captured during the benchmark. In this case, however, each row of the table corresponds to an individual concept within the ontology. Consequently, the mapping recommender searches for a corresponding concept for each row of the table within the ontology by applying similarity metrics to each of these rows/concepts. As a result, a mapping entry is generated for every table row. Listing B4.3 shows the mapping results for the *NumberOfEmployees* table and the *Revenue* table (cf. Figure B4.3) labeled with *Number of employees* and *Yearly revenue* to their corresponding ontology concepts.

```
:ind1   rdf:type       bm:NumberOfEmployees;
        bm:hasLabel    "Number␣of␣employees"^^xsd:string.
:ind2   rdf:type       bm:Revenue;
        bm:hasLabel    "Yearly␣revenue"^^xsd:string.
```

Listing B4.3: *Result of an exemplary row-concept mapping.*

Both of these mapping cases are implemented through the use of the same underlying bipartite matching algorithm (based on Kuhn/Yaw (1955)) differing from its run-time configuration. In the first case (i.e., mapping (virtual) tables to ontology concepts), the total set of virtual and physical table names and the names of the ontology concepts are used as input configuration. In the second case (i.e., mapping (virtual) table records to ontology concepts), the total set of rows of a specified table and the names of ontology concepts are used as the input configuration for the mapping algorithm.

These mappings represent the assignment between the entities and attributes from the data sources and their corresponding concepts and properties of the ontology. According to these mappings, the data integration process is stepwise performed as follows (executed by the ETL module):

- Load the mapping entries in accordance with the selected versions of both the ontology and the connected databases.
- Apply transformation rules to the relational models of the connected databases to create an intermediate model with bidirectional links between tables; this is realized by creating a set of SQL statements wrapped around the original tables.
- Load data from attached databases via the data source manager using the generated SQL statements.
- According to the second part of the mapping specifications, map tables to concepts by converting their rows into instances of the ontology using the triple-store format.
- Load the data into the semantic DB as a new graph within the semantic database; old data are kept in the old graph.

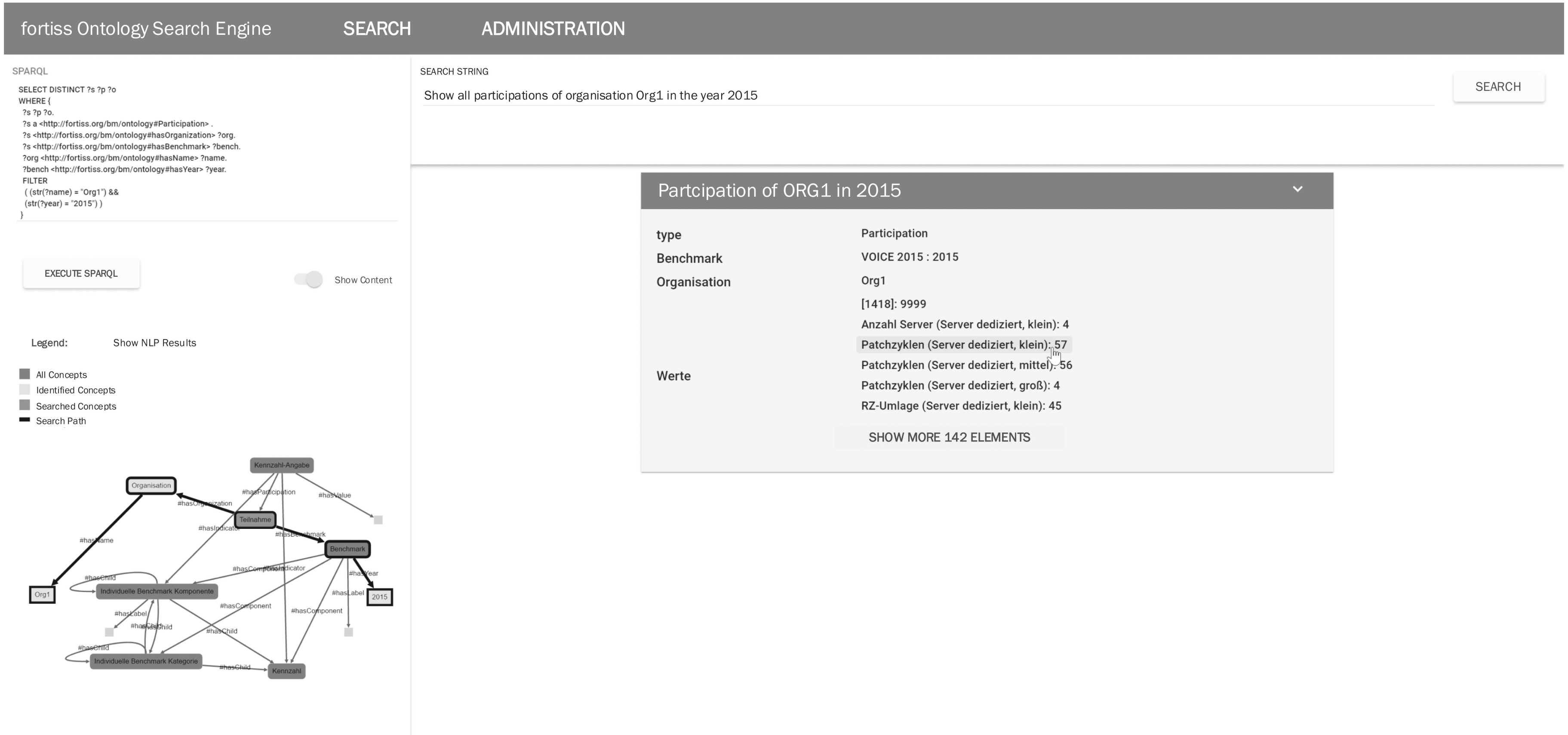

Figure B4.5: *Client-side search mask for ontology-based data access in ITBM*

- Check whether the new graph differs from the data loaded in previous ETL iterations and log changes.

A web interface can be used to access the attached data sources via natural language text (text-to-sparql). This client-side user interface is implemented using AngularJS (Google, 2016) and is shown in Figure B4.5. As a result of most of the data sets being in German, the output of the user query (*"Show all participations of organisation Org1 in the year 2015"*) is presented in the German language. Directly underneath the automatically generated SPARQL query, the search tree within the ontology is presented. Blue nodes represent the corresponding concepts in the ontology when the user searches for data sets. In addition, the automatically generated SPARQL queries can be directly edited or reformulated using the web interface.

B4.5.2 Competency Questions and SPARQL Queries

Because data access is generally performed through the use of natural language queries (see Section B4.5) and can also be performed by executing SPARQL queries, the correspondence between the CQs and the resulting SPARQL queries is outlined in the following, focusing on the most complex or interesting queries (see Table B4.5 and Table B4.6).

CQ2 asks for all performance indicators that have been collected in a specific benchmark of a specific year. In SPARQL, these performance indicators are queried by filtering the set of all benchmarks in accordance to the defined benchmark name and year. As previously stated, all indicators of a specific benchmark are linked to a specific questionnaire (see Section B4.4.1.1). Thus, all performance indicators that are linked to this questionnaire are queried. Please note that the root questionnaire directly categorizes all indicators linked to a benchmark due to the *bm:categorizesIndicator* property chain (see Section B4.4.1.2).

CQ4 asks for the existence of all IT services to which an organization responded within a specific benchmark (i.e. values for indicators are provided by the organization). An organization can participate within various benchmarks; therefor all its participations, the corresponding indicator declarations and its indicators are queried. As a result of this CQ the result set of this query only contains indicators that have been specified within a specific IT service.

CQ10 asks for the total number of responses provided by an organization for the specific indicator *bm:NumberOfEmployees*. The resulting SPARQL counts the number of indicator declaration instances referring to this indicator.

Next, CQ11 queries all participations of all organizations and the benchmarks they participated in using the introduced object property chain, which infers the *dul:involvesAgent* property for all benchmarks and organizations.

Table B4.5: *Excerpt of competency questions and corresponding SPARQL queries for indicator structure and individual benchmarks.*

<table>
<tr><th>Group</th><th>CQ</th><th>SPARQL Query</th></tr>
<tr><td rowspan="2">Indicator
Structure</td><td>CQ2</td><td><pre>SELECT * WHERE {
  ?bm a bm:Benchmark ;
        bm:hasLabel "<BENCHMARK_NAME>" ;
        dul:hasTimeInterval <YEAR> ;
        bm:hasReporting ?qn .
  ?qn bm:categorizesIndicator ?ind .
  ?ind a bm:PerformanceIndicator .
}</pre></td></tr>
<tr><td>CQ4</td><td><pre>SELECT DISTINCT ?service WHERE {
  ?org a dul:Organization ;
         bm:hasOrgName "<ORGANIZATION_NAME>"
            ;
         bm:isIncludedInParticipation ?part .
  ?dec a bm:IndicatorDeclaration ;
         bm:isIncludedInParticipation ?part ;
         bm:measuresIndicator ?indicator .
  ?service a bm:ITService ;
         bm:categorizesIndicator ?indicator .
}</pre></td></tr>
<tr><td rowspan="2">Individual
Benchmarks</td><td>CQ10</td><td><pre>SELECT (COUNT(?dec) AS ?count) WHERE {
  ?dec a bm:IndicatorDeclaration ;
         bm:measuresIndicator ?indicator .
  ?indicator a bm:NumberOfEmployees .
}</pre></td></tr>
<tr><td>CQ11</td><td><pre>SELECT ?org ?bm WHERE {
  ?org a dul:Organization .
  ?bm a bm:Benchmark ;
        dul:involvesAgent ?org .
}</pre></td></tr>
</table>

CQ13 queries the number of organizations that participated in at least one benchmark. Similar to CQ11, this is achieved using the inverse of *dul:involvesAgent*, that is, *dul:isAgentInvolvedIn*, and then by counting over the distinct result set. Note that without using the DISTINCT command, organizations that have participated in more than one benchmark would be counted multiple times.

By CQ15, the yearly revenue of a specific organization is queried. Using the abstract property *bm:isIncludedInParticipation*, the organization is identified by its name, the years are queried using the specific benchmarks that the organization participated in, and the corresponding values of the revenues are returned.

By CQ19, the average number of employees of all organizations in a specified year with a revenue within a specified range is calculated. Again, the abstract *bm:isIncludedInParticipation* property is used to query the participation pattern. Thus, the organizations, the benchmarks, the indicator declaration of the revenue, and the indicator declaration of the number of employees are queried. The resulting set of values is filtered to match the specified revenue range and the number of employees is averaged and returned.

Table B4.6: *Excerpt of competency questions and corresponding SPARQL queries for participants and values*

Group	CQ	SPARQL Query

Participants and Values	CQ13	SELECT (COUNT(DISTINCT ?org) AS ?count) WHERE {
		?bm a bm:Benchmark .
		?org a dul:Organization ;
		dul:isAgentInvolvedIn ?bm
		}

	CQ15	SELECT ?org ?year ?value WHERE {
		?org a dul:Organization ;
		bm:hasOrgName "<ORGANIZATION_NAME>" ;
		bm:isIncludedInParticipation ?part .
		?dec a bm:IndicatorDeclaration ;
		bm:isIncludedInParticipation ?part ;
		bm:measuresIndicator ?ind ;
		bm:hasValue ?value .
		?ind a bm:Revenue .
		?bm a bm:Benchmark ;
		bm:isIncludedInParticipation ?part ;
		dul:hasTimeInterval ?year .
		}

	CQ19	SELECT (AVG(?value) AS ?avg) WHERE {
		?org a dul:Organization ;
		bm:isIncludedInParticipation ?part .
		?bm a bm:Benchmark ;
		dul:hasTimeInterval <YEAR> ;
		bm:isIncludedInParticipation ?part .
		?dec a bm:IndicatorDeclaration ;
		bm:isIncludedInParticipation ?part ;
		bm:measuresIndicator ?ind ;
		bm:hasValue ?value .
		?revDec a bm:IndicatorDeclaration ;
		bm:isIncludedInParticipation ?part ;
		bm:measuresIndicator ?revenueInd ;
		bm:hasValue ?revenue .
		?ind a bm:NumberOfEmployees .
		?revenueInd a bm:Revenue .
		FILTER (?revenue > <NUMBER_1> && ?revenue < <NUMBER_2>)
		}

B4.6 Conclusion and Outlook

This work introduces a domain-specific ontology for the domain of IT benchmarking to bridge the gap between a systematic characterization of IT services, which is closely related to ITSM, and their data-based valuation in the context of IT benchmarking. This ontology will serve as a universal link for the semantic integration of different types of different benchmarking data. It is based on ITBM data and IT service catalogs collected over the last eight years in the context of research activities at fortiss and TUM. The ontology is implemented in an evaluation and reporting tool for ITBM as a core concept for the data access and connection of different ITBM data sources.

The layered indicator structure addresses two major aspects that have to be considered when developing an ontology for IT benchmarking. First, it provides the flexibility needed when assembling a new service based on individual indicators, as it separates the service structure from the indicator structure. Second, new indicators can be introduced or modified apart from the service structure. This eases the maintenance of the ontology for future improvements and customizations on both sides; the indicators and the service structure.

At present, the ontology is divided into three sections: (i) Individual Benchmarks, (ii) Participants and Values, and (iii) General Indicator Declaration. Therefore, a separation of the general time-related information of a benchmark and the structural information of the utilized questionnaires from the corresponding data that are connected to a specific indicator is achieved. For future work, the *General Indicator Declaration* section, which is implemented in a three-layer (L1 to L3) architecture that considers the relevant relations and dependencies of all indicators within a benchmark could be extended by introducing further categorization within the service template dimension as well as by introducing a new dimension, therein consisting of a set of several disjoint L2 classes in the L2 layer referring to different unit types. It could be the case that various indicators share their unit or may be of different indicator unit types within different IT services. For example, one performance indicator can be represented by a single number (e.g., number of physical hosts), whereas another indicator can be indicated by textual values (e.g., the name of a specific software product). The same holds true for cost indicators, which might be expressed in different currencies (e.g., Euros or Dollars) or other units (e.g., Full Time Equivalents (FTEs)). In addition, some indicators that are neither cost nor performance indicators (i.e., that are not classified within this dimension) could also share their type of unit with cost or performance indicators. For example, the yearly revenue, which is part of the basic data service, could be seen as a shared cost indicator, and the number of employees of an organization can be an example of a shared performance indicator. To overcome this fragmentation of different indicator types, the dimension of the *General Indicator Declaration* could facilitate defining a set of restrictions across different dimensions, i.e., classes referring to unit types could be declared pairwise disjoint from classes belonging to different dimensions (e.g., CostIndicators could be defined disjoint from any type of textual unit types). By directly assigning the unit type to an indicator, a more fine-grained indicator categorization would be achieved.

The ITBM ontology is already implemented as bilingual (viz. English and German) using annotation properties, and the application that the ontology is part of handles terminological transformations through the NLP module, which is sufficient for the current use case, as all concepts of the ontology are already lemmatized. In the future, this linguistic information could be further improved through the use of an ontology lexicon such as the lexicon model for ontologies (lemon) as introduced by Cimian/McCrae/Buitelaar (2014). In this manner, it could be possible to improve the results of the NLP module, especially if the ITBM ontology is continuously expanding and if multiple languages and vocabularies need to be associated with the ontology.

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Chapter B5

A Web-Based System Architecture for Ontology-Based Data Integration in the Domain of IT Benchmarking

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Table B5.1: *Bibliographic details for P5*

[26]`https://jcr.incites.thomsonreuters.com`
[27]`http://www.scimagojr.com/journalsearch.php?q=10900153330&tip=sid&clean=0`

A web-based system architecture for ontology-based data integration in the domain of IT enchmarking

Abstract In the domain of IT benchmarking (ITBM), and especially within a specific benchmark a variety of data and information are collected. Although these data serve as the basis for business analyses, no unified semantic representation of such data yet exists. Consequently, data analysis across different distributed data sets and different benchmarks is almost impossible. This paper presents a system architecture and prototypical implementation for an integrated data management of distributed databases based on a domain-specific ontology. To preserve the semantic meaning of the data, the ITBM ontology is linked to data sources and functions as the central concept for database access. Thus, additional databases can be integrated by linking them to this domain-specific ontology and are directly available for further business analyses. Moreover, the web-based system supports the process of mapping ontology concepts to external databases by introducing a semi-automatic mapping recommender and by visualizing possible mapping candidates. The system also provides a natural language interface to easily query linked databases. The expected result of this ontology-based approach of knowledge representation and data access is an increase in knowledge and data sharing in this domain, which will enhance existing business analysis methods.

B5.1 Introduction

Benchmarking, as a systematic process for improving organizational performance, has considerably increased in popularity worldwide since the 1980s. This process is based on the insight that by observing organizations and analyzing their performance, an organization can transform the way that it conducts business. In the context of benchmarking, such a transformation is generally achieved by applying the lessons learned from benchmarking results to one's own organization (Camp, 1989; Peters, 1994). Moreover, such performance measurements (or benchmarking) can often assist in explaining value or cost aspects to stakeholders (Spendolini, 1992). Thus, the analysis and evaluation of this type of performance measurement approach have been the subject of various studies (e.g., Smith/McKeen (1996); Gacenga et al. (2011)).

In fact, research in the field of ITBM is typically focused on the structuring, standardizing and generalizing of IT service catalogs and on their implementation within companies (e.g., Dattakumar/Jagadeesh (2003); Kütz (2006); Nissen et al. (2014)) to model internally provided IT services in a standardized manner. Since IT service catalogs are commonly designed for internal or individual purposes only, they are often not directly comparable, particularly across different organizations. The information collected in a benchmark exercise is generally obtained using questionnaires on a broad range of topics, such as employee costs, software licensing costs, quantities of hardware and so forth. All of these approaches have one commonality: a concept for a uniform data management is not considered although it is strongly recommended (Wollersheim/Pfaff/Krcmar, 2014; Pfaff/Krcmar, 2015). Moreover, little work published to date in the IS literature addresses this challenge of data integration across different types of IT benchmarks. Thus, most literature sources omit facts related to data quality and data integration. The lack of a uniform description of any arbitrary parameter that is measured and the relationships between parameters, limit the comparability of different types of benchmarks. In general, a domain-specific ontology may be a solution to ensure that the collected data are meaningful and to overcome these limitations of data comparability (Horkoff et al., 2012; Pfaff/Krcmar, 2014).

An ontology can either be constructed with assistance from domain experts or be discovered from domain-specific data. The first approach in ontology construction is performed manually and has high time and energy demands. If the ontology is to be developed for a more complex application area, then it tends to become increasingly subjective. An ontology may differ in numerous aspects depending on the recipient of the ontology, even when the ontology is constructed by domain experts. This is in contrast to the idea of a universal, common description of domain-specific knowledge. The second method of developing an ontology using the support of automated or semi-automated methods reduces the manual effort required for ontology construction and enhances the quality of the obtained ontology. Therefore, this paper is based on the results of the development of a domain-specific ontology in the ITBM domain supported by the use of NLP techniques, as presented in (Pfaff/Krcmar, 2014). This ontology was initially constructed based on already existing IT service descriptions and catalogs of numerous small- to medium-sized enterprises and on several questionnaires from different ITBM approaches. The data presented here were collected over the past seven years; they were supervised and evaluated within different benchmarking approaches and they encompass data from strategic and consortial IT benchmarks. Subsequently, as a result of the different acquisition channels through which the data were collected (i.e., on-line web platforms, Excel questionnaires and other sources), various different distributed data sources could be integrated using this domain ontology. In this paper, this ontology is used as the basis for a uniform data description in the domain of ITSM in general and ITBM in particular. To foster reuse of the benchmarking ontology the linkage to concepts provided by the DUL ontology (2016b) is also implemented. The benchmarking ontology in version 1.1 is available at `https://w3id.org/bmontology`. In addition to this domain ontology, a system architecture for the integration of existing distributed data sources is presented in this paper. Thus, this work addresses the following questions: How can a system be designed to integrate existing distributed data sources using a domain-specific ontology? How can the administrator be supported to keep all the system components (mappings) up to date? To provide users with simple access to these distributed data sources NLP techniques are used to translate natural language requests into SPARQL (Prud'hommeaux/Seaborne, 2008) queries. The system architecture follows a service-oriented design, encapsulating client (user)-side functionalities in a browser application and server-side funcionalities in replaceable (service) components. Because ontologies are not static entities but evolve over time, the system is able to handle version changes of the ontology to safeguard data accessibility to the attached data sources.

The remainder of this paper is organized as follows: Section B5.2 provides an overview of the relevant literature on the domain of ITBM, the ITBM ontology and on ontology-based applications. Section B5.3 addresses methods for data integration in ITBM and describes the proposed system architecture for the ontology-based data integration of various distributed data sources in this domain. Section B5.4 summarizes the results and metrics used for the data integration and presents the prototypical implementation of the proposed system architecture. Finally, Section B5.5 offers conclusions and perspectives for future work and extension possibilities of the proposed system.

B5.2 Background

B5.2.1 The Domain of IT Benchmarking

As a systematic process for improving organizational performance, benchmarks can be classified according to the type of study (e.g., processes, products, strategies or generic objects) (Carpinetti/Oiko, 2008). Benchmarking partners may be units of the same organization, competitors in the same or different geographical markets, or organizations in related or unrelated industries. Thus, a distinction is drawn between internal and external comparisons of these performance measurements. Whereas an internal performance measurement focuses on the operation of a single company, an external performance measurement focuses on different companies. A benchmark can be subdivided into several process phases, beginning that the initial conception which describes the object of investigation and ending with optimizing and re-organizing internal (business) processes. In each of these phases of a benchmark, numerous data are collected in various data formats. These data consists of both qualitative and quantitative statements and are collected throughout the entire benchmarking cycle for every benchmark. Furthermore, these data are collected for every benchmarking participant. As previously stated by Ziaie et al. (2013) and described in a structural form by Riempp/Müller/Ahlemann (2008), tool-based data collection is quite common in the ITBM domain.

The representation of business knowledge using ontologies has become popular in recent years, with a particular focus on the representation of business processes (Thomas/Fellmann, 2009; Garcia-Crespo et al., 2011; Aldin/Cesare, 2011; Jung et al., 2013; Hachicha et al., 2016). By nature, when an ontology is constructed with a focus on business processes, it lacks the information needed to shift the focus to financial aspects, which are of crucial importance in the ITBM domain. The same holds true for ontologies used for business modelling, system configuration and execution management systems, as presented by Cai et al. (2015), as well as for typologies in the context of BPM, as introduced by Müller et al. (2016). On the one hand, this also applies for ontologies in the context of ITSM (Freitas/Correia/Abreu, 2008; Valiente/Garcia-Barriocanal/Sicilia, 2012), IT governance frameworks in the context of the ITIL (ITIL, 2011) and for related ontologies, such as the GoodRelations ontology (Hepp, 2008) or the FIBO (Council, 2016). On the other hand, ontologies such as the BMO (Osterwalder/Pigneur/Tucci, 2005) and the e^3-value ontology (Gordijn/Akkermans, 2001) only focus on the conceptualization of economic aspects within a single enterprise or economic aspects within a network of enterprises. To the best of our knowledge, the only existing approach for measuring the impact of IT infrastructure changes on business processes and vice versa by an ontology was introduced by vom Brocke et al. (2014). However, the focus of this study is in linking (inner) organizational processes to their corresponding IT resources. However, (semi) automatically compare IT-related and business-related performance indicators across company boundaries, a more fine-grained conceptualization of such information is needed, especially if linking external data sources (i.e., map ontology concepts to IT KPIs) to concepts within an ontology.

B5.2.2 The IT Benchmarking Ontology

The basis for the development of the ITBM ontology is IT service descriptions in the form of IT service catalogs from different (IT) companies. Moreover, ITBM questionnaires (based on Riempp/Müller/Ahlemann (2008); Rudolph/Krcmar (2009)) are used to construct the ontology. The structural layout of an IT service catalog can be generalized to (i) basic organizational information (such as the number of employees and revenue), subsequently referred to as basic data service, and (ii) 19 additional IT services, describing more specific aspects of IT offerings (see Figure B5.1). These IT services provide some general information about the purpose of the service offering (for example providing a mailbox or a virtual machine/server) and detailed information about the performance and cost indicators that are used to measure the performance of this service. Note that calculations of indicators may be dependent on different services. For example, the storage service contains all costs associated with disk storage in a data center; however, some of these storage-specific costs are also required within a more general IT service, such as in the context of server costs (as disk storage is associated with servers in general). Additionally, costs originally related to the database service are based on both the general server costs as part of the infrastructure component and the more specific disk storage costs. Again, some cost indicators of the database service depend on the performance indicators of the server and data storage service. It is also possible that IT services inherit indicators or values from the basic organizational information (such as the total number of employees of an organization) to perform further calculations within a specific service based on such a basic indicator.

The structural layout of the IT service catalogs and IT service descriptions used to construct the ontology is presented in Figure B5.1. In short, IT services are monohierarchically structured. Each top-level service consists of a set of subordinated service segments and optionally additional indicator groups. As shown in Figure B5.1, the basic data service's segments correspond to general organizational information (i.e., organiza-

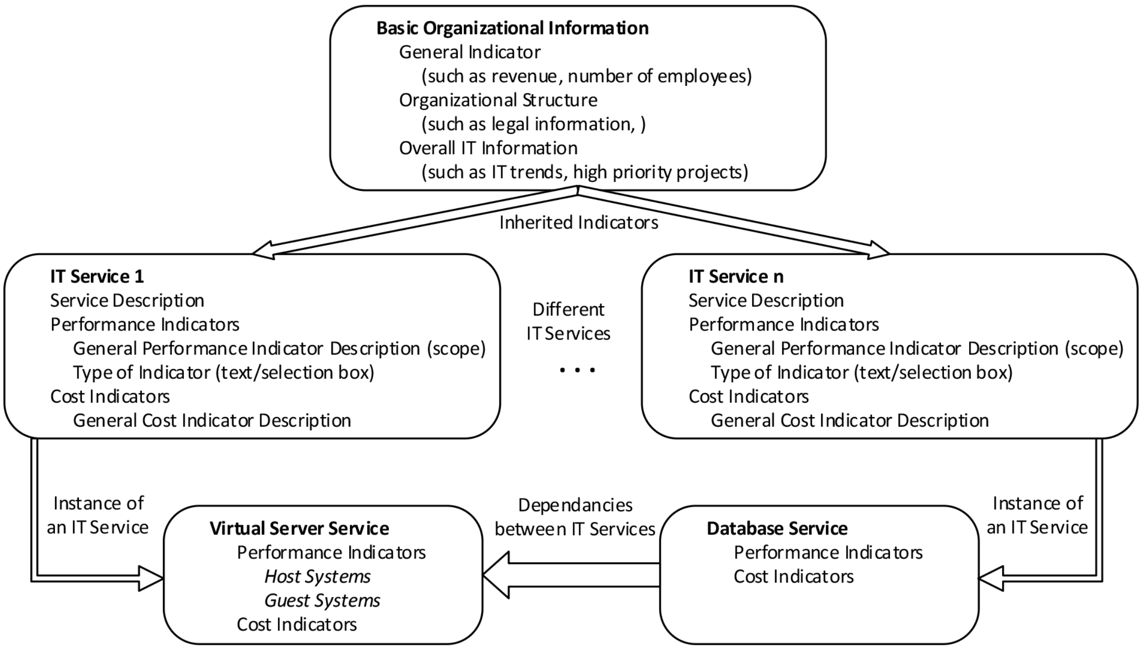

Figure B5.1: *Structural overview of the IT service catalogs used to construct the ontology*

tional structure, IT costs, and so forth), and the remaining IT services are segmented based on whether they are cost or performance indicators and optionally grouped into smaller logical units (for example, the host or guest systems in the context of the virtual server service). Services may also include the costs of other services (e.g., a database service also includes the cost specified in a virtual server service). The core concepts of the benchmarking ontology are described in Section B5.3.1.2.

To allow ontologies to be machine processable, their modeling is often implemented in the OWL because it is part of the W3C languages (Calvanese/De Giacomo/Lenzerini, 2001; McGuinness/Van Harmelen, 2004). Technically, OWL is an extension of the *RDF* and the *RDFS*), which are based on XML as an interchange syntax. As an extension of RDF and RDFS, OWL ensures the smooth technical exchange of information among applications within the context of the Semantic Web and business modeling frameworks (e.g., BPMN framework), which are also based on XML as their interchange syntax. An OWL ontology consists of: (i) classes as sets of individuals, (ii) individuals as instances of classes (i.e., real-world objects in the domain), and (iii) properties as binary relations between individuals. In addition to the implementation of domain knowledge, it is possible to define cardinality ranges and reasoning rules within an ontology. Several reasoning engines (e.g., Pellet, 2015) exist that can be used to infer additional knowledge explicitly included in an OWL ontology (e.g., class equivalence checks). An OWL ontology can be modeled using open-source ontology editors such as Protégé (2014), which is one of the most common tools for ontology development (Khondoker/Mueller, 2010).

To develop the ITBM ontology, we implemented a customized process based on the NeOn framework for ontology engineering (Suárez-Figueroa/Gómez-Pérez/Fernández López, 2012). The ITBM ontology is the result of a number of iterations of the overall ontology engineering process, which is based on an iterative-incremental life cycle model. Thus far, both the NeOn core scenario and the NeOn scenario for the reuse of ontological resources have

Table B5.2: *Extract of competency questions created during the specification activity grouped by pre-established categories as suggested by NeOn: (i) indicator structure, (ii) individual benchmarks, and (iii) participants and values. The square brackets indicate lists of values (Pfaff/Neubig/Krcmar, 2017)*

Group	Competency Question	Exemplary Answer
Indicator Structure	What performance indicators exist?	[NumberOfUsersIndicator]
	What performance indicators are contained in the BENCHMARK_NAME in YEAR?	[NumberOfUsersIndicator]
	Regarding BENCHMARK_NAME of YEAR, how many cost indicators exist?	NUMBER
	What IT services are of interest (i.e., values have been provided for) for the ORGANIZATION_NAME ?	[BasicDataIndicator]
	How many values have been provided for the revenue indicator of the SERVICE_NAME in total?	NUMBER
Individual Benchmarks	How many benchmarks exist?	NUMBER
	In which years was the BENCHMARK_NAME conducted?	[YEAR]
	Which indicators have been queried in at least two benchmarks?	[DesktopInstallCostIndicator]
Participants and Values	How many organizations exist?	NUMBER
	How many organizations have participated in at least one benchmark?	NUMBER
	Does ORGANIZATION_NAME participate in at least one benchmark called BENCHMARK_NAME ?	YES/NO
	What is the yearly revenue of ORGANIZATION_NAME ?	[(YEAR, NUMBER)]
	Regarding YEAR, what is the minimum number of employees of organizations having a revenue between $NUMBER and $NUMBER ?	NUMBER

been used. In addition, some of the NeOn activities were adapted to keep the engineering process as lightweight as possible. According to the NeOn specification for *knowledge acquisition* ontology learning was conducted to support the domain experts in performing the ontology elicitation activity; here, existing service catalogs and databases were analyzed using NLP techniques to extract the most important concepts, as described in detail in (Pfaff/Krcmar, 2015). Following the NeOn guidelines for the specification activity, competency questions were formulated, categorized and prioritized (see Table B5.2). Moreover, the ITBM ontology is grounded in the upper ontology DUL to set the semantic foundation of the ITBM ontology (for details on the relevant concepts that are linked in DUL and the ITBM, see Section B5.3.1.2. The ITBM ontology was modeled using the open-source ontology editor Protégé.

B5.2.3 Ontology-Based Applications

Storing information in ontology-based knowledge bases or systems is becoming increasingly popular across various areas of research. Lehmann et al. (2015) introduced an approach to extract knowledge from Wikipedia using the Semantic Web and linked data technologies, called DBpedia. DBpedia serves as a linked data source on the Web since it covers RDF links pointing to various external data sources and vice versa. This linkage (mapping) is performed manually by the community. For DBpedia, Paredes-Valverde et al. (2015) developed an Ontology-Based Natural Language Interface (ONLI) for querying DBpedia using natural language techniques. Rodríguez-García et al. (2014) proposed a semantically enhanced platform based on an ontology for annotating cloud services to assist in the process of discovering the cloud services. This annotation for the cloud service's semantic repository is generated automatically, but no further external data sources are directly attached by the semantic structure of an ontology. Ong et al. (2017) introduced Ontobee as a linked ontology data server that stores ontology information using RDF triple-store technology that supports the query, visualization and linkage of ontology terms in the biomedical and biological domains. Ontobee primarily used for ontology term querying and result visualization, and it allows the execution manually written SPARQL code. In the health care domain, Lasierra et al. (2014) introduced an ontology-based system to capture knowledge regarding item management and usage for hospitals and medical centers. The focus of this system is to align and unify dispersed health catalog modeling items and the structure of the organization related to their management rather than in data access of external sources by an ontology. Using Ontop, Calvanese et al. (2016) presented an open-source Ontology-Based Data Access (OBDA) system that is used for querying relational data sources in terms of executing manually written end-user's SPARQL queries. The mapping is of mappings to an existing ontology and by executing end-user's SPARQL queries. The mapping of ontology concepts to data sources is performed manually using traditional mapping languages, such as the W3C RDB2RDF mapping-language (R2RML) (Souripriya/Seema/Cyganiak, 2012). The advantages of an ontology-based data management approach were evaluated by Daraio et al. (2016). Keeping all components of the system up to date, particularly the ontology and the mapping, is still the responsibility of the administrators of the system and is performed manually. Tatu et al. (2016) presented an approach for converting users' natural language questions into SPARQL for querying and retrieving answers from an RDF store. Because the focus of their research is in transforming semantic structures identified in unstructured data sources (documents) to an RDF store that is accessible via natural language questions, the mapping of ontological concepts to (external) data sources is beyond the scope of their proposed framework. The same constraint holds true for OntoNLQA (Asiaee et al., 2015), which was introduced to query RDF data annotated using ontologies to allow posing questions in natural language. In the clinical and clinical research contexts, Mate et al. (2015) introduced a system for linking information of different systems using declarative transformation rules for ontologies of the source system and the target system. Here, the mapping of the target ontology to the source ontology is also created manually. Focusing on specific technologies for the translation of Relational Data Base (RDB) to RDF, Michel/Montagnat/Faron-Zucker (2014) and Sahoo et al. (2009) provided a brief overview on the individual technologies. As a symmetrization of the work, at present, domain-specific mappings for data semantics that lies outside an RDB schema are commonly performed manually.

B5.3 Benchmarking Data and Knowledge Integration

A system for the integration of various distributed data sources and documents must be able not only to handle various data sources, but also to integrate various data formats to A system for integrating various distributed data sources and documents must be able to not only handle various data sources but also integrate various data formats to serve as an effective tool for knowledge processing and knowledge representation (Nalepa, 2010; Pfaff/Krcmar, 2015). Therefore, this paper presents an ontology-based knowledge support system with a domain-specific ontology as a pivotal methodology for representing domain-specific conceptual knowledge, as proposed by Guo/Zhang (2009) and Pfaff/Krcmar (2014); Pfaff/Krcmar (2015). Because ontologies offer certain advantages over regular database schema, for example, they are highly flexible and enable modifications and extensions in a straightforward manner (Zhang/Hu/Xu, 2010), the presented system architecture addresses this unique capability through the use of a separate metadata repository. This repository is used to map the distributed data sources to the ontology (and its possible version changes over time) in a continuous update/integration interval.

B5.3.1 System Architecture

The basic service-oriented architecture of the web-based system for ontology-based data integration is illustrated in Figure B5.2. The web application is implemented using the Play Framework (Play, 2016), offering stateless Representational State Transfer (REST) services Fielding/Taylor (2000) for (client-side) interactions and encapsulating application logic in services with a uniformly defined interface (server-side). In this figure, *Client* represents the web browser-based user interface, allowing the user to interact with the server-side implementation. On the server side, the *Web Service Container* encapsulates Web Service (WS) for both user roles: the general user (User WS) and the administration user (Admin WS). The general user has only limited rights to modify the links between the attached data sources and the ontology: thus he is only allowed to formulate natural language requests, which are automatically translated into SPARQL queries using NLP techniques and the extract, transform, load (ETL) module. Conversely, the administration user is allowed to reconfigure the complete system, including the mapping configuration. At present, this type of user and access management is sufficient because all individuals using the system have the right to access all data attached to the system. For future implementation possibilities in terms of more fine-grained user management and access controls, see Section B5.5.

B5.3.1.1 Web Service Container

As previously mentioned, the system is implemented in the REST paradigm and is therefore accessible via the Web, and the web service container provides functionalities for two different user roles. The *user web service* (User WS) processes user requests in natural

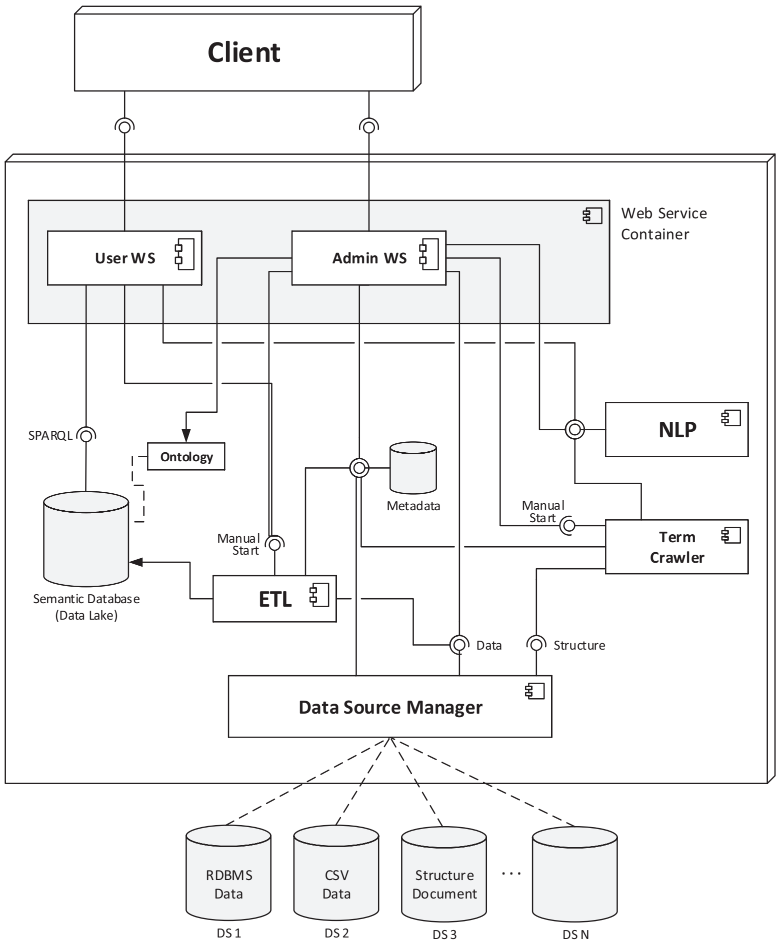

Figure B5.2: *System architecture for ontology-based data integration*

language form. These requests are analyzed using NLP techniques and are transformed and forwarded to the semantic database using SPARQL. By design, the NLP module, which can be executed by any user, focuses on a high rate of accuracy in its first iteration with the purpose of identifying as many domain-specific terms as possible within the data sets to be analyzed. In its second iteration, a high rate of *precision* is desired, identifying only results relevant to the (user or administration) queries (Pfaff/Krcmar, 2015). In addition to these search requests, users may also trigger the ETL module to reload the linkage between the ontology and the attached data sources. Note that through the user role, only the existing linkage between the attached database and the ontology can be reloaded. It is not possible for the user to update or modify links between concepts of the ontology and database objects.

The *Admin WS* performs the following operations:

- *Ontology Update:* Through this operation, it is possible to either upload a new ontology or update an existing one. This ontology is stored in the semantic database. At this point, the new ontology is versioned, and the metadata repository is flagged as no longer valid due to possible mismatches between the data sources and the new ontology (see Section B5.3.1.3 for details). Moreover, the dictionary that is part of the NLP module may be updated with new terms introduced by concepts or synonyms contained within the new version of the ontology.

- *Data Source Management:* The attached data sources can be configured using the data source manager. It is also possible to connect structured and unstructured data sources. All necessary configurations for access to the data sources, such as internal database names or source folders, are stored in the metadata repository. Moreover, all attached sources (ontology and databases) are versioned to ensure that later mapping activities are linked with the correct version (for details see Section B5.3.1.3).

- *Structure Mapping:* For a user with the administrator role, it is possible to specify the mapping of the attached databases to concepts contained within the ontology. Thus, this role possesses the right to read from the attached data sources and the right to write the mappings into the metadata repository. Using the NLP module, similar terms contained in the ontology and the attached data sources are first recommended as mapping candidates.

- *Term Crawler Configuration:* It is possible to configure the term crawler to run periodically in addition to its manual execution by a user with the administrator role. The term crawler, which uses NLP techniques was previously introduced by Pfaff/Krcmar (2015).

- *Manual ETL Start:* In addition to the periodic execution of the ETL process, it is possible for this event to be triggered manually by a user or administrator.

All operations are performed through a Graphical User Interface (GUI)) with which administrators and users are able to trigger the previously mentioned operations stepwise guided by an operation wizard.

B5.3.1.2 SemDB and Ontology

The Semantic Database (SemDB) is implemented with Virtuoso Universal Server as a triple store (Erling/Mikhailov, 2010; OpenLink, 2015). Because the database represents a SPARQL endpoint, it can be accessed through SPARQL queries. In addition to the semantically processed data provided by the attached external databases, SemDB also stores the ontology used for the mapping process.

The ontology can be divided into the three following sections: *individual benchmarks* (equivalent to one specific benchmark), *participants and values* and the *general indicator declaration*. Three concepts are used to describe the *individual benchmarks*, including a customizable structure of selectable indicators (measured within a benchmark), participants (viz., organizations) and the values that may be instantiated based on the concepts described in the *participants and values* section. The indicators themselves and their hierarchical and intermediate relationships are organized in the *general indicator declaration* section. An *indicator* itself is either a *PerformanceIndicator* or a *CostIndicator*. Indicators at the *PerformanceIndicator* level are non-cost indicators, such as quantity details or performance details. As indicated by the name, *CostIndicator* subsumes all indicators related to financial aspects that are compared in a benchmark. Because each indicator is included in at least one benchmark, this information is represented through by the indicator label. In this manner, it is possible to associate an indicator of one benchmark with an indicator of a different benchmark that has a different name but is identical from a semantic perspective (i.e., measure the same objective). A specific benchmark is specified by its label, represented by an arbitrary string and the year is represented by the standardized *gYear* literal type according to Peterson et al. (2012) within the concept of *individual benchmarks*. Here, the type property refers to the set of benchmark types (such as a process, product, strategic or generic benchmark (cf. Carpinetti/Oiko, 2008) and is limited to those values. For the connection to DOLCE, the *benchmark* class has been defined as a sub class of the *DUL:Event* class of the DUL ontology.

The components property facilitates the assignment of multiple *BMComponents*. Each BMComponent is either an instance of an indicator or a collection *(BMCategory)* of indicators. Consequently, it is possible to instantiate any arbitrary hierarchical structure of *BMCategories* and indicators. A *participation* in a benchmark is represented for each participating *organization* and its associated responses to an indicator by the intermediate concept *IndicatorDeclaration*. Thus, it is possible to associate an organization with a benchmark even without the existence of any specific indicator values (e.g., no responses have yet been given but the organization is participating in the benchmark) using the concept of *participants and values*. To foster reuse, an *organization* refers to the *DUL:Organization* concept provided by the DUL ontology (Gangemi, 2016b).

Figure B5.3 provides a conceptual overview of these three ontology sections and the relations in between. Grey nodes indicate DUL concepts and properties. The nodes of the graph illustrated in Figure B5.3 refer to *concepts* (i.e., classes) or *datatypes* (cf.

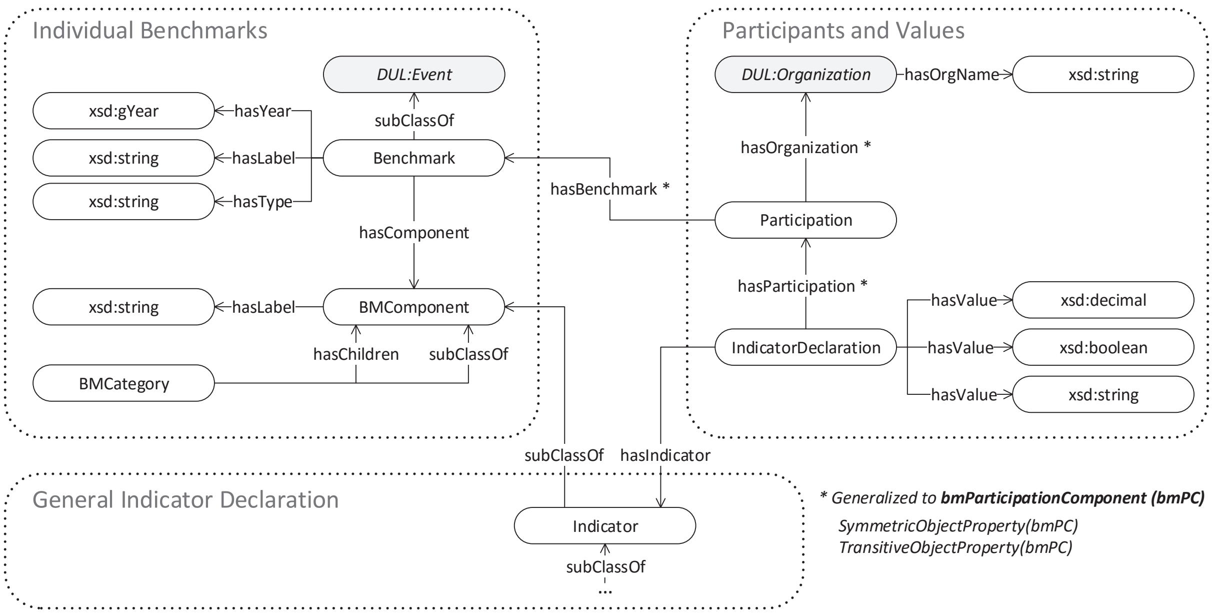

Figure B5.3: *Benchmarking ontology, based on (Pfaff/Neubig/Krcmar, 2017)*

Motik/Patel-Schneider/Parsia, 2012) of the ontology, whereas the edges refer to *properties* provided by the ontology. A class can also be considered as a set of instances, and a subclass can be considered as a subset of those instances (Motik/Patel-Schneider/Parsia, 2012). A property can either establish a direct link between instances of two classes or link an instance to a literal (i.e., a value of a certain data type).

B5.3.1.3 Extract, Transform, Load Module and Metadata Repository

The ETL module is implemented as an independent single thread with a continuous execution interval in addition to being a triggered event (executed on demand by the user). The main tasks of the ETL process are (i) loading the external data into the semantic database by generating a virtual table based on the database structure of the external database, and (ii) resolving redundancies that may occur during the loading process by the entity resolution (Entity Resolution (ER)) step (see Section B5.3.1.4 for details on ER).

Prior to the execution of the ETL module, the versions of the currently used ontology and its attached databases are identified. The versioning of the ontology is assured because an uploaded ontology is always annotated with its version number (using the OWL *versionInfo* tag). The data source manager is used to ensure the correct mapping of the relational structure of the attached databases to the corresponding ontology version. These steps are crucial to ensuring compatibility between the metadata and the ontology/databases and thus to guarantee that the mapping is performed on a sound basis.

The mapping of metadata that are stored in the metadata repository is two-fold. The first part specifies a set of transformation rules that transform the relational models of the connected databases into virtual models (i.e., nested SQL queries rather than physically transformed tables) and where each table of a connected database corresponds to a concept within the ontology. The second part specifies mappings from this virtual model to the target ontology itself. These mappings consist of the assignment between the entities and attributes from the data sources and their corresponding concepts and properties of the ontology. According to these mappings, the data integration process is performed stepwise as follows:

(i) Load the mapping entries from the metadata repository in accordance with the selected versions of both the ontology and the connected databases.

(ii) Apply transformation rules to the relational models of the connected databases to create an intermediate model with bidirectional links between tables; this is realized creating a set of SQL statements wrapped around the original tables.

(iii) Load data from the attached databases via the data source manager using the generated SQL statements.

(iv) According to the second part of the mapping specifications, map tables to concepts by converting their rows into instances of the ontology using the triple-store format.

(v) Use the Virtuoso bulk loader to load the data into a new graph within the semantic database; old data are retained in the old graph.

(vi) Check whether the new graph differs from the data loaded in previous ETL iterations and log changes.

The following example in Listing B5.1-Listing B5.5 illustrates the result of the ETL process (i.e., the *mapping* between the ontology) based on Figure B5.3 and two external data sources. The name space used for the URIs for the concepts and properties of the ontology is represented in shortened form by the prefix *bm*. The instances of benchmarking values depending on which data source is mapped are indicated by the prefixes *v* and (i). In this example, two indicators (Indicator1a and Indicator2a) of a data set *a* from the first data source *v* and one indicator (Indicator 2b) of a different data set *b* from the second data source *v* are linked to each other using the benchmarking ontology. As previously noted and shown in Figure B5.3, a data set is always linked to an organization that is a participant in a specific benchmark. Thus, these three indicators are associated with two organizations (organizations A and B, where organization A is a participant in two benchmarks). The linkage between these three indicators and the ontology is shown below. In this example, *OrganizationA* is a participant in *benchmarkA*, providing *indicator1* and *indicator2*, and it is also a participant in *benchmarkB*, providing only *indicator2*. *OrganizationB* is a participant only in *benchmarkB*, providing *indicator1*.

Listing B5.1: *Instances of indicator with label for each benchmark*

```
v:indicator1            rdf:type bm:Iindicator1;
                        bm:label ''Indicator 1a''^^xsd:string.
v:indicator2            rdf:type bm:Indicator2;
                        bm:label ''Indicator 2a''^^xsd:string.
i:indicator1            rdf:type bm:Indicator2;
                        bm:label ''Indicator 2b''^^xsd:string.
```

Listing B5.2: *Definitions of benchmarks*

```
v:benchmarkA            rdf:type bm:Benchmark;
                        bm:year 2015;
                        bm:label ''Benchmark A''^^xsd:string;
                        bm:components v:indicator1;
                        bm:components v:indicator2.
i:benchmarkB            rdf:type bm:Benchmark;
                        bm:year 2015;
                        bm:label ''Benchmark B''^^xsd:string;
                        bm:components i:indicator2.
```

Listing B5.3: *Definitions of the organizations for each benchmark*

```
v:OrganizationA         rdf:type bm:Organization;
                        bm:organizationName ''Name of Org A''^^xsd:string.
v:OrganizationB         rdf:type bm:Organization;
                        bm:organizationName ''Name of Org B''^^xsd:string.
i:OrganizationA         rdf:type bm:Organization;
                        bm:organizationName ''Name of Org A''^^xsd:string.
```

Listing B5.4: *Definitions of participation*

```
v:OrganizationA_part      rdf:type bm:Participation;
                          bm:benchmark v:benchmarkA;
                          bm:organization v:OrganizationA
v:OrganizationB_part      rdf:type bm:Participation;
                          bm:benchmark v:benchmarkA;
                          bm:organization v:OrganizationB
i:OrganizationA_part      rdf:type bm:Participation;
                          bm:benchmark i:benchmarkB;
                          bm:organization i:OrganizationA
```

Listing B5.5: *Values of indicators*

```
v:OrganizationA_ind1      rdf:type bm:IndicatorDeclaration;
                          bm:indicator v:indicator1;
                          bm:participation v:OrganizationA_part;
                          bm:indicatorValue 100
v:OrganizationA_ind2      rdf:type bm:IndicatorDeclaration;
                          bm:indicator v:indicator2;
                          bm:participation v:OrganizationA_part;
                          bm:indicatorValue 200.
i:OrganizationA_ind1      rdf:type bm:IndicatorDeclaration;
                          bm:indicator i:indicator1;
                          bm:participation i:OrganizationA_part;
                          bm:indicatorValue 100.
v:OrganizationB_ind1      rdf:type bm:IndicatorDeclaration;
                          bm:indicator v:indicator1;
                          bm:participation v:OrganizationB_part;
                          bm:indicatorValue 500.
```

B5.3.1.4 Entity Resolution

After data from multiple databases have been loaded using the ETL module, multiple instances resolved from different data sources may exist that actually refer to the same thing; in the above example, *organization A* exists in both connected databases (i.e., *v* and *i*). Thus, from the SemDB's point of view, they are considered as two distinct instances; consequently, associated properties are not considered as belonging to the same organization (e.g., organization *v:OrganizationA* participates in benchmark A, and a different organization *i:OrganizationA* with the same name participates in benchmark B).

To consider both instances equally and thus integrate all associated data sets, ER has to be performed. In contrast to the mapping metadata, the ER metadata are only bound to the ontology's version. For all concepts with instances to be resolved, the ER metadata specify criteria on how to compare such instances, i.e., (i) transformations to be conducted to ease comparison and (ii) criteria about the comparison itself. Considering organizations, transformations involve crossing out common suffixes (e.g., *Inc*), and comparison criteria may include the calculation of string distance metrics (e.g., Levenshtein distance). If two instances are considered equal with respect to the specified comparison criteria, then they are resolved by adding an *owl:sameAs* definition. In the current version of the system, only organizations are considered for ER. Data contributions within a benchmark are not integrated, even if the same indicator is requested within the scope of two different benchmarks running at the same time period. This is because each contribution refers to a distinct benchmark instance and we want to keep that knowledge.

B5.3.2 Semi-automatic Mapping Recommender

To support the mapping of database contents to ontology concepts, a semi-automatic mapping recommender is developed. Here, “semi-automatic” refers to the fact that mappings are recommended in the first place and not applied automatically; thus, human interaction is needed to confirm recommended mappings for the purpose of quality assurance. The system supports two different types of mapping recommendations. The first type assumes that an entire database table corresponds to an existing ontology concept, and the second type assumes that each database table record is mapped to a different ontology concept. In both cases, mappings are only recommended if a certain level of confidence is reached (see also Section B5.4.2).

Mapping (virtual) tables to ontology concepts: Often, a (physical) table from the original database schema directly corresponds to a concept defined in the ontology. In this case, all records of this table are converted into instances of this concept. Note that if concepts in the ontology are specified on a more fine- or coarse-grained level of abstraction, such a table may still be constructed virtually using appropriate SQL statements (e.g., JOINs); within the scope of the system, these types of tables have been referred to as *generators*. For this type of mapping, the implementation in pseudo-code is shown in Listing B5.6.

Listing B5.6: *Type-1-Generator-Mapping in pseudo-code*

```
generateMappingsFromGeneratorLayer():

    // Create concept list and generator list
    conceptList = getConceptNamesUsingSparql()
    generatorList = getGeneratorNamesFromMetadata()

    // Clean generators by deleting unnecessary prefixes
    for (i, name) in generatorList:
        generatorList[i] = clean(name)

    // Execute bipartit matching
    matchings = bipartiteMatching(getLevenshteinMetric(),
        threshold = 0.6, conceptList, generatorList)

    // Create empty set of mapping meta data
    // and add identified matchings
    mappingMetadata = createEmptyMappingMetadata()
    for (concept, generator) in matchings:
        mappingMetadata.push(createMappingMetadata(
            from = generator, to = concept))

return mappingMetadata
```

Mapping (virtual) table records to ontology concepts: Occasionally records are not meant to be converted to instances of the same concept but are rather partitioned to different concepts. In this case, a specific table is chosen, and each of its records is converted into one instance of a specific concept of the ontology. For this second type of mapping, the implementation in pseudo-code is shown in Listing B5.7.

Both of these mapping cases are implemented using the same underlying bipartite matching algorithm (based on Kuhn/Yaw (1955)) while differing in terms of its run-time configuration. In the first case (i.e., mapping (virtual) tables to ontology concepts), the total set of virtual and physical table names and the names of the ontology concepts are used as the input configuration. In the second case (i.e., mapping (virtual) table records to ontology concepts), the total set of rows of a specified table and the names of ontology concepts are used as the input configuration for the mapping algorithm. The respective configurations of the algorithms are described in the following.

Listing B5.7: *Type-2-Generator-Mapping in pseudo-code*

```
// Parameters are (i) the name of the generator,
// which instances shall be mapped to concepts
// and (ii) the pivotal columne name pivotal used fot the mapping,
generateMappingsFromGeneratorInstances(generator, column):

    // Create empty concept list and an empty list of instances
    conceptList = getConceptNamesUsingSparql()
    instanceList = []

    // Load instances (single row) of the generator form the external
    // data source and add the corresponding value to the list
    // of instances
    result = executeSQL(generatorManager[generator].sql)
    for row in result:
            instanceList.push(row[column])

    // Execute bipartit matching
    matchings = bipartiteMatching(getFuzzyJaccardJaroWinklerMetric(),
        threshold = 0.2, conceptList, generatorList)

    // Create empty set of meta data for the mappings
    // and populate this set by the calculated best matches
    // of the FuzzyJaccardJaroWinklerMetric
    mappingMetadata = createEmptyMappingMetadata()
    for (concept, instance) in matchings:

        // A row of the generator (from) and a concept (to)
        // is only mapped if the generator row is a match
            mappingMetadata.push(createMappingMetadata(
                from = generator, to = concept,
                require = (column, instance)))

return mappingMetadata
```

B5.3.2.1 Bipartite Matching Algorithm

Both of the scenarios explained above are based on a highly configurable bipartite matching algorithm. Starting with two sets of items, this algorithm assigns each item of the first set to an item of the other set such that the total difference of pairwise matched items is as minimal as possible. Moreover, items are only matched if a certain confidence threshold of confidence is exceeded, meaning that the resulting set of matched items is not necessarily complete. As input, the bipartite matching algorithm requires two parameters, namely, a metric to be used to calculate the distance between two items and a minimum confidence threshold.

The implementation of the bipartite matching algorithm is based on an execution of the Hungarian method (Kuhn/Yaw, 1955). In the first step, a cost metric is calculated by assigning each pair of items from the two different sets a specific distance, which is expressed as a floating point number between 0 and 1. Here, 0 refers to the equality of items, and 1 refers to a maximum difference. The derived cost matrix is passed to the Hungarian method, which assigns each item of the first set an item of the second set. After the Hungarian method has completed, the similarity of the items within each matched item pair is derived by subtracting the beforehand calculated cost from 1. If the resulting similarity is below the specified minimum (i.e., the passed confidence threshold), then this match is removed from the result set.

Two different groups of metrics are used within the mapping recommendation system based on the metric class of the SimMetrics[28] Java library. The first group of metrics compares strings and consists of the Levenshtein distance (Levenshtein, 1966), and the Jaro-Winkler distance (Winkler, 1990) is used to compare single words. The second is more coarse grained and compares complete groups of words. It is based on the Jaccard index (Jaccard, 1901) (i.e., comparing two sets by dividing the number of common items by the number of (distinct) total items), which additionally makes use of the previously calculated distances of the first group of metrics. Assuming equality between items, even if they slightly differ, these metrics are denoted as fuzzy Jaccard metrics. Thus, in our case, this *FuzzyJaccardJaroWinkler metric* calculates the Jaccard index while assuming equality between two items if their Jaro-Winkler similarity is greater than 0.94. For further details see Section B5.4.2 .

B5.4 Results and Evaluation

B5.4.1 Ontology

At present, the ITBM ontology (Version 1.1) consists of a number of statements which are summarized in Table B5.3.

[28] https://github.com/Simmetrics/simmetrics

Table B5.3: *Number of classes, properties, axioms and annotations in the ITBM ontology*

Ontology Metric	#	Ontology Metric	#
Classes	1,250	Logical Axioms	2,927
Object Properties	113	Annotations	5,362
Data Properties	10		

The number of classes corresponds to the concepts described in the previous sections, including the 20 top-level service classes (one of which is the basic data service), corresponding to IT services that are commonly measured within an IT benchmark. The 1,250 indicator classes correspond to key performance indicators that are measured during an IT benchmark. Entities of the indicator taxonomy do not have their own properties defined because they only inherit them from the BMComponent class. Therefore, only a small set of object and data properties need to be additionally defined, and they are shown in Figure B5.3. Currently, the majority of axioms refer to the number of *SubClassOf* definitions. However, axioms on the domain and range of object properties and statements relevant to the characterization of disjoint classes also exist. The number of annotations includes bilingual (viz., English and German) *rdfs:label* for all classes. The description logic expressiveness for the benchmarking ontology itself is $\mathcal{SHI}(\mathcal{D})$, and in combination with the DUL ontology the logic expressiveness is $\mathcal{SHIN}(\mathcal{D})$.

B5.4.2 Metrics and Minimum Confidences of the Mapping Recommender

Both the previously described metrics (see Section B5.3.2.1) and the best minimum matching confidences have been derived and proven in various experiments. Regarding the mapping within the *virtual* table layer (case one in Section B5.3.2), a simple Levenshtein metric with a minimum confidence of 0.6 is applied; in the instance mapping scenario (case two in Section B5.3.2), a fuzzy Jaccard metric using the Jaro-Winkler metric is used. The internal threshold of equality has been set to 0.94 as already mentioned; the minimum confidence threshold necessary for accepting a match resulting from the Jaccard index has been set to 0.2. The computational complexity is of square, for calculating the cost matrix and calculating the distances for each pair of items. If the fuzzy Jaccard metric is used for the similarity check, then the computational complexity increases to mn^2, where m is the (largest) number of words contained in each item. Regarding to the Hungarian method, we utilize its optimized version, reducing its complexity from $O(n^4)$ to $O(n^3)$. Removing the items with a distance that is worse than the minimum confidence threshold is performed linearly. Thus, the overall computational complexity of the bipartite matching algorithm is $O(n^3)$ (Edmonds/Karp, 1972).

B5.4.3 Prototypical Implementation

B5.4.3.1 User Interface for Natural Language Text to SPARQL Queries

A web interface can be used to access the attached data sources via natural language text (text-to-sparql). This client-side user interface is implemented using AngularJS (Google, 2016) and is shown in Figure B5.4.

As a result of the German data sets, the outputs of the user search ("Show all participations of organisation ORG1 in year 2016") are presented in the German language.The search tree within the ontology is presented directly underneath the automatically generated SPARQL query. Blue nodes represent the corresponding concepts in the ontology that the user was searching for data sets.

In this previous example, the search string "Show all participations of organisation ORG1 in year 2016" is parsed and processed by the NLP module. In the first step, concepts that the user searched for are identified by comparing all words within the search string with the *label* description of all concepts. Note that all already specified concepts of the system are already lemmatized within a *CachingDictionary* as lemmatization of all concepts for every single user search would be very time consuming.

As shown in Figure B5.5, the Levinshtein distance of each lemmatized word within the search string and the implemented concepts is calculated. In the next step, these distances are evaluated against the operations needed to transform the lemmatized word into a concept. Only if this is possible by less than three NLP operations is the entered word identified as a concept. In Figure B5.5 all identified concepts are highlighted using yellow background color. Analogous to the concept identification, the remaining words are analyzed to identify literals that are specified within the ontology. Consequently, the identified literals are transformed into filter parameters such as *subject, predicate, and object*. The *subject* specifies the concept for which the filter is set, the *predicate* specifies the *rdfs:type*, and the *object* is set by the literal itself. The following example (see Listing B5.8 shows the filter results for the identified literal "ORG1". In the last step, all identified literals are marked as "processed" (indicated by the green background color in Figure B5.5).

Listing B5.8: *Filter results for identified literals*

```
Filter
    Type URI:         ,,http://fortiss.org/bm/ontology#Organization''
    Predicate URI:    ,,http://fortiss.org/bm/ontology#hasName''
    Value:            ,,ORG1 GmbH''
Filter
    Type URI:         ,,http://fortiss.org/bm/ontology#Organization''
    Predicate URI:    ,,http://fortiss.org/bm/ontology#hasName''
    Value:            ,,ORG1''
```

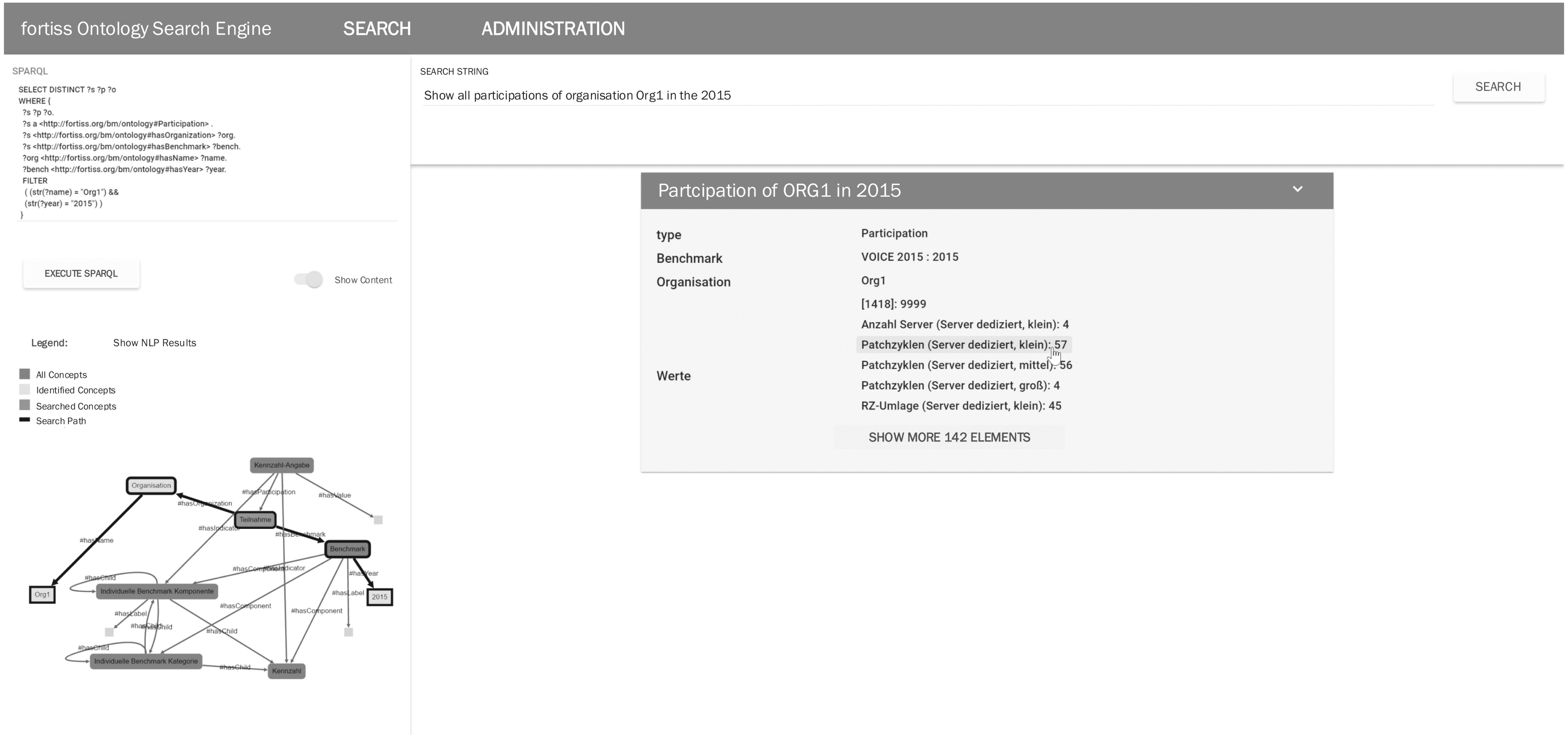

Figure B5.4: *Client-side user interface for ontology-based data access*

Figure B5.5: *Stepwise identification and assignment of identified tokens*

B5.4.3.2 Data Source Configuration and Mapping Recommender

The configuration of the mapping between an ontology and corresponding data sources is supported by an administrator user interface (see Figure B5.6). For each data source this configuration needs to be performed before the mapping of concepts to generators can be conducted. For consistency and data loss prevention reasons, all changes of the mapping between data sources and the ontology are stored temporarily and need to be confirmed separately after the configuration procedure. The mapping is performed stepwise, following the workflow shown in Figure B5.7.

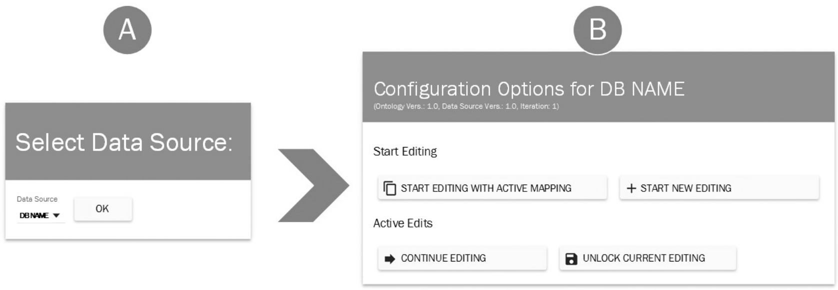

Figure B5.6: *Admin interface for the configuration of data sources*

(A) An external data source needs to be selected first. In this step, all already configured data connections are available for selection

(B) Based on the selected data source, different editing options for the mapping are available, depending on the different work-flow states.

- A new mapping can be started by "Start Editing", or an active mapping can by modified by "Start Editing With Active Mapping". In both of these cases, the active mappings between ontology concepts and generators are overwritten by a new configuration.
- If not already finished and stored, an existing mapping configuration can be edited and locked or unlocked to prevent data loss.

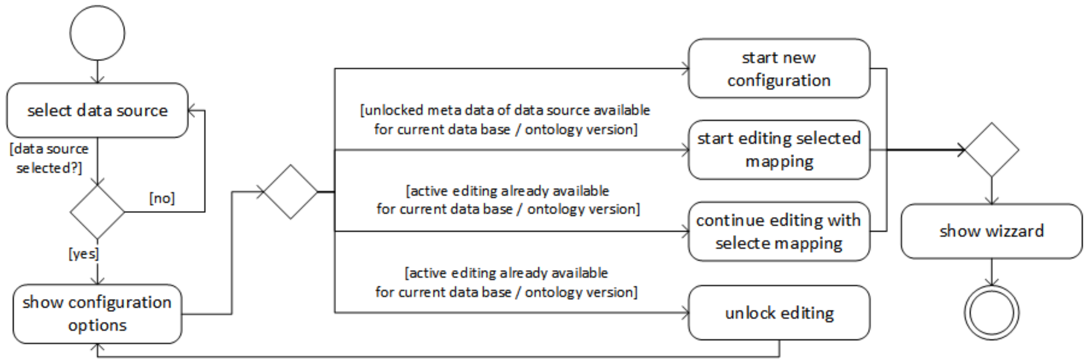

Figure B5.7: *Workflow of the administration wizard*

Once the configuration of the mapping is finished, the user is forwarded to the actual mapping web interface (see Figure B5.8). This interface can basically be divided into four sections.

- The first section (1) contains all of the actions that are available, such as saving the manually generated mappings; re-plotting the graph, which is shown in (2); and starting the semi-automatic mapping recommender (see Section B5.3.2).
- The second section (2) shows the graph and all connections of the generators for the previously selected data source.
- The third section (3) shows all concepts within the ontology that can be mapped to generators.
- The fourth section (4) provides the details for a selected entity (concept, connection or generator) and configuration options to implement the mapping.

The mapping of a selected entity can be displayed and configured using the linkage button (highlighted by a red "one" in Figure B5.8). The number represents how many mappings already exist for this selected entity. If a generator and one or more concepts are selected in combination, the number indicates all mappings that exist for the selected pairings. Because various possibilities exist for mapping configurations depending on the selected concepts or generators, Figure B5.9 shows the different mapping options based on different pairing possibilities.

After an entity is mapped manually or as a result from the mapping recommender, Figure B5.10 shows the user interface for a detailed overview on the mapping parameters. In this assignment interface for each mapping, the header (A) and the detailed mapping configuration (B) for this entity are shown. In this example, the header consists of the generator name and its mapped ontology concept.

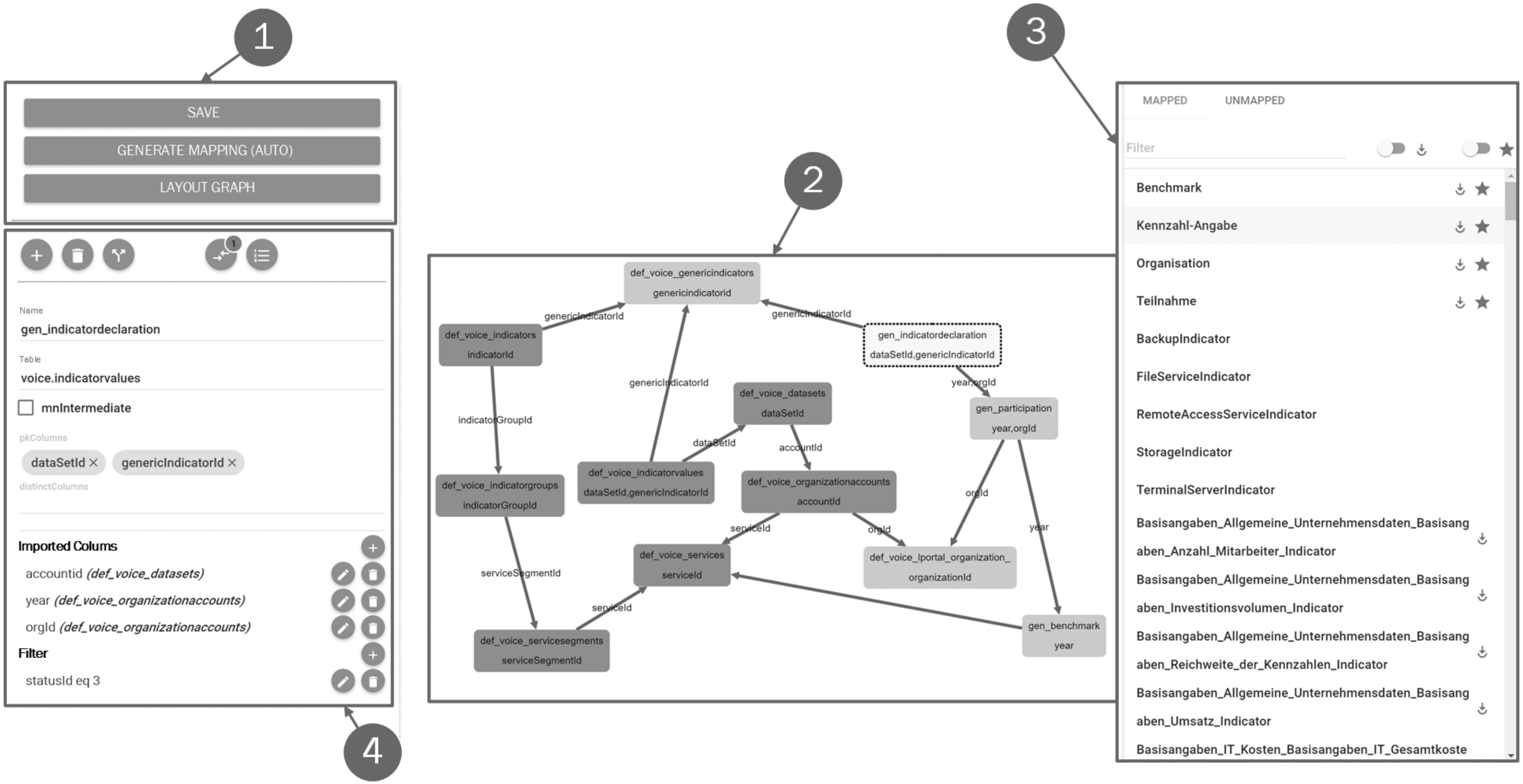

Figure B5.8: *Client side administration wizard for the configuration of mappings*

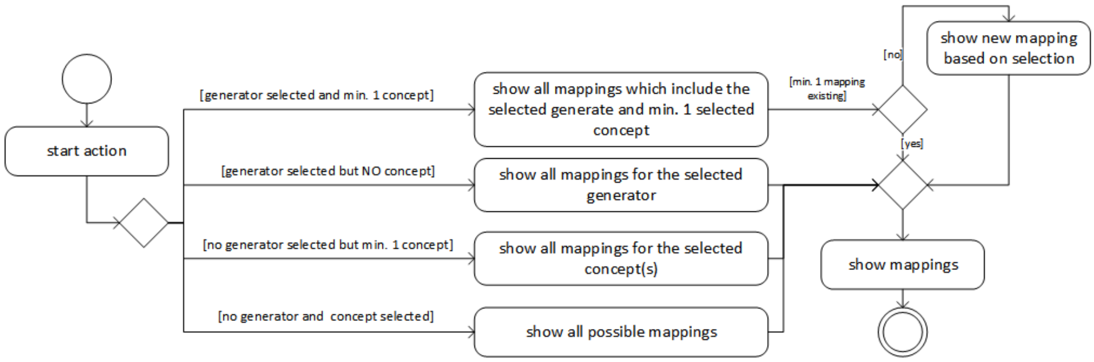

Figure B5.9: *Mapping options based on different pairing possibilities*

In the scope of this header interface, it is also possible to show/hide the details for the mapping; to copy the current mapping, which is use full if only "Required Attributes" differ for a selected entity; and to mark this mapping for deletion. The deleting process is performed during the save operation of the entire mapping process. Within the detailed view, attributes are separated according to their allocation. On the left side, the generator is shown together with its "Required Attributes". On the right side of the detailed view, all mapped concepts are shown, together with their associated properties. The red overlay (1) indicates a previously performed deletion operation on this generator. Note that for all "Required Attributes", only one value can be specified, whereas for the "DataTypeProperties" (2), columns of the linked data sources can be specified (using „#{..}“ notation) as well as a free text. For "ObjectProperties" (3), only the specification of corresponding generators is possible. Note that although it might be possible that a very large number of nearly similar mappings need to be configured for a concept, it is possible to copy "Data- and ObjectProperties" to reduce the configuration effort.

Figure B5.10: *Admin interface for the configuration of mappings for entities*

B5.5 Conclusion and Future Work

Because there are numerous challenges related to data integration in the domain of ITBM and the related field of ITSM, this paper introduced an architecture for the (semi-)automatic and ontology-based integration of data from distributed data sources. To the best of our knowledge, the proposed system architecture and software prototype constitute the first approach to bridge the gap between a systematic characterization of IT services and their data-based valuation based on an ontology. Moreover, because the mapping of databases to ontology concepts is a very complex and time-consuming task, a semi-automatic mapping recommender was developed to support the user in this process. This recommender semi-automatically identifies similarities of possible mapping candidates and visualizes them in a graph to reduce the complexity of the mapping process for the system administrators. On the user side, the complexity for the use of such a system could also be reduced as it provides an easy way to access data by using NLP techniques to translate natural language questions into SPARQL queries. This translation process is also implemented in a transparent manner by showing the generated SPARQL query and by visualizing the resulting search graph.

The proposed web-based system architecture for data integration allows numerous external data sources to be linked through the use of the domain ontology, which is a flexible way to link data sources without knowing the structures of already attached data sources. The separation of structural information provided by the ontology on the one hand and the data sources on the other hand addresses the need for flexibility in the case that the linkage must adapt to changes on both sides. In this way, already existing data sets from various data sources, such as MySQL databases, could be interlinked in terms of their semantic equivalence. At present, all non-administrator users are allowed to access all attached data sources. By using this client-/server-side implementation, based on web technologies, a more fine-grained access control could be implemented in the future. This would address possible security needs that could occur if the system is used beyond company boundaries. Moreover, it is conceivable that restrictions for the use of specific data sources and specific data points within a single data source could also be implemented to ensure that the attached data sources are only allowed to be used within a special context (benchmark) or by special users/organizations.

The ITBM ontology was developed on a large collection of ITBM documents and data set and covers various types of IT benchmarks and (IT) service descriptions from numerous organizations. Thus the developed ontology covers all aspects relevant for using it as universal link for the integration of different types of external benchmarking data. Because the quality of an ontology, in terms of its expressiveness and consistency, is highly dependent on domain knowledge, a broad range of different data are needed as a basis for the development process. Thus, the analysis of such an enormous amount of data, is generally extremely time consuming. This issue in the ontology construction process was already addressed by Pfaff/Krcmar (2015) using NLP techniques to populate the domain ontology and in this paper re-used to identify similar indicators in data sets across different IT benchmarks. In addition, the use of NLP also grounds the development process of an ontology and reduces the variations of an ontology that may occur if it is constructed manually by different domain experts. However, since an ontology is generally discontinuously changing over time, a periodic consistency check of the ontology and the linked data sources was also implemented. In the future, this already implemented consistency check could be developed further to automatically recognize changes upon their occurrence. Additionally, the mapping process for the ontology could also be extended to support and automatically resolve relations across different indicators that characterize the same concept. For now, the structural description of a benchmark within the ontology is limited to a hierarchical structure; this limitation could also be addressed in future research to enable the modeling of more complex coherence. Developing the capability of (semi-)automatic linkage with additional ontologies will be the next step in this research for the purpose of propagating a uniform description of domain knowledge in ITBM.

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Part C

Summary of Results and Discussion of Implications

Chapter C1

Research Results

In this chapter, the results of this dissertation are summarized. Specifically, the key results of the included publications are first outlined. Second, an overall summary of the results of this work presented. An overview of the results of the included publication is also provided in Table C1.1.

C1.1 Results of the Included Publications

The first publication (**P1**: *"Semantic Integration of Semi-Structured Distributed Data in the Domain of IT Benchmarking - Towards a Domain Specific Ontology"*; see Chapter B1) described the challenges of (semantic) data integration in the field of ITBM, using informed arguments. The state of the art of research in this field was highlighted, and its shortcomings were discussed. One major shortcoming was identified to be the difficulties in comparing benchmarking data beyond the specific context of the benchmark in which they were collected. In such comparisons across various IT benchmarks, this shortcoming results from the lack of a uniform means of description for any arbitrary parameter that may be measured during a benchmark. To address this shortcoming, a domain-specific ontology was proposed. Moreover, the resulting opportunities for an ontology-based IT benchmark were discussed.

As described in the first publication, the need for uniform description of measurable parameters is not unique to ITBM. The second publication (**P2**: *"Information Need in Cloud Service Procurement – An Exploratory Case Study"*; see Chapter B2) highlighted the need for further research on service description languages and ontologies in domains closely related to ITBM. Cloud computing can be understood as a specific type of IT service provision and thus may also be considered as part of an IT; however, as outlined by this publications, no common understanding of such services yet exists. To identify the specific information needed for the procurement of cloud services, 16 interviews were conducted, with small-to-large organizations. By combining these responses with literature-based findings, a set of 39 items was derived, which represents the essential set of characteristics required by an organization when procuring cloud services. The gathered information was structured in accordance with the dimensions used in SQuaRE and expanded based on quality-in-use characteristics. The paper also described how the present lack of clarity in cloud service descriptions, in turn, leads to manual requests for further information throughout the service procurement process. Moreover, it was suggested, that the formalization of the identified items might not only enable automated searches for required services but also serve as one of the next steps toward agile and lean cloud service procurement. Thus, these findings provided a conceptualizing overview of service properties that should be covered by ontologies and vocabularies for the domain of cloud services and in turn, for related domains such as ITBM.

The third publication (**P3**:*"Natural Language Processing Techniques for Document Classification in IT Benchmarking - Automated Identification of Domain Specific Terms"*; see Chapter B3) presented an approach for the automated extraction of terms from unstructured data by means of NLP techniques. Based on already existing documents (i.e., service descriptions and benchmarking results from the last seven years), an automatic term extraction method was described, and a prototype was implemented. The extracted documents-specific terms were representative of each document in terms of semantic meaning. Using a domain-specific dictionary, a pre-classification of the used documents could performed. Subsequently, because it could not be assumed that the initially generated dictionary was completely sound, this dictionary was iteratively adjusted/extended with the automatically identified terms themselves. For the evaluation of the presented approach, a subset of manually categorized documents was used as a test data set to measure the *precision* and *recall* of the implemented algorithm. Emphasis was placed on a high *recall* value because in the case of IT benchmarking, and especially for the development of an ontology, nearly all relevant information/documents should be identified. It was shown that the presented approach for term extraction in ITBM achieves an overall accuracy of 93,3% for document identification.

Publication four (**P4**:*"Ontology for Semantic Data Integration in the Domain of IT Benchmarking"*; see Chapter B4) integrated methods and results from publication **P3** and presented the design development of all main parts of the ITBM ontology. Following the NeOn core scenario and the NeOn scenario for the reuse of ontological resources, a lightweight ontology building process was described to ensure that all relevant design decisions were presented in a comprehensible manner. In addition, already existing ontologies domains related to ITBM were presented and discussed with respect to their limitations for use within the specific context of ITBM. As previously stated, existing service catalogs and databases from the involved ITBM projects were analyzed, using NLP techniques to extract the most important concepts and terms that could be relevant for building the ontology. The ontology was implemented in the OWL 2 DL fragment using Protégé. The ontology was evaluated against competency questions, and various tools (i.e., the HermiT reasoner and the OOPS) were applied to ensure that the ontology was consistent and implemented with adequate quality. Moreover, the ontology was made accessible by means of a stable URI[29], arcived by the Marine Metadata Interoperability (MMI) Ontology Registry and Repository (ORR)[30], and an online documentation was produced using the Live OWL Documentation Environment (LODE). For the attachment

[29]https://w3id.org/bmontology
[30]http://mmisw.org/ont/?iri=https://w3id.org/bmontology

of external data sources (see publication **B5**), the ITBM ontology was subdivided into three parts: *Individual Benchmarks* (each equivalent to one specific benchmark), *Participants and Values* and *General Indicator Declaration.* This segmentation was necessary to separate the general time-related information about a benchmark from the structural information regarding the questionnaires used and the corresponding data that need to be connected to specific indicators. Moreover, the semantic foundation of the ITBM ontology was achieved by grounding relevant concepts in the DUL ontology. This ensures the semantic interoperability of distinct conceptualizations from different (domain) ontologies and was implemented to allow the ITBM ontology to be linkable to various related domains. At present, the ITBM ontology contains 1192 classes, 123 object properties and 3287 logical axioms and is implemented in two languages (English and German). The linkage of the ontology to DUL resulted in a DL expressivity of $\mathcal{SRIQ}(\mathcal{D})$.

Bringing all of the previous work together, the fifth publication (**P5**: *"A Web-Based System Architecture for Ontology-Based Data Integration in the Domain of IT Benchmarking"*; see Chapter B5) integrated the results and NLP techniques from publication **P3** and the domain ontology presented in **P4**. After a description of the motivation for the research topic, methods of data integration in ITBM were described, and the system architecture for the ontology-based integration of data from various distributed data sources in this domain was outlined. Moreover, the architecture of already existing ontology-based applications in domains related to ITBM was presented and discussed with respect to their limitations for use in the specific context of ITBM. A prototype web application was implemented using the Play Framework. This application offers stateless REST services for (client-side) interactions and encapsulates application logic in services with a uniformly defined (server-side) interface. Two user roles were implemented, separating the configuration activities that need to be performed by an administrator (such as mapping ontology concepts to database tables) from general user interactions (such as querying the attached databases). Because the mapping of database contents to ontology concepts is a very time-consuming process, a semi-automatic mapping recommender was developed, based on a highly configurable bipartite matching algorithm. This recommender suggests to the administrator possible mapping candidates, which then must be confirmed manually for quality assurance. The system provides a workflow for administrator users and for all configuration and mapping activities. For clarity, the mapping activities are textually and graphically supported by the system, showing the ontology concepts and the corresponding graph that needs to be mapped. The system also provides the possibility to define specific labels for object or data properties to improve the readability of query results for the user. By this means, URIs can be resolved up to their specific label and data value(s). For general users a web interface was implemented to enable access to the attached data sources via natural language text (text-to-SPARQL); this interface parses and processes queries using the previously developed NLP module. The prototype was successfully evaluated using real-world data structures by mapping the ITBM ontology to a MySQL database. Accordingly, the results showed that the system architecture successfully bridges the gab between semantic resources (such as based on OWL) and external databases, as the prototype provides an easy way to access data by using NLP techniques to translate natural language questions into SPARQL.

Table C1.1: *Key results of the included publications*

No.	Title	Key Result(s)
P1	Semantic Integration of Semi-Structured Distributed Data in the Domain of IT Benchmarking - Towards a Domain Specific Ontology	• Outlines the necessity of ontology-based data integration in the domain of ITBM and describes current challenges that need to be addressed by future research
P2	Information Need in Cloud Service Procurement – An Exploratory Case Study	• Highlights the need for further research on the formal representation of information in related fields of research • Identifies a set of 39 items as a starting point for the development of a domain-specific vocabulary, service descriptions, and ontologies in the context of cloud service procurement
P3	Natural Language Processing Techniques for Document Classification in IT Benchmarking - Automated Identification of Domain Specific Terms	• Introduces a solution for the automatic identification for domain-specific terms form documents related to ITBM • Introduces an NLP module and dictionary as a basis for further query processing
P4	Ontology for Semantic Data Integration in the Domain of IT Benchmarking	• Extends the previously identified domain-specific terms by using external MySQL databases for ontology population • Introduces a domain ontology for ITBM with a particular focus on data integration • Successfully evaluates the ITBM ontology against CQ, and with various tools to ensure its consistency
P5	A Web-Based System Architecture for Ontology-Based Data Integration in the Domain of IT Benchmarking	• Introduces an application for semantic data integration in ITBM based on a web-based system architecture • Introduces a semi-automatic mapping recommender to support ontology mapping activities • Successfully evaluates the system architecture and the mapping recommender, by a prototypical implementation for an integrated data management of distributed databases based on the ITBM ontology

C1.2 Overall Summary of the Results

As outlined in the introduction, the overall goal of this dissertation is to ground ITBM in a domain-specific ontology and to support performance measurement by introducing a concept for tool-based semantic data integration in this domain.

To achieve this goal, three RQs were formulated, leading to the research results of this dissertation. Guided by these questions a domain-specific ontology, a system architecture for semantic data access and a semi-automatic mapping recommender for ontology mapping support were introduced, and a prototype was implemented. In this context, it must be noted that the system architecture and the ontology are designed not to replace existing ITBM systems but to establish links between the different data sources used by such systems in a flexible way and without knowledge of the structures of already attached data sources.

First, this dissertation presented the conceptual and practical challenges faced in ITBM, with a focus on data description and data interoperability. One key challenge in the construction of machine-processable information was addressed by introducing a domain-specific ontology that provides a machine-readable semantic formalization of information in this domain. This ontology was initially developed, and continuously improved, based on a large collection of ITBM documents and data sets that include various types of IT benchmarks and (IT) service descriptions from numerous organizations.

Second, a system architecture for semantic data integration was introduced to address the question of how such a system needs to be designed to facilitate the integration of existing distributed data sources using a domain-specific ontology. During the design of this architecture, requirements for functionalities were identified to guarantee critical aspects, in terms of consistency, for relevant system components (mappings). Moreover, an easy means of querying the attached data sources was introduced through the use of NLP technologies for the translation of natural language text queries into corresponding SPARQL queries.

As the last step, a prototype was implemented using the domain-specific ontology as the core concept for the linkage of external data sources based on the previously developed system architecture. A semi-automatic mapping recommender was introduced to directly support one of the the most complex and time-consuming tasks during the initial creation of mappings and their maintenance. This recommender suggests an highlights certain mappings within the corresponding data graph. Moreover, the text-to-SPARQL translation process is made transparent by showing the generated SPARQL query and visualizing the resulting search graph. The ontology and the prototype were evaluated against previously defined competence questions using real-world data structures and data sources and by mapping the OWL ITBM ontology to a MySQL database. Thus, the applicability of the proposed ontology and system in the domain of ITBM was demonstrated.

Chapter C2

Contributions and Limitations

In the following sections, the main contributions to theory and practice are described. Moreover, this chapter also delineates the limitations of this research, which are expected to be overcome in future work (see Chapter C3).

C2.1 Contributions to Theory

As noted in the introduction, the research presented in this dissertation is based on the scientific areas of design science, ontology engineering, ITBM and semantic data integration as well as related areas. Consequently, it offers contributions to these different knowledge bases.

Research in the field of ITBM is typically focused on the structuring, standardization and generalization of IT service catalogs or on methods for their implementation within companies. Yet, despite the growing interest in this field, little work published in the IS literature addresses the problem of data integration across different kinds of IT benchmarks. One of the difficulties in such integration arises from the lack of a uniform description method for any arbitrary measured parameter. Moreover, a description of the relations between such parameters also lacking. The main contribution of this dissertation to research on ITBM therefore lies in providing an ontological formalization of all relevant elements, attributes, and properties in this domain. This ITBM ontology provides a common language to enable data analysis across different distributed data sets and different IT benchmarks and to foster interoperability among ITBM tools. A more specific contribution related to the ITBM ontology lies in the description of a technical architecture in which an ontology-based approach for data integration can be applied to achieve interoperability and reuse and to structure an inherently unstructured field.

Because this dissertation is also influenced by the research areas of OE and semantic data integration, it also contributes to both of them. At present, the mapping of databases to ontology concepts is a very complex and time-consuming task, with rather poor tool support. However, since the ITBM ontology is very large in terms of the number of concepts that need to be mapped to corresponding data sets, this dissertation presents a concept for tool-supported mapping and introduces a (semi-)automatic recommender that directly support the mapping activities that must be performed to link an ontology to external databases. This research also contributes to design science in general by showing how theories can be used to guide design decisions for the construction of ontology-based applications.

C2.2 Contributions to Practice

The system architecture and the prototype application developed in this dissertation can guide the future development of tools to support ITBM benchmarking, particularly web-based systems for the semantic data integration of different IT benchmarks. Through the theory-driven approach adopted in this research, it contributes to improving the already existing benchmarking tools, which lack data interoperability. The developed ITBM ontology can be used as an independent data format to achieve interoperability between different tools in the area of ITBM. Moreover, it could function as a starting point for companies to develop interoperable tool-based benchmarks that would enable them to more easily perform performance comparisons within their own organizations and across organizational boundaries. With the linking of data sources to a benchmarking system that provides a standardized interface in the form of the ITBM ontology, benchmarking-as-a-service could be offered in the future.

For ontology engineers, the (semi-)automatic recommender reduces the time end effort required to configure the mapping of ontology concepts to data sources. Moreover, it also lowers the initial hurdles for this activity by enabling mapping without knowledge of the structures of already attached data sources.

C2.3 Research Limitations

This research has some limitations. This work assumes that the trend toward tool-based ITBM will continues and that the formal description of IT services will become increasingly important for the automation of performance analyses that are based upon it. The current increase in formalization activities is consistent with this assumption (e.g., Osterwalder/Pigneur/Tucci (2005); Dietz/Hoogervorst (2008); vom Brocke et al. (2014)) and thus supports the relevance of this research.

Since this research was conducted over a period of five years and because of the rapid pace of technological change, the data sources used for the development of the ontology might not cover all recent developments in IT. This is a common limitation in ITBM, as some period of time is needed to define new KPIs for the evaluation of new technologies. This is because ITBM retrospectively measures the performance of already implemented technologies within organizations. Thus, a technology that is a candidate for implementation by a company must reach a certain level of maturity, meaning that it must be available on the market for at least some time. Moreover, the implementation process needs to be completed for the corresponding (novel) IT service to be evaluated based on the technology itself rather than the implementation costs.

The ITBM ontology was developed based on various IT service catalogs and on strategic and service-oriented benchmarking data collected over the last seven years. Although these data provide a broad basis for the development of a domain-specific ontology, they cannot be considered to cover all aspects of every IT benchmark on the market. Thus, the ontology has been made publicly available to provide a greater opportunity to identify current shortcomings for consideration in the next version of the ontology.

Additional limitations arise from the data formats used for integration. At present, the implementation presupposes connections to relational databases. This is because most of the underlying data used for integration within this dissertation are already stored in relational databases. This limitation will likely lead to higher effort in attaching non-relational databases to the system by third parties.

Moreover, the system is designed for the internal purposes of an ITBM provider with no special security clearances. As a result, all users of the system are allowed to access all attached data sources. This is not considered to be a shortcoming as long as the system is to be used within a single organization or such transparency of the attached data is permitted. However, if the system is to be used beyond company boundaries or in compliance with certain data protection regulations, more fine-grained access control will need to be implemented, with restrictions regarding the use of specific databases and specific data points from a single data source.

Chapter C3

Future Research

BASED on the results of the included publications and in conjunction with the previously mentioned limitations, the following section presents ideas for future research in the major areas addressed by this work.

Extending the ITBM Ontology

The ITBM ontology provides the first broad systematic overview of the required key information for semantic data access in this domain. At present, the ontology is grounded in a DUL ontology. In this form, the ontology can serve as a formal basis for further research activities focused on the modeling and formalization of IT-related business models because it describes services that are commonly related to business processes.

To foster reuse and to increase the acceptance of the ITBM ontology, future research could focus on the extension of already implemented links to already existing ontologies in related domains, such as the FIBO and the GoodRelations ontology in the domain of ITSM. In this context, the extension of the ontology model with recent technological developments will also be of interest for keeping the ontology up to date. Moreover, at present, the ontology is subdivided into three specific sections. Thus, a separation of the general time-related information about a benchmark, the structural information regarding the questionnaires used and the the corresponding data that are connected to specific indicators is achieved. Future research could focus on the introduction of new dimensions within the ontology to allow type sharing for specific indicators (e.g., allowing multiple currencies).

Furthermore, future research should also aim to exploit additional reasoning capabilities regarding semantically related subjects, especially when linking the ITBM ontology to ontologies from related domains.

System Architecture and Semi-automatic Mapping Recommender

Future research in the context of the system architecture could focus on solutions for the flexible and automatic recognition of dynamic replacements for the applied ontology. For this purpose, the ontology engineering life cycle process could be supported with tools to guide the engineering during this process and to ensure consistency of the linkages between the applied ontology and the corresponding data sources. Moreover, the already implemented term crawler could be extended to automatically populate an existing ontology with new structural information provided by newly attached data sources. Another potential research opportunity could be the improvement of the already implemented NLP functionalists. This could result in a more effective identification of more complex linguistic connections among the concepts encompassed by the ontology. Additionally, some sort of signal word detection could also be considered to achieve automatic calculations based corresponding concepts implying mathematical operations.

The identification of methods for mapping different unstructured data formats with the aid of the already implemented concepts would also be beneficial. By this means, the effort required for the integration of external data sources could be reduced, leading to broader acceptance of such a benchmarking system. Additionally, the ontology mapping process for the ontology could also be extended to support and automatically resolve relations across different indicators that characterize the same concept.

Because the ontology is used for accessing (external) data sources, approaches that focus on securing and optimizing ontology-based systems are also of interest. The more such a system grows, in the sense that more additional and more widely varied external data sources are linked to the system, the more important fine-grained access control becomes for guaranteeing data security and data access. Additionally, when more users are working with such a system, query optimization also becomes inreasingly important to ensure efficient handling of operations on both the ontology side and the database side.

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Appendix: IT Benchmarking Ontology Vocabulary Specification

IT Benchmarking Ontology Vocabulary Specification

IRI: `https://w3id.org/bmontology`

Current version: 1.4 (Date: 06.20.2017)

Older version: Version 1.3, Version 1.1

Authors: Matthias Pfaff, Stefan Neubig, Helmut Krcmar

Imported Ontologies: DOLCE-UltraLite

Other visualisation: Ontology source, MMI Ontology Registry and Repository

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Abstract

The domain specific ontology for IT benchmarking has been developed to bridge the gap between a systematic characterization of IT services and their data based valuation. It is aligned to the DOLCE-UltraLite foundational ontology in order to foster reuse.

Table of Content

Introduction

As information is generally collected in a benchmark exercise using questionnaires on a broad range of topics, such as employee costs, software licensing costs, and quantities of hardware, it is commonly stored as natural language text; thus, it is stored in an intrinsically unstructured form. Even though these data are the basis for identifying potentials for IT cost reductions, neither does a uniform description of any arbitrary parameter that is measured nor the relationship between parameters currently exist. Hence, we proposes an ontology for the domain of IT benchmarking. The design of this ontology is based on requirements mainly elicited from a domain analysis, which considers analyzing documents and interviews with representatives of Small and Medium-Sized Enterprises (SME) and ICT companies over the last seven years. The ontology is aligned to the DOLCE-UltraLite foundational ontology in order to foster reuse.

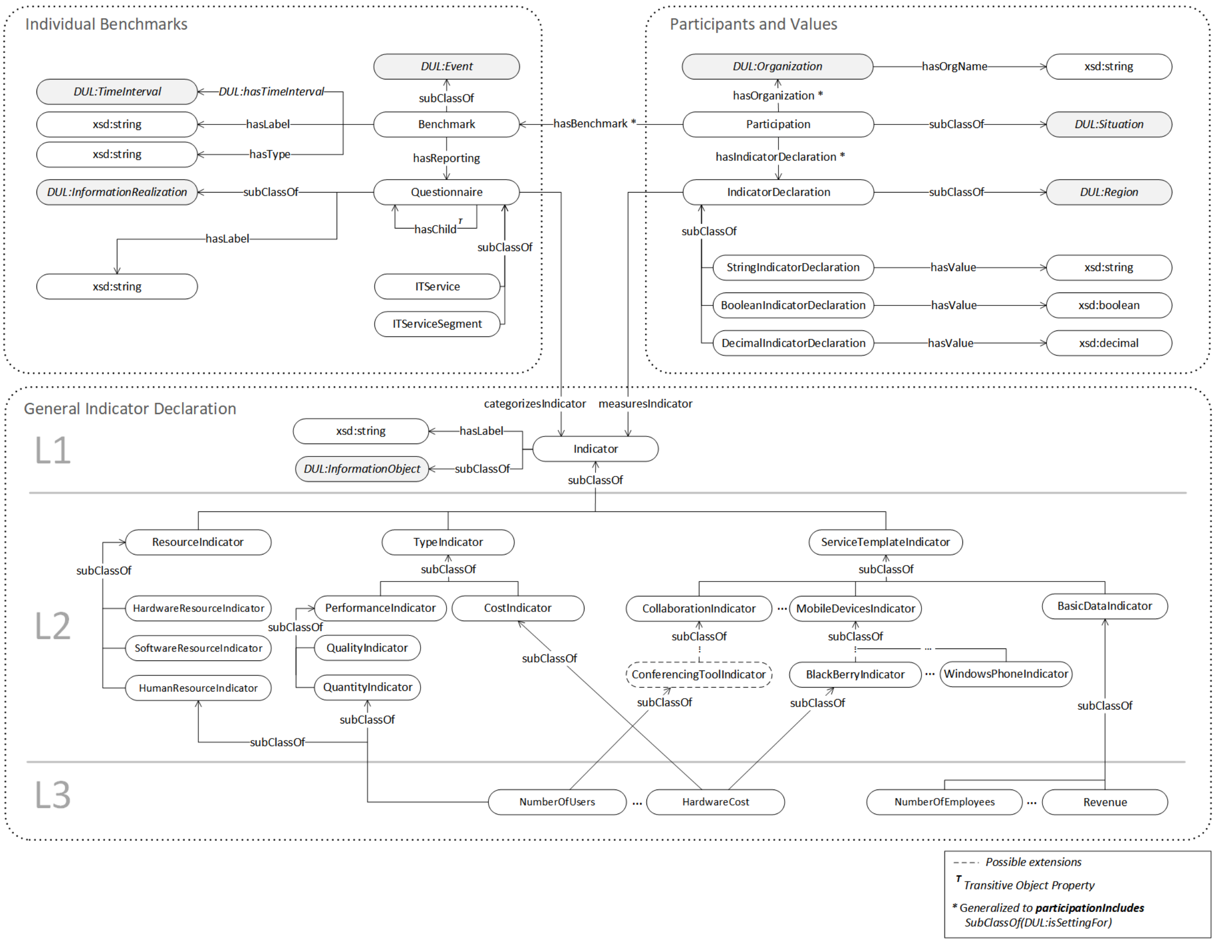

Figure 1: *Conceptual overview of the ITBM ontology*

Classes

- 24/7 service / regular office hours (performance indicators, quantity structure and performance)
- Access points (performance indicators, SSL VPN access)
- Access points (performance indicators, standard mass connection)
- Access points (performance indicators, VPN client)
- Access points (performance indicators, VPN tunel to business partners)
- ACD system (performance indicators, technology)
- Active solutions in use (performance indicators, general indicators)
- Add - Additional hardware components (cost indicators, costs add)
- Add - Software (automatically) (cost indicators, costs add)
- Add - Software (manually) (cost indicators, costs add)
- Added value of VoIP (performance indicators, performance information)
- Additional backup technologies (performance indicators, quantity structure and performance)
- Additional information (performance indicators, variant 1 (high availability))
- Additional information (performance indicators, variant 2)
- Administration costs (cost indicators, BC: basic system)
- Administration costs (cost indicators, co: controlling)
- Administration costs (cost indicators, CS: customer service)
- Administration costs (cost indicators, EC: corporate controlling)
- Administration costs (cost indicators, FI: finance)
- Administration costs (cost indicators, MM: materials management)
- Administration costs (cost indicators, PM: plant maintenance)
- Administration costs (cost indicators, PP: production planning and control)
- Administration costs (cost indicators, SD: sales and distribution)
- Are SLAs offered (performance indicators, conferencing (incl. video conferencing tools))
- Are SLAs offered (performance indicators, lync and other applications (without telephony))

- Are SLAs offered (performance indicators, sharePoint and other applications)
- Autonomous installation of apps (performance indicators, security indicators (blackberry))
- Autonomous installation of apps (performance indicators, security indicators (iPhone))
- Autonomous installation of apps (performance indicators, security indicators (other))
- Autonomous installation of apps (performance indicators, security indicators (windows phone))
- Availability (performance indicators, service level)
- Average frequency of change of a client (performance indicators, performance indicators)
- Backend and client systems (performance indicators, SSL VPN access)
- Backend and client systems (performance indicators, standard mass connection)
- Backend and client systems (performance indicators, VPN client)
- Backend and client systems (performance indicators, VPN tunel to business partners)
- Backup
- Backup software (performance indicators, quantity structure and performance)
- Backup strategy (performance indicators, cross-system)
- Backup strategy (performance indicators, quantity structure (large))
- Backup strategy (performance indicators, quantity structure (medium))
- Backup strategy (performance indicators, quantity structure (small))
- Backup strategy (performance indicators, quantity structure and performance)
- Backup strategy (performance indicators, quantity structure and performance)
- Backup strategy (performance indicators, quantity structure)
- Backup strategy (performance indicators, quantity structure)
- Backup strategy (performance indicators, variant 1 (high availability))
- Backup strategy (performance indicators, variant 2)
- Backup technology over WAN (performance indicators, quantity structure and performance)
- Backup volume (performance indicators, quantity structure and performance)

- Bandwidth management (performance indicators, quantity structure and performance)
- Basic data
- Batch processing (performance indicators, additional information)
- Benchmark
- Bring your own device (performance indicators, general indicators)
- Cabling Gbit over copper (performance indicators, additional information)
- Category performance (performance indicators, quantity structure and performance)
- Change/Delete - Total (cost indicators, costs change)
- Characteristics of LAN (performance indicators, additional information)
- Characteristics of persistence (performance indicators, quantity structure and performance)
- Client software (cost indicators, SSL VPN access)
- Client software (cost indicators, standard mass connection)
- Client software (cost indicators, VPN client)
- Client software (cost indicators, VPN tunel to business partners)
- Collaboration
- Computer center levy (cost indicators, cost indicator (medium))
- Computer center levy (cost indicators, cost indicators (large))
- Computer center levy (cost indicators, cost indicators (small))
- Computer center levy (cost indicators, cost indicators)
- Computer center levy (cost indicators, high)
- Computer center levy (cost indicators, low)
- Computer center levy (cost indicators, medium)
- Computer center levy (cost indicators, total costs of host systems)
- Contract term WAN (performance indicators, quantity structure and performance)
- Contractual regulation regarding the usage of data volume (performance indicators, general indicators)
- Copy of backup inventory (performance indicators, quantity structure and performance)
- Cost Indicator

- Cost rate FTE (performance indicators, SSL VPN access)
- Cost rate FTE (performance indicators, standard mass connection)
- Cost rate FTE (performance indicators, VPN client)
- Cost rate FTE (performance indicators, VPN tunel to business partners)
- Costs APA (cost indicators, WAN APA)
- Costs Brazil (cost indicators, WAN SA)
- Costs China (cost indicators, WAN APA)
- Costs EMEA (cost indicators, WAN EMEA)
- Costs Germany (cost indicators, WAN EMEA)
- Costs India (cost indicators, WAN APA)
- Costs Mexico (cost indicators, WAN NA)
- Costs NA (cost indicators, WAN NA)
- Costs of development and training of employees (IT costs, basic data)
- Costs other APA (cost indicators, WAN APA)
- Costs other countries (cost indicators, WAN other countries)
- Costs other EMEA (cost indicators, WAN EMEA)
- Costs other NA (cost indicators, WAN NA)
- Costs other SA (cost indicators, WAN SA)
- Costs Russia (cost indicators, WAN EMEA)
- Costs SA (cost indicators, WAN SA)
- Costs South Africa (cost indicators, WAN EMEA)
- Costs Turkey (cost indicators, WAN EMEA)
- Costs USA (cost indicators, WAN NA)
- CRM (performance indicators, quantity structure and performance (blackberry))
- CRM (performance indicators, quantity structure and performance (iPhone))
- CRM (performance indicators, quantity structure and performance (other))
- CRM (performance indicators, quantity structure and performance (windows phone))
- Customer (Number of users) (performance indicators, general)
- Data encryption (performance indicators, security indicators (blackberry))

- Data encryption (performance indicators, security indicators (iPhone))
- Data encryption (performance indicators, security indicators (other))
- Data encryption (performance indicators, security indicators (windows phone))
- Database
- Database (Variant 1)
- Database in use (performance indicators, variant 1 (high availability))
- Database in use (performance indicators, variant 2)
- Database systems (performance indicators, variant 1 (high availability))
- Database systems (performance indicators, variant 2)
- Datenbanken (Variante 2)
- DB size (performance indicators, additional information)
- Dedicated or shared service desk (performance indicators, quantity structure and performance)
- Dedicated server
- Dedicated server (large)
- Dedicated server (medium)
- Dedicated server (small)
- Degree of coverage (performance indicators, general)
- Degree of maturity of the module (performance indicators, BC: basic system)
- Degree of maturity of the module (performance indicators, co: controlling)
- Degree of maturity of the module (performance indicators, CS: customer service)
- Degree of maturity of the module (performance indicators, EC: corporate controlling)
- Degree of maturity of the module (performance indicators, FI: finance)
- Degree of maturity of the module (performance indicators, MM: materials management)
- Degree of maturity of the module (performance indicators, PM: plant maintenance)
- Degree of maturity of the module (performance indicators, PP: production planning and control)
- Degree of maturity of the module (performance indicators, SD: sales and distribution)

- Degree of maturity SAP ERP (performance indicators, general)
- Degree of virtualization (performance indicators, cross-system)
- Delivery time (performance indicators, service level of IMAC processes)
- Depreciation period (performance indicators, basic data)
- Depreciation period (performance indicators, quantity structure and performance (blackberry))
- Depreciation period (performance indicators, quantity structure and performance (iPhone))
- Depreciation period (performance indicators, quantity structure and performance (other))
- Depreciation period (performance indicators, quantity structure and performance (windows phone))
- Depth authorization concept (performance indicators, quantity structure)
- Development and project engineering of the IT (IT and development, basic data)
- Dialog processing (performance indicators, additional information)
- Dialog response time (performance indicators, additional information)
- Distribution of tertiary cabling (performance indicators, additional information)
- Distribution of tickets (performance indicators, quantity structure and performance)
- Document collaboration (performance indicators, tools)
- Duration until image is available (performance indicators, service level of IMAC processes)
- Duration until mass rollout of patch installations at clients are freed (performance indicators, service level of IMAC processes)
- Duration until patch publication (performance indicators, service level of IMAC processes)
- Dynamics of changes (performance indicators, general)
- Effort of external administration (FTE) (performance indicators, BC: basic system)
- Effort of external administration (FTE) (performance indicators, co: controlling)
- Effort of external administration (FTE) (performance indicators, CS: customer service)
- Effort of external administration (FTE) (performance indicators, EC: corporate controlling)
- Effort of external administration (FTE) (performance indicators, FI: finance)

- Effort of external administration (FTE) (performance indicators, MM: materials management)
- Effort of external administration (FTE) (performance indicators, PM: plant maintenance)
- Effort of external administration (FTE) (performance indicators, PP: production planning and control)
- Effort of external administration (FTE) (performance indicators, SD: sales and distribution)
- Effort of external maintenance (FTE) (performance indicators, BC: basic system)
- Effort of external maintenance (FTE) (performance indicators, co: controlling)
- Effort of external maintenance (FTE) (performance indicators, CS: customer service)
- Effort of external maintenance (FTE) (performance indicators, EC: corporate controlling)
- Effort of external maintenance (FTE) (performance indicators, FI: finance)
- Effort of external maintenance (FTE) (performance indicators, MM: materials management)
- Effort of external maintenance (FTE) (performance indicators, PM: plant maintenance)
- Effort of external maintenance (FTE) (performance indicators, PP: production planning and control)
- Effort of external maintenance (FTE) (performance indicators, SD: sales and distribution)
- Effort of in-house development (performance indicators, BC: basic system)
- Effort of in-house development (performance indicators, co: controlling)
- Effort of in-house development (performance indicators, CS: customer service)
- Effort of in-house development (performance indicators, EC: corporate controlling)
- Effort of in-house development (performance indicators, FI: finance)
- Effort of in-house development (performance indicators, MM: materials management)
- Effort of in-house development (performance indicators, PM: plant maintenance)
- Effort of in-house development (performance indicators, PP: production planning and control)
- Effort of in-house development (performance indicators, SD: sales and distribution)

- Effort of internal administration (FTE) (performance indicators, BC: basic system)
- Effort of internal administration (FTE) (performance indicators, co: controlling)
- Effort of internal administration (FTE) (performance indicators, CS: customer service)
- Effort of internal administration (FTE) (performance indicators, EC: corporate controlling)
- Effort of internal administration (FTE) (performance indicators, FI: finance)
- Effort of internal administration (FTE) (performance indicators, MM: materials management)
- Effort of internal administration (FTE) (performance indicators, PM: plant maintenance)
- Effort of internal administration (FTE) (performance indicators, PP: production planning and control)
- Effort of internal administration (FTE) (performance indicators, SD: sales and distribution)
- Effort of internal maintenance (FTE) (performance indicators, BC: basic system)
- Effort of internal maintenance (FTE) (performance indicators, co: controlling)
- Effort of internal maintenance (FTE) (performance indicators, CS: customer service)
- Effort of internal maintenance (FTE) (performance indicators, EC: corporate controlling)
- Effort of internal maintenance (FTE) (performance indicators, FI: finance)
- Effort of internal maintenance (FTE) (performance indicators, MM: materials management)
- Effort of internal maintenance (FTE) (performance indicators, PM: plant maintenance)
- Effort of internal maintenance (FTE) (performance indicators, PP: production planning and control)
- Effort of internal maintenance (FTE) (performance indicators, SD: sales and distribution)
- Electricity costs of computer centers (data center levy, basic data)
- Ensured availability (performance indicators, additional information)
- Ensured availability (performance indicators, cross-system)
- Ensured availability (performance indicators, quantity structure (large))

- Ensured availability (performance indicators, quantity structure (medium))
- Ensured availability (performance indicators, quantity structure (small))
- Ensured availability (performance indicators, quantity structure and performance)
- Ensured availability (performance indicators, quantity structure and performance)
- Ensured availability (performance indicators, quantity structure and performance)
- Ensured availability (performance indicators, quantity structure)
- Ensured availability (performance indicators, quantity structure)
- Ensured availability (performance indicators, service level of IMAC processes)
- Ensured availability (performance indicators, variant 1 (high availability))
- Ensured availability (performance indicators, variant 2)
- Ensured storage volume in data backup system (performance indicators, quantity structure and performance)
- Equipment of a default workingplace computer (desktop/laptop) (performance indicators, quantity structure and performance)
- Estimated distribution storage architecture DASD (performance indicators, quantity structure and performance)
- Estimated distribution storage architecture NAS (performance indicators, quantity structure and performance)
- Estimated distribution storage architecture SAN (performance indicators, quantity structure and performance)
- Existence of a process for for emergency management (IT and development, basic data)
- Existence of knowledge management in IT (IT and development, basic data)
- External services (cost indicators, active components)
- External services (cost indicators, blackberry)
- External services (cost indicators, classical telephony)
- External services (cost indicators, conferencing (incl. video conferencing tools))
- External services (cost indicators, cost indicator (medium))
- External services (cost indicators, cost indicators (large))
- External services (cost indicators, cost indicators (small))
- External services (cost indicators, cost indicators)

- External services (cost indicators, desktop)
- External services (cost indicators, high)
- External services (cost indicators, iPhone)
- External services (cost indicators, laptop)
- External services (cost indicators, low)
- External services (cost indicators, lync and other applications (without telephony))
- External services (cost indicators, medium)
- External services (cost indicators, monitoring and administration environment)
- External services (cost indicators, others)
- External services (cost indicators, security environment)
- External services (cost indicators, sharePoint and other applications)
- External services (cost indicators, SSL VPN access)
- External services (cost indicators, standard mass connection)
- External services (cost indicators, total costs of guest systems)
- External services (cost indicators, total costs of host systems)
- External services (cost indicators, total costs)
- External services (cost indicators, total costs)
- External services (cost indicators, total costs)
- External services (cost indicators, total costs)
- External services (cost indicators, total costs)
- External services (cost indicators, variant 1 (high availability))
- External services (cost indicators, variant 2)
- External services (cost indicators, voIP)
- External services (cost indicators, VPN client)
- External services (cost indicators, VPN tunel to business partners)
- External services (cost indicators, windows phone)
- External services (cost indicators, WLAN)
- Factor of redundancy (performance indicators, host systems)
- File Service

- File service user (performance indicators, quantity structure)
- First level support (performance indicators, included)
- Frequency Add additional HW components (performance indicators, performance indicators)
- Frequency Add SW automatically (performance indicators, performance indicators)
- Frequency Add SW manually (performance indicators, performance indicators)
- Frequency of a desktop installation (performance indicators, performance indicators)
- Frequency of a laptop installation (performance indicators, performance indicators)
- Frequency of a thin client installation (performance indicators, performance indicators)
- Frequency of Change/Delete (performance indicators, performance indicators)
- Frequency of changes (years) (performance indicators, general indicators)
- Frequency of logical move (performance indicators, performance indicators)
- Frequency of password changes (weeks) (performance indicators, security indicators (blackberry))
- Frequency of password changes (weeks) (performance indicators, security indicators (iPhone))
- Frequency of password changes (weeks) (performance indicators, security indicators (other))
- Frequency of password changes (weeks) (performance indicators, security indicators (windows phone))
- Frequency of physical move (performance indicators, performance indicators)
- Further submodules (performance indicators, BC: basic system)
- Further submodules (performance indicators, co: controlling)
- Further submodules (performance indicators, CS: customer service)
- Further submodules (performance indicators, EC: corporate controlling)
- Further submodules (performance indicators, FI: finance)
- Further submodules (performance indicators, MM: materials management)
- Further submodules (performance indicators, PM: plant maintenance)
- Further submodules (performance indicators, PP: production planning and control)
- Further submodules (performance indicators, SD: sales and distribution)

- Further usage scenarios (performance indicators, quantity structure and performance (blackberry))
- Further usage scenarios (performance indicators, quantity structure and performance (iPhone))
- Further usage scenarios (performance indicators, quantity structure and performance (other))
- Further usage scenarios (performance indicators, quantity structure and performance (windows phone))
- Governance (performance indicators, general)
- Guaranteed performance (performance indicators, quantity structure and performance)
- Hardware (cost indicators, active components)
- Hardware (cost indicators, blackberry)
- Hardware (cost indicators, classical telephony)
- Hardware (cost indicators, conferencing (incl. video conferencing tools))
- Hardware (cost indicators, cost indicator (medium))
- Hardware (cost indicators, cost indicators (large))
- Hardware (cost indicators, cost indicators (small))
- Hardware (cost indicators, cost indicators)
- Hardware (cost indicators, desktop)
- Hardware (cost indicators, high)
- Hardware (cost indicators, iPhone)
- Hardware (cost indicators, laptop)
- Hardware (cost indicators, low)
- Hardware (cost indicators, lync and other applications (without telephony))
- Hardware (cost indicators, medium)
- Hardware (cost indicators, monitoring and administration environment)
- Hardware (cost indicators, others)
- Hardware (cost indicators, security environment)
- Hardware (cost indicators, sharePoint and other applications)
- Hardware (cost indicators, total costs of host systems)

- Hardware (cost indicators, total costs)
- Hardware (cost indicators, total costs)
- Hardware (cost indicators, total costs)
- Hardware (cost indicators, total costs)
- Hardware (cost indicators, variant 1 (high availability))
- Hardware (cost indicators, variant 2)
- Hardware (cost indicators, voIP)
- Hardware (cost indicators, windows phone)
- Hardware (cost indicators, WLAN)
- Hardware maintenance (cost indicators, active components)
- Hardware maintenance (cost indicators, blackberry)
- Hardware maintenance (cost indicators, classical telephony)
- Hardware maintenance (cost indicators, conferencing (incl. video conferencing tools))
- Hardware maintenance (cost indicators, cost indicator (medium))
- Hardware maintenance (cost indicators, cost indicators (large))
- Hardware maintenance (cost indicators, cost indicators (small))
- Hardware maintenance (cost indicators, cost indicators)
- Hardware maintenance (cost indicators, high)
- Hardware maintenance (cost indicators, iPhone)
- Hardware maintenance (cost indicators, low)
- Hardware maintenance (cost indicators, lync and other applications (without telephony))
- Hardware maintenance (cost indicators, medium)
- Hardware maintenance (cost indicators, monitoring and administration environment)
- Hardware maintenance (cost indicators, others)
- Hardware maintenance (cost indicators, security environment)
- Hardware maintenance (cost indicators, sharePoint and other applications)
- Hardware maintenance (cost indicators, total costs of host systems)
- Hardware maintenance (cost indicators, total costs)

- Hardware maintenance (cost indicators, total costs)
- Hardware maintenance (cost indicators, total costs)
- Hardware maintenance (cost indicators, total costs)
- Hardware maintenance (cost indicators, variant 1 (high availability))
- Hardware maintenance (cost indicators, variant 2)
- Hardware maintenance (cost indicators, voIP)
- Hardware maintenance (cost indicators, windows phone)
- Hardware maintenance (cost indicators, WLAN)
- Hardware resource indicator
- High availability (performance indicators, variant 2)
- Hight unit computer center (data center levy, basic data)
- How are end devices purchased (performance indicators, general indicators)
- How is the infrastructure integration regulated (performance indicators, conferencing (incl. video conferencing tools))
- How is the infrastructure integration regulated (performance indicators, lync and other applications (without telephony))
- How is the infrastructure integration regulated (performance indicators, sharePoint and other applications)
- Human resource indicator
- IMAC
- IMAC completion according to SLA (performance indicators, service level of IMAC processes)
- Indicate your most important projects (IT and development, basic data)
- Indicator
- Indicator Declaration
- Indicator declaration of a boolean value
- Indicator declaration of a decimal value
- Indicator declaration of a string value
- Indicator scope (general organization data, basic data)
- Information about admin environment (performance indicators, performance and architecture)

- Infrastructure - backend (cost indicators, SSL VPN access)
- Infrastructure - backend (cost indicators, standard mass connection)
- Infrastructure - backend (cost indicators, VPN client)
- Infrastructure - backend (cost indicators, VPN tunel to business partners)
- Infrastructure - decentral (cost indicators, SSL VPN access)
- Infrastructure - decentral (cost indicators, standard mass connection)
- Infrastructure - decentral (cost indicators, VPN client)
- Infrastructure - decentral (cost indicators, VPN tunel to business partners)
- Install - Desktop (cost indicators, costs install)
- Install - Laptop (cost indicators, costs install)
- Install - Thin client (cost indicators, costs install)
- Installation supported by automation (performance indicators, cross-system)
- Instant messaging (performance indicators, tools)
- Interface self service (performance indicators, technology)
- Interfaces (performance indicators, general)
- Internationality (performance indicators, general)
- Internet access (performance indicators, quantity structure and performance (blackberry))
- Internet access (performance indicators, quantity structure and performance (iPhone))
- Internet access (performance indicators, quantity structure and performance (other))
- Internet access (performance indicators, quantity structure and performance (windows phone))
- Intranet access (performance indicators, quantity structure and performance (blackberry))
- Intranet access (performance indicators, quantity structure and performance (iPhone))
- Intranet access (performance indicators, quantity structure and performance (other))
- Intranet access (performance indicators, quantity structure and performance (windows phone))
- Introsion detection systems (performance indicators, additional information)
- Investment volume (general organization data, basic data)
- Is the module used in production (performance indicators, BC: basic system)

- Is the module used in production (performance indicators, co: controlling)
- Is the module used in production (performance indicators, CS: customer service)
- Is the module used in production (performance indicators, EC: corporate controlling)
- Is the module used in production (performance indicators, FI: finance)
- Is the module used in production (performance indicators, MM: materials management)
- Is the module used in production (performance indicators, PM: plant maintenance)
- Is the module used in production (performance indicators, PP: production planning and control)
- Is the module used in production (performance indicators, SD: sales and distribution)
- IT costs applications (IT costs, basic data)
- IT costs Change (projects) (IT costs, basic data)
- IT costs management (IT costs, basic data)
- IT costs of external performance (IT costs, basic data)
- IT costs of infrastructure (IT costs, basic data)
- IT costs of internal performance (IT costs, basic data)
- IT costs Run (line activities) (IT costs, basic data)
- IT investment (IT costs, basic data)
- IT involved in purchasing process (IT and development, basic data)
- IT personnel costs (IT costs, basic data)
- IT service questionnaire
- IT total costs (IT costs, basic data)
- IT trends (IT and development, basic data)
- Knowledge management (performance indicators, technology)
- LAN
- Legal form of the organization (performance indicators, basic data)
- License costs (cost indicators, total costs)
- Location of first level support (performance indicators, quantity structure and performance)

- Mailbox
- Mailbox - operating mode (performance indicators, quantity structure)
- Mailbox - Usage of mailbox archiving (performance indicators, quantity structure)
- Main scope (performance indicators, quantity structure and performance)
- Maintenance (cost indicators, desktop)
- Maintenance (cost indicators, laptop)
- Maintenance costs (cost indicators, BC: basic system)
- Maintenance costs (cost indicators, co: controlling)
- Maintenance costs (cost indicators, CS: customer service)
- Maintenance costs (cost indicators, EC: corporate controlling)
- Maintenance costs (cost indicators, FI: finance)
- Maintenance costs (cost indicators, MM: materials management)
- Maintenance costs (cost indicators, PM: plant maintenance)
- Maintenance costs (cost indicators, PP: production planning and control)
- Maintenance costs (cost indicators, SD: sales and distribution)
- Maintenance costs service desk tool (cost indicators, total costs)
- Management of mobile contracts (performance indicators, general indicators)
- Management of mobile devices (performance indicators, general indicators)
- Manufacturer of telephony platform (performance indicators, performance information)
- Master data and avoidance of redundancy (performance indicators, quantity structure and performance)
- Master data central or decentral (performance indicators, quantity structure and performance)
- Master data management (performance indicators, quantity structure and performance)
- Max. data loss time (performance indicators, quantity structure and performance)
- Mobile carrier (performance indicators, general indicators)
- Mobile devices
- Mobile Devices (Blackberry)
- Mobile Devices (iPhone)

- Mobile Devices (Others)
- Mobile Devices (Windows Phone)
- Module adaption (performance indicators, BC: basic system)
- Module adaption (performance indicators, co: controlling)
- Module adaption (performance indicators, CS: customer service)
- Module adaption (performance indicators, EC: corporate controlling)
- Module adaption (performance indicators, FI: finance)
- Module adaption (performance indicators, MM: materials management)
- Module adaption (performance indicators, PM: plant maintenance)
- Module adaption (performance indicators, PP: production planning and control)
- Module adaption (performance indicators, SD: sales and distribution)
- Modules in use (performance indicators, additional information)
- Move - Logical (cost indicators, costs move)
- Move - Physical (cost indicators, costs move)
- Name of the mailsystem (performance indicators, quantity structure)
- Number of access point (performance indicators, WLAN)
- Number of access ports 1 Gbit with PoE (performance indicators, quantity structure)
- Number of access ports 1 Gbit without PoE (performance indicators, quantity structure)
- Number of access ports 100Mbit with PoE (performance indicators, quantity structure)
- Number of access ports 100Mbit without PoE (performance indicators, quantity structure)
- Number of active devices in the organization (performance indicators, general indicators)
- Number of application server (performance indicators, additional information)
- Number of authorized users (performance indicators, SSL VPN access)
- Number of authorized users (performance indicators, standard mass connection)
- Number of authorized users (performance indicators, VPN client)
- Number of backup instances (performance indicators, quantity structure and performance)

- Number of backup servers (performance indicators, quantity structure and performance)
- Number of clients (performance indicators, quantity structure and performance)
- Number of computer centers (computer center levy, basic data)
- Number of connected devices using access ports (performance indicators, quantity structure)
- Number of connections to business partners RAS VPN tunnel (performance indicators, VPN tunel to business partners)
- Number of cores (performance indicators, host systems)
- Number of countries managed by the IT (performance indicators, basic data)
- Number of database version (performance indicators, variant 1 (high availability))
- Number of database version (performance indicators, variant 2)
- Number of databases (performance indicators, variant 1 (high availability))
- Number of databases (performance indicators, variant 2)
- Number of dedicated servers (performance indicators, quantity structure and performance)
- Number of devices (performance indicators, performance indicators)
- Number of distributed packages per year (performance indicators, quantity structure and performance)
- Number of distributed packages per year (performance indicators, service level of IMAC processes)
- Number of employees (general organization data, basic data)
- Number of employees in service desk management (FTE) (performance indicators, quantity structure and performance)
- Number of end devices (this platform) (performance indicators, quantity structure and performance (blackberry))
- Number of end devices (this platform) (performance indicators, quantity structure and performance (iPhone))
- Number of end devices (this platform) (performance indicators, quantity structure and performance (other))
- Number of end devices (this platform) (performance indicators, quantity structure and performance (windows phone))
- Number of external IT employees (FTE) (performance indicators, basic data)

- Number of external personnel (FTE) (performance indicators, conferencing (incl. video conferencing tools))
- Number of external personnel (FTE) (performance indicators, cross-system)
- Number of external personnel (FTE) (performance indicators, lync and other applications (without telephony))
- Number of external personnel (FTE) (performance indicators, performance indicators)
- Number of external personnel (FTE) (performance indicators, quantity structure (large))
- Number of external personnel (FTE) (performance indicators, quantity structure (medium))
- Number of external personnel (FTE) (performance indicators, quantity structure (small))
- Number of external personnel (FTE) (performance indicators, quantity structure and performance)
- Number of external personnel (FTE) (performance indicators, quantity structure and performance)
- Number of external personnel (FTE) (performance indicators, quantity structure and performance)
- Number of external personnel (FTE) (performance indicators, quantity structure and performance)
- Number of external personnel (FTE) (performance indicators, quantity structure and performance)
- Number of external personnel (FTE) (performance indicators, quantity structure and performance)
- Number of external personnel (FTE) (performance indicators, quantity structure)
- Number of external personnel (FTE) (performance indicators, quantity structure)
- Number of external personnel (FTE) (performance indicators, quantity structure)
- Number of external personnel (FTE) (performance indicators, sharePoint and other applications)
- Number of external personnel (FTE) (performance indicators, SSL VPN access)
- Number of external personnel (FTE) (performance indicators, standard mass connection)
- Number of external personnel (FTE) (performance indicators, variant 1 (high availability))

- Number of external personnel (FTE) (performance indicators, variant 2)
- Number of external personnel (FTE) (performance indicators, VPN client)
- Number of external personnel (FTE) (performance indicators, VPN tunel to business partners)
- Number of external personnel per platform (FTE) (performance indicators, performance information)
- Number of external personnel per platform (FTE) (performance indicators, quantity structure and performance (blackberry))
- Number of external personnel per platform (FTE) (performance indicators, quantity structure and performance (iPhone))
- Number of external personnel per platform (FTE) (performance indicators, quantity structure and performance (other))
- Number of external personnel per platform (FTE) (performance indicators, quantity structure and performance (windows phone))
- Number of external personnel WLAN (FTE) (performance indicators, WLAN)
- Number of full users (performance indicators, quantity structure and performance)
- Number of guest systems (performance indicators, guest system)
- Number of guest systems (performance indicators, quantity structure and performance)
- Number of incident tickets per year (performance indicators, quantity structure and performance)
- Number of incidents (performance indicators, additional information)
- Number of internal IT employees (FTE) (performance indicators, basic data)
- Number of internal personnel (FTE) (performance indicators, conferencing (incl. video conferencing tools))
- Number of internal personnel (FTE) (performance indicators, cross-system)
- Number of internal personnel (FTE) (performance indicators, lync and other applications (without telephony))
- Number of internal personnel (FTE) (performance indicators, performance indicators)
- Number of internal personnel (FTE) (performance indicators, quantity structure (large))
- Number of internal personnel (FTE) (performance indicators, quantity structure (medium))

- Number of internal personnel (FTE) (performance indicators, quantity structure (small))
- Number of internal personnel (FTE) (performance indicators, quantity structure and performance)
- Number of internal personnel (FTE) (performance indicators, quantity structure and performance)
- Number of internal personnel (FTE) (performance indicators, quantity structure and performance)
- Number of internal personnel (FTE) (performance indicators, quantity structure and performance)
- Number of internal personnel (FTE) (performance indicators, quantity structure and performance)
- Number of internal personnel (FTE) (performance indicators, quantity structure and performance)
- Number of internal personnel (FTE) (performance indicators, quantity structure)
- Number of internal personnel (FTE) (performance indicators, quantity structure)
- Number of internal personnel (FTE) (performance indicators, quantity structure)
- Number of internal personnel (FTE) (performance indicators, sharePoint and other applications)
- Number of internal personnel (FTE) (performance indicators, SSL VPN access)
- Number of internal personnel (FTE) (performance indicators, standard mass connection)
- Number of internal personnel (FTE) (performance indicators, variant 1 (high availability))
- Number of internal personnel (FTE) (performance indicators, variant 2)
- Number of internal personnel (FTE) (performance indicators, VPN client)
- Number of internal personnel (FTE) (performance indicators, VPN tunel to business partners)
- Number of internal personnel per plantform (FTE) (performance indicators, performance information)
- Number of internal personnel per plantform (FTE) (performance indicators, quantity structure and performance (blackberry))
- Number of internal personnel per plantform (FTE) (performance indicators, quantity structure and performance (iPhone))

- Number of internal personnel per plantform (FTE) (performance indicators, quantity structure and performance (other))
- Number of internal personnel per plantform (FTE) (performance indicators, quantity structure and performance (windows phone))
- Number of internal personnel WLAN (FTE) (performance indicators, WLAN)
- Number of IT developers (FTE) (performance indicators, basic data)
- Number of IT users (performance indicators, basic data)
- Number of languages (performance indicators, quantity structure and performance)
- Number of libraries (disk & tapes) (performance indicators, quantity structure and performance)
- Number of light users (performance indicators, quantity structure and performance)
- Number of location video WAN APA (performance indicators, quantity structure (APA))
- Number of locations (performance indicators, general)
- Number of locations (performance indicators, quantity structure (other countries))
- Number of locations APA (performance indicators, quantity structure (APA))
- Number of locations Brazil (performance indicators, quantity structure (SA))
- Number of locations China (performance indicators, quantity structure (APA))
- Number of locations EMEA (performance indicators, quantity structure (EMEA))
- Number of locations Germany (performance indicators, quantity structure (EMEA))
- Number of locations India (performance indicators, quantity structure (APA))
- Number of locations Mexico (performance indicators, quantity structure (NA))
- Number of locations NA (performance indicators, quantity structure (NA))
- Number of locations other APA (performance indicators, quantity structure (APA))
- Number of locations other EMEA (performance indicators, quantity structure (EMEA))
- Number of locations other NA (performance indicators, quantity structure (NA))
- Number of locations other SA (performance indicators, quantity structure (SA))
- Number of locations prioritization WAN (performance indicators, quantity structure (other countries))
- Number of locations prioritization WAN APA (performance indicators, quantity structure (APA))

- Number of locations prioritization WAN Brazil (performance indicators, quantity structure (SA))
- Number of locations prioritization WAN China (performance indicators, quantity structure (APA))
- Number of locations prioritization WAN EMEA (performance indicators, quantity structure (EMEA))
- Number of locations prioritization WAN Germany (performance indicators, quantity structure (EMEA))
- Number of locations prioritization WAN India (performance indicators, quantity structure (APA))
- Number of locations prioritization WAN Mexico (performance indicators, quantity structure (NA))
- Number of locations prioritization WAN NA (performance indicators, quantity structure (NA))
- Number of locations prioritization WAN other APA (performance indicators, quantity structure (APA))
- Number of locations prioritization WAN other EMEA (performance indicators, quantity structure (EMEA))
- Number of locations prioritization WAN other NA (performance indicators, quantity structure (NA))
- Number of locations prioritization WAN other SA (performance indicators, quantity structure (SA))
- Number of locations prioritization WAN Russia (performance indicators, quantity structure (EMEA))
- Number of locations prioritization WAN SA (performance indicators, quantity structure (SA))
- Number of locations prioritization WAN South Africa (performance indicators, quantity structure (EMEA))
- Number of locations prioritization WAN Turkey (performance indicators, quantity structure (EMEA))
- Number of locations prioritization WAN USA (performance indicators, quantity structure (NA))
- Number of locations Russia (performance indicators, quantity structure (EMEA))
- Number of locations SA (performance indicators, quantity structure (SA))
- Number of locations South Africa (performance indicators, quantity structure (EMEA))

- Number of locations Turkey (performance indicators, quantity structure (EMEA))
- Number of locations USA (performance indicators, quantity structure (NA))
- Number of locations video WAN (performance indicators, quantity structure (other countries))
- Number of locations video WAN Brazil (performance indicators, quantity structure (SA))
- Number of locations video WAN China (performance indicators, quantity structure (APA))
- Number of locations video WAN EMEA (performance indicators, quantity structure (EMEA))
- Number of locations video WAN Germany (performance indicators, quantity structure (EMEA))
- Number of locations video WAN India (performance indicators, quantity structure (APA))
- Number of locations video WAN Mexico (performance indicators, quantity structure (NA))
- Number of locations video WAN NA (performance indicators, quantity structure (NA))
- Number of locations video WAN other APA (performance indicators, quantity structure (APA))
- Number of locations video WAN other EMEA (performance indicators, quantity structure (EMEA))
- Number of locations video WAN other NA (performance indicators, quantity structure (NA))
- Number of locations video WAN other SA (performance indicators, quantity structure (SA))
- Number of locations video WAN Russia (performance indicators, quantity structure (EMEA))
- Number of locations video WAN SA (performance indicators, quantity structure (SA))
- Number of locations video WAN South Africa (performance indicators, quantity structure (EMEA))
- Number of locations video WAN Turkey (performance indicators, quantity structure (EMEA))
- Number of locations video WAN UA (performance indicators, quantity structure (NA))

- Number of locations VoIP WAN (performance indicators, quantity structure (other countries))
- Number of locations VoIP WAN APA (performance indicators, quantity structure (APA))
- Number of locations VoIP WAN Brazil (performance indicators, quantity structure (SA))
- Number of locations VoIP WAN China (performance indicators, quantity structure (APA))
- Number of locations VoIP WAN EMEA (performance indicators, quantity structure (EMEA))
- Number of locations VoIP WAN Germany (performance indicators, quantity structure (EMEA))
- Number of locations VoIP WAN India (performance indicators, quantity structure (APA))
- Number of locations VoIP WAN Mexico (performance indicators, quantity structure (NA))
- Number of locations VoIP WAN NA (performance indicators, quantity structure (NA))
- Number of locations VoIP WAN other APA (performance indicators, quantity structure (APA))
- Number of locations VoIP WAN other EMEA (performance indicators, quantity structure (EMEA))
- Number of locations VoIP WAN other NA (performance indicators, quantity structure (NA))
- Number of locations VoIP WAN other SA (performance indicators, quantity structure (SA))
- Number of locations VoIP WAN Russia (performance indicators, quantity structure (EMEA))
- Number of locations VoIP WAN SA (performance indicators, quantity structure (SA))
- Number of locations VoIP WAN South Africa (performance indicators, quantity structure (EMEA))
- Number of locations VoIP WAN Turkey (performance indicators, quantity structure (EMEA))
- Number of locations VoIP WAN USA (performance indicators, quantity structure (NA))

- Number of locations without prioritization WAN (performance indicators, quantity structure (other countries))
- Number of locations without prioritization WAN APA (performance indicators, quantity structure (APA))
- Number of locations without prioritization WAN Brazil (performance indicators, quantity structure (SA))
- Number of locations without prioritization WAN China (performance indicators, quantity structure (APA))
- Number of locations without prioritization WAN EMEA (performance indicators, quantity structure (EMEA))
- Number of locations without prioritization WAN Germany (performance indicators, quantity structure (EMEA))
- Number of locations without prioritization WAN India (performance indicators, quantity structure (APA))
- Number of locations without prioritization WAN Mexico (performance indicators, quantity structure (NA))
- Number of locations without prioritization WAN NA (performance indicators, quantity structure (NA))
- Number of locations without prioritization WAN other APA (performance indicators, quantity structure (APA))
- Number of locations without prioritization WAN other EMEA (performance indicators, quantity structure (EMEA))
- Number of locations without prioritization WAN other NA (performance indicators, quantity structure (NA))
- Number of locations without prioritization WAN other SA (performance indicators, quantity structure (SA))
- Number of locations without prioritization WAN Russia (performance indicators, quantity structure (EMEA))
- Number of locations without prioritization WAN SA (performance indicators, quantity structure (SA))
- Number of locations without prioritization WAN South Africa (performance indicators, quantity structure (EMEA))
- Number of locations without prioritization WAN Turkey (performance indicators, quantity structure (EMEA))
- Number of locations without prioritization WAN USA (performance indicators, quantity structure (NA))

- Number of long running batch processes (performance indicators, quantity structure and performance)
- Number of mailboxes (performance indicators, quantity structure)
- Number of mailservers (performance indicators, quantity structure)
- Number of maintaned phone numbers (performance indicators, quantity structure (classical telephony))
- Number of managed locations (performance indicators, performance information)
- Number of managed phone numbers (performance indicators, quantity structure (voIP))
- Number of module users (performance indicators, BC: basic system)
- Number of module users (performance indicators, co: controlling)
- Number of module users (performance indicators, CS: customer service)
- Number of module users (performance indicators, EC: corporate controlling)
- Number of module users (performance indicators, FI: finance)
- Number of module users (performance indicators, MM: materials management)
- Number of module users (performance indicators, PM: plant maintenance)
- Number of module users (performance indicators, PP: production planning and control)
- Number of module users (performance indicators, SD: sales and distribution)
- Number of other access ports (performance indicators, quantity structure)
- Number of passive devices in the organization (performance indicators, general indicators)
- Number of patch cycles per year (performance indicators, quantity structure and performance)
- Number of physical hosts (performance indicators, quantity structure and performance)
- Number of physical hosts in the server farm (performance indicators, host systems)
- Number of providers WLAN (performance indicators, quantity structure and performance)
- Number of Runtime errors (performance indicators, quantity structure and performance)
- Number of servers (performance indicators, quantity structure (large))
- Number of servers (performance indicators, quantity structure (small))

- Number of servers (platform-specific) (performance indicators, quantity structure (medium))
- Number of servers (platform-specific) (performance indicators, quantity structure and performance (blackberry))
- Number of servers (platform-specific) (performance indicators, quantity structure and performance (iPhone))
- Number of servers (platform-specific) (performance indicators, quantity structure and performance (other))
- Number of servers (platform-specific) (performance indicators, quantity structure and performance (windows phone))
- Number of service desk agents, first level (FTE) (performance indicators, quantity structure and performance)
- Number of service requests per year (performance indicators, quantity structure and performance)
- Number of snapshots in primary storage per day (performance indicators, quantity structure and performance)
- Number of supported users (performance indicators, quantity structure and performance)
- Number of system lines (Landscape) (performance indicators, quantity structure and performance)
- Number of systems (ERP + HR) (performance indicators, quantity structure and performance)
- Number of systems (Landscape) (performance indicators, quantity structure and performance)
- Number of systems to be secured (performance indicators, quantity structure and performance)
- Number of sytem lines (ERP + HR) (performance indicators, quantity structure and performance)
- Number of tape drives (performance indicators, quantity structure and performance)
- Number of telephony end devices (performance indicators, quantity structure (classical telephony))
- Number of telephony end devices (performance indicators, quantity structure (voIP))
- Number of used operation systems (performance indicators, cross-system)
- Number of used operation systems (performance indicators, quantity structure and performance)

- Number of users China (performance indicators, quantity structure (APA))
- Number of users (performance indicators, conferencing (incl. video conferencing tools))
- Number of users (performance indicators, lync and other applications (without telephony))
- Number of users (performance indicators, quantity structure (other countries))
- Number of users (performance indicators, sharePoint and other applications)
- Number of users APA (performance indicators, quantity structure (APA))
- Number of users Brazil (performance indicators, quantity structure (SA))
- Number of users concurrent (performance indicators, quantity structure and performance)
- Number of users EMEA (performance indicators, quantity structure (EMEA))
- Number of users Germany (performance indicators, quantity structure (EMEA))
- Number of users India (performance indicators, quantity structure (APA))
- Number of users Mail (performance indicators, quantity structure)
- Number of users Mexico (performance indicators, quantity structure (NA))
- Number of users NA (performance indicators, quantity structure (NA))
- Number of users other APA (performance indicators, quantity structure (APA))
- Number of users other EMEA (performance indicators, quantity structure (EMEA))
- Number of users other NA (performance indicators, quantity structure (NA))
- Number of users other SA (performance indicators, quantity structure (SA))
- Number of users Russia (performance indicators, quantity structure (EMEA))
- Number of users SA (performance indicators, quantity structure (SA))
- Number of users South Africa (performance indicators, quantity structure (EMEA))
- Number of users supported from the cental location (performance indicators, quantity structure (classical telephony))
- Number of users supported from the cental location (performance indicators, quantity structure (voIP))
- Number of users total (performance indicators, quantity structure and performance)
- Number of users Turkey (performance indicators, quantity structure (EMEA))
- Number of users USA (performance indicators, quantity structure (NA))

- Number of WLAN controller (performance indicators, WLAN)
- Number of working students / intern (performance indicators, basic data)
- Number of workplaces (desktop) (performance indicators, quantity structure and performance)
- Number of workplaces (laptop) (performance indicators, quantity structure and performance)
- Offered services (performance indicators, quantity structure and performance)
- Offetting backup (cost indicators, classical telephony)
- Offetting backup (cost indicators, conferencing (incl. video conferencing tools))
- Offetting backup (cost indicators, lync and other applications (without telephony))
- Offetting backup (cost indicators, sharePoint and other applications)
- Offetting backup (cost indicators, total costs)
- Offetting backup (cost indicators, total costs)
- Offetting backup (cost indicators, total costs)
- Offetting backup (cost indicators, variant 1 (high availability))
- Offetting backup (cost indicators, variant 2)
- Offetting backup (cost indicators, voIP)
- Offsetting Install (cost indicators, desktop)
- Offsetting Install (cost indicators, laptop)
- Offsetting Server (cost indicators, blackberry)
- Offsetting Server (cost indicators, classical telephony)
- Offsetting Server (cost indicators, conferencing (incl. video conferencing tools))
- Offsetting Server (cost indicators, cost indicators)
- Offsetting Server (cost indicators, high)
- Offsetting Server (cost indicators, iPhone)
- Offsetting Server (cost indicators, low)
- Offsetting Server (cost indicators, lync and other applications (without telephony))
- Offsetting Server (cost indicators, medium)
- Offsetting Server (cost indicators, others)
- Offsetting Server (cost indicators, sharePoint and other applications)

- Offsetting Server (cost indicators, total costs)
- Offsetting Server (cost indicators, total costs)
- Offsetting Server (cost indicators, total costs)
- Offsetting Server (cost indicators, total costs)
- Offsetting Server (cost indicators, variant 1 (high availability))
- Offsetting Server (cost indicators, variant 2)
- Offsetting Server (cost indicators, voIP)
- Offsetting Server (cost indicators, windows phone)
- Offsetting Storage (cost indicators, classical telephony)
- Offsetting Storage (cost indicators, conferencing (incl. video conferencing tools))
- Offsetting Storage (cost indicators, cost indicators)
- Offsetting Storage (cost indicators, lync and other applications (without telephony))
- Offsetting Storage (cost indicators, sharePoint and other applications)
- Offsetting Storage (cost indicators, total costs)
- Offsetting Storage (cost indicators, total costs)
- Offsetting Storage (cost indicators, total costs)
- Offsetting Storage (cost indicators, total costs)
- Offsetting Storage (cost indicators, variant 1 (high availability))
- Offsetting Storage (cost indicators, variant 2)
- Offsetting Storage (cost indicators, voIP)
- On which platforms are the solutions based? (performance indicators, general indicators)
- Operating system in use (performance indicators, variant 1 (high availability))
- Operating system in use (performance indicators, variant 2)
- Operationally used storage volume (performance indicators, quantity structure (high))
- Operationally used storage volume (performance indicators, quantity structure (low))
- Operationally used storage volume (performance indicators, quantity structure (medium))
- Organizational form of IT (performance indicators, basic data)
- Other end devices (performance indicators, others (classical telephony))

- Other end devices (performance indicators, sourcing (voIP))
- Other technologie (performance indicators, technology)
- Others (cost indicators, active components)
- Others (cost indicators, blackberry)
- Others (cost indicators, classical telephony)
- Others (cost indicators, conferencing (incl. video conferencing tools))
- Others (cost indicators, cost indicator (medium))
- Others (cost indicators, cost indicators (large))
- Others (cost indicators, cost indicators (small))
- Others (cost indicators, cost indicators)
- Others (cost indicators, desktop)
- Others (cost indicators, high)
- Others (cost indicators, iPhone)
- Others (cost indicators, laptop)
- Others (cost indicators, low)
- Others (cost indicators, lync and other applications (without telephony))
- Others (cost indicators, medium)
- Others (cost indicators, monitoring and administration environment)
- Others (cost indicators, others)
- Others (cost indicators, security environment)
- Others (cost indicators, sharePoint and other applications)
- Others (cost indicators, SSL VPN access)
- Others (cost indicators, standard mass connection)
- Others (cost indicators, total costs of guest systems)
- Others (cost indicators, total costs of host systems)
- Others (cost indicators, total costs)
- Others (cost indicators, total costs)
- Others (cost indicators, total costs)
- Others (cost indicators, total costs)

- Others (cost indicators, total costs)
- Others (cost indicators, variant 1 (high availability))
- Others (cost indicators, variant 2)
- Others (cost indicators, voIP)
- Others (cost indicators, VPN client)
- Others (cost indicators, VPN tunel to business partners)
- Others (cost indicators, windows phone)
- Others (cost indicators, WLAN)
- Own computers allowed for external employees (performance indicators, additional information)
- Participation
- Password changes in fixed periods of time required (performance indicators, security indicators (blackberry))
- Password changes in fixed periods of time required (performance indicators, security indicators (iPhone))
- Password changes in fixed periods of time required (performance indicators, security indicators (other))
- Password changes in fixed periods of time required (performance indicators, security indicators (windows phone))
- Patch cycles (performance indicators, quantity structure (large))
- Patch cycles (performance indicators, quantity structure (medium))
- Patch cycles (performance indicators, quantity structure (small))
- Patch cycles (performance indicators, variant 1 (high availability))
- Patch cycles (performance indicators, variant 2)
- Performance Indicator
- Personal Information Management (PIM) (performance indicators, quantity structure and performance (blackberry))
- Personal Information Management (PIM) (performance indicators, quantity structure and performance (iPhone))
- Personal Information Management (PIM) (performance indicators, quantity structure and performance (other))
- Personal Information Management (PIM) (performance indicators, quantity structure and performance (windows phone))

- Personnel (cost indicators, active components)
- Personnel (cost indicators, blackberry)
- Personnel (cost indicators, classical telephony)
- Personnel (cost indicators, conferencing (incl. video conferencing tools))
- Personnel (cost indicators, cost indicator (medium))
- Personnel (cost indicators, cost indicators (large))
- Personnel (cost indicators, cost indicators (small))
- Personnel (cost indicators, cost indicators)
- Personnel (cost indicators, desktop)
- Personnel (cost indicators, high)
- Personnel (cost indicators, iPhone)
- Personnel (cost indicators, laptop)
- Personnel (cost indicators, low)
- Personnel (cost indicators, lync and other applications (without telephony))
- Personnel (cost indicators, medium)
- Personnel (cost indicators, monitoring and administration environment)
- Personnel (cost indicators, others)
- Personnel (cost indicators, security environment)
- Personnel (cost indicators, sharePoint and other applications)
- Personnel (cost indicators, SSL VPN access)
- Personnel (cost indicators, standard mass connection)
- Personnel (cost indicators, total costs of guest systems)
- Personnel (cost indicators, total costs of host systems)
- Personnel (cost indicators, total costs)
- Personnel (cost indicators, total costs)
- Personnel (cost indicators, total costs)
- Personnel (cost indicators, total costs)
- Personnel (cost indicators, variant 1 (high availability))
- Personnel (cost indicators, variant 2)

- Personnel (cost indicators, voIP)
- Personnel (cost indicators, VPN client)
- Personnel (cost indicators, VPN tunel to business partners)
- Personnel (cost indicators, windows phone)
- Personnel (cost indicators, WLAN)
- Personnel employee service desk management (cost indicators, total costs)
- Personnel service desk agents (first level) (cost indicators, total costs)
- Platform (cost indicators, others)
- Platform (performance indicators, quantity structure and performance (other))
- Platform (performance indicators, security indicators (other))
- Platform remote wipe offered (performance indicators, security indicators (blackberry))
- Platform remote wipe offered (performance indicators, security indicators (iPhone))
- Platform remote wipe offered (performance indicators, security indicators (other))
- Platform remote wipe offered (performance indicators, security indicators (windows phone))
- Portion LX port (performance indicators, port information)
- Portion of access ports with NAC (performance indicators, port information)
- Portion of costs in service desk for other modules (cost indicators, total costs)
- Portion QoS for video (Portion of ports) (performance indicators, port information)
- Portion QoS for VoIP (Portion of ports) (performance indicators, port information)
- Primary storage volume to be backed up (performance indicators, quantity structure and performance)
- Primary used backup technology (cost recording) (performance indicators, quantity structure and performance)
- Private usage allowed (performance indicators, security indicators (blackberry))
- Private usage allowed (performance indicators, security indicators (iPhone))
- Private usage allowed (performance indicators, security indicators (other))
- Private usage allowed (performance indicators, security indicators (windows phone))
- Processing of Non-IT services (performance indicators, quantity structure and performance)

- Proportion of backup (Agents) (performance indicators, quantity structure and performance)
- Proportion of backup (Files) (performance indicators, quantity structure and performance)
- Proportion of backup (NDMP) (performance indicators, quantity structure and performance)
- Provider SLA WAN (performance indicators, quantity structure and performance)
- PUE (Power Usage Effectiveness) (data center levy, basic data)
- Quality indicator
- Quantity indicator
- Questionnaire of an individual benchmark
- Range of service 'telephony' in other countries (performance indicators, performance information)
- Recovery time (performance indicators, service level of IMAC processes)
- Recovery time in category low (performance indicators, quantity structure and performance)
- Redundancy of computer centers (IT and development, basic data)
- Redundant uplinks of access and distribution switches (performance indicators, performance and architecture)
- Remote access service
- Renewal of end devices (performance indicators, general indicators)
- Reporting (performance indicators, technology)
- Resource dimension for indicator classification
- Response time for calls (performance indicators, service level)
- Response time in hours IMAC (performance indicators, service level of IMAC processes)
- Response time web service (performance indicators, service level)
- Revenue (general organization data, basic data)
- RFC processing (performance indicators, additional information)
- S/MIME email encryption (performance indicators, security indicators (blackberry))
- S/MIME email encryption (performance indicators, security indicators (iPhone))
- S/MIME email encryption (performance indicators, security indicators (other))

- S/MIME email encryption (performance indicators, security indicators (windows phone))
- Sandbox (performance indicators, security indicators (blackberry))
- Sandbox (performance indicators, security indicators (iPhone))
- Sandbox (performance indicators, security indicators (other))
- Sandbox (performance indicators, security indicators (windows phone))
- SAP basis
- SAP modules
- SAPS value (performance indicators, quantity structure and performance)
- Security checks for foreign computers of external employees (performance indicators, additional information)
- Security settings based on a central policy (performance indicators, security indicators (blackberry))
- Security settings based on a central policy (performance indicators, security indicators (iPhone))
- Security settings based on a central policy (performance indicators, security indicators (other))
- Security settings based on a central policy (performance indicators, security indicators (windows phone))
- Self services (performance indicators, included)
- Service desk communication (performance indicators, quantity structure and performance)
- Service requests (performance indicators, included)
- Service segment questionnaire
- Service template dimension for indicator classification
- Servicedesk
- SLA (performance indicators, SSL VPN access)
- SLA (performance indicators, standard mass connection)
- SLA (performance indicators, VPN client)
- SLA (performance indicators, VPN tunel to business partners)
- SLA for backup available (performance indicators, quantity structure and performance)

- SLA for recovery available (performance indicators, quantity structure and performance)
- Social Enterprise Collaboration (performance indicators, tools)
- Social Media Collaboration (performance indicators, tools)
- Software (cost indicators, active components)
- Software (cost indicators, blackberry)
- Software (cost indicators, classical telephony)
- Software (cost indicators, conferencing (incl. video conferencing tools))
- Software (cost indicators, cost indicator (medium))
- Software (cost indicators, cost indicators (large))
- Software (cost indicators, cost indicators (small))
- Software (cost indicators, cost indicators)
- Software (cost indicators, desktop)
- Software (cost indicators, high)
- Software (cost indicators, iPhone)
- Software (cost indicators, laptop)
- Software (cost indicators, low)
- Software (cost indicators, lync and other applications (without telephony))
- Software (cost indicators, medium)
- Software (cost indicators, monitoring and administration environment)
- Software (cost indicators, others)
- Software (cost indicators, security environment)
- Software (cost indicators, sharePoint and other applications)
- Software (cost indicators, total costs of guest systems)
- Software (cost indicators, total costs of host systems)
- Software (cost indicators, total costs)
- Software (cost indicators, total costs)
- Software (cost indicators, total costs)
- Software (cost indicators, total costs)

- Software (cost indicators, variant 1 (high availability))
- Software (cost indicators, variant 2)
- Software (cost indicators, voIP)
- Software (cost indicators, windows phone)
- Software (cost indicators, WLAN)
- Software Asset Management (SAM) (IT and development, basic data)
- Software maintenance (cost indicators, active components)
- Software maintenance (cost indicators, blackberry)
- Software maintenance (cost indicators, classical telephony)
- Software maintenance (cost indicators, conferencing (incl. video conferencing tools))
- Software maintenance (cost indicators, cost indicator (medium))
- Software maintenance (cost indicators, cost indicators (large))
- Software maintenance (cost indicators, cost indicators (small))
- Software maintenance (cost indicators, cost indicators)
- Software maintenance (cost indicators, high)
- Software maintenance (cost indicators, iPhone)
- Software maintenance (cost indicators, low)
- Software maintenance (cost indicators, lync and other applications (without telephony))
- Software maintenance (cost indicators, medium)
- Software maintenance (cost indicators, monitoring and administration environment)
- Software maintenance (cost indicators, others)
- Software maintenance (cost indicators, security environment)
- Software maintenance (cost indicators, sharePoint and other applications)
- Software maintenance (cost indicators, total costs of guest systems)
- Software maintenance (cost indicators, total costs of host systems)
- Software maintenance (cost indicators, total costs)
- Software maintenance (cost indicators, total costs)
- Software maintenance (cost indicators, total costs)

- Software maintenance (cost indicators, total costs)
- Software maintenance (cost indicators, variant 1 (high availability))
- Software maintenance (cost indicators, variant 2)
- Software maintenance (cost indicators, voIP)
- Software maintenance (cost indicators, windows phone)
- Software maintenance (cost indicators, WLAN)
- Software resource indicator
- Solution rate first level (performance indicators, service level)
- Sourcing Platform - Maintenance (performance indicators, others (classical telephony))
- Sourcing Platform - Maintenance (performance indicators, sourcing (voIP))
- Sourcing Platform - Provision (performance indicators, others (classical telephony))
- Sourcing Platform - Provision (performance indicators, sourcing (voIP))
- Storage
- Storage (High)
- Storage (Low)
- Storage (Medium)
- Storage internal/external (performance indicators, quantity structure and performance)
- Storage period (default) (performance indicators, quantity structure and performance)
- Storage volume (performance indicators, variant 1 (high availability))
- Storage volume (performance indicators, variant 2)
- Structure of IT in the organization (performance indicators, basic data)
- Sum of backup bandwidth (performance indicators, quantity structure (other countries))
- Sum of backup bandwidth APA (performance indicators, quantity structure (APA))
- Sum of backup bandwidth Brazil (performance indicators, quantity structure (SA))
- Sum of backup bandwidth China (performance indicators, quantity structure (APA))
- Sum of backup bandwidth EMEA (performance indicators, quantity structure (EMEA))

- Sum of backup bandwidth Germany (performance indicators, quantity structure (EMEA))
- Sum of backup bandwidth India (performance indicators, quantity structure (APA))
- Sum of backup bandwidth Mexico (performance indicators, quantity structure (NA))
- Sum of backup bandwidth NA (performance indicators, quantity structure (NA))
- Sum of backup bandwidth other APA (performance indicators, quantity structure (APA))
- Sum of backup bandwidth other EMEA (performance indicators, quantity structure (EMEA))
- Sum of backup bandwidth other NA (performance indicators, quantity structure (NA))
- Sum of backup bandwidth other SA (performance indicators, quantity structure (SA))
- Sum of backup bandwidth Russia (performance indicators, quantity structure (EMEA))
- Sum of backup bandwidth SA (performance indicators, quantity structure (SA))
- Sum of backup bandwidth South Africa (performance indicators, quantity structure (EMEA))
- Sum of backup bandwidth Turkey (performance indicators, quantity structure (EMEA))
- Sum of backup bandwidth USA (performance indicators, quantity structure (NA))
- Sum primary bandwidth (performance indicators, quantity structure (other countries))
- Sum primary bandwidth APA (performance indicators, quantity structure (APA))
- Sum primary bandwidth Brazil (performance indicators, quantity structure (SA))
- Sum primary bandwidth China (performance indicators, quantity structure (APA))
- Sum primary bandwidth EMEA (performance indicators, quantity structure (EMEA))
- Sum primary bandwidth Germany (performance indicators, quantity structure (EMEA))
- Sum primary bandwidth India (performance indicators, quantity structure (APA))
- Sum primary bandwidth Mexico (performance indicators, quantity structure (NA))
- Sum primary bandwidth NA (performance indicators, quantity structure (NA))

- Sum primary bandwidth other APA (performance indicators, quantity structure (APA))
- Sum primary bandwidth other EMEA (performance indicators, quantity structure (EMEA))
- Sum primary bandwidth other NA (performance indicators, quantity structure (NA))
- Sum primary bandwidth other SA (performance indicators, quantity structure (SA))
- Sum primary bandwidth Russia (performance indicators, quantity structure (EMEA))
- Sum primary bandwidth SA (performance indicators, quantity structure (SA))
- Sum primary bandwidth South Africa (performance indicators, quantity structure (EMEA))
- Sum primary bandwidth Turkey (performance indicators, quantity structure (EM-EA))
- Sum primary bandwidth USA (performance indicators, quantity structure (NA))
- Support of users having broken devices (performance indicators, general indicators)
- Telephony
- Terminal server
- Throughput time first level (performance indicators, service level)
- Ticket system (performance indicators, technology)
- Time for service providers (performance indicators, service level of IMAC processes)
- Total area of computer centers (data center levy, basic data)
- Total capacity (gross) incl. reserves (performance indicators, quantity structure (high))
- Total capacity (gross) incl. reserves (performance indicators, quantity structure (low))
- Total capacity (gross) incl. reserves (performance indicators, quantity structure (medium))
- Total capacity (net) (performance indicators, quantity structure)
- Total capacity (net) incl. reserves (performance indicators, quantity structure (high))
- Total capacity (net) incl. reserves (performance indicators, quantity structure (low))
- Total capacity (net) incl. reserves (performance indicators, quantity structure (medium))
- Total costs per computer center (data center levy, basic data)
- Total disk storage (performance indicators, guest system)

- Total disk storage (performance indicators, host systems)
- Total main memory (RAM) (performance indicators, host systems)
- Total number of virtual cores (performance indicators, guest system)
- Total size of assigned RAM (performance indicators, guest system)
- Total storage size of mailboxes (performance indicators, quantity structure)
- Type dimension for indicator classification
- Type of service delivery (performance indicators, quantity structure and performance (blackberry))
- Type of service delivery (performance indicators, quantity structure and performance (iPhone))
- Type of service delivery (performance indicators, quantity structure and performance (other))
- Type of service delivery (performance indicators, quantity structure and performance (windows phone))
- Type of sourcing (performance indicators, additional information)
- Type of sourcing (performance indicators, additional information)
- Type of sourcing (performance indicators, cross-system)
- Type of sourcing (performance indicators, performance indicators)
- Type of sourcing (performance indicators, quantity structure (large))
- Type of sourcing (performance indicators, quantity structure (medium))
- Type of sourcing (performance indicators, quantity structure (small))
- Type of sourcing (performance indicators, quantity structure and performance)
- Type of sourcing (performance indicators, quantity structure and performance)
- Type of sourcing (performance indicators, quantity structure and performance)
- Type of sourcing (performance indicators, quantity structure and performance)
- Type of sourcing (performance indicators, quantity structure and performance)
- Type of sourcing (performance indicators, quantity structure and performance)
- Type of sourcing (performance indicators, quantity structure)
- Type of sourcing (performance indicators, quantity structure)
- Type of sourcing (performance indicators, variant 1 (high availability))
- Type of sourcing (performance indicators, variant 2)

- Types of tape drives (performance indicators, quantity structure and performance)
- Usage of BLOB files (performance indicators, variant 1 (high availability))
- Usage of BLOB files (performance indicators, variant 2)
- Usage of iPass (performance indicators, general indicators)
- Usage of snapshot technologies (performance indicators, quantity structure and performance)
- Usage of snapshots of primary storage for restore (performance indicators, quantity structure and performance)
- Usage of telephone expense (performance indicators, general indicators)
- Usage scenarios (performance indicators, conferencing (incl. video conferencing tools))
- Usage scenarios (performance indicators, lync and other applications (without telephony))
- Usage scenarios (performance indicators, sharePoint and other applications)
- Usage WAN (performance indicators, quantity structure and performance)
- Used capacity (performance indicators, quantity structure)
- User management (performance indicators, included)
- Video conferencing (performance indicators, tools)
- Virtual server
- Virtualization technology in use (performance indicators, guest system)
- Voice over W-LAN in use (performance indicators, performance information)
- Voice over WLAN (performance indicators, WLAN)
- Volume reserves (performance indicators, quantity structure (high))
- Volume reserves (performance indicators, quantity structure (low))
- Volume reserves (performance indicators, quantity structure (medium))
- WAN
- WAN backup (performance indicators, quantity structure and performance)
- WAN trends (performance indicators, quantity structure and performance)
- Way of internet access (performance indicators, security indicators (blackberry))
- Way of internet access (performance indicators, security indicators (iPhone))
- Way of internet access (performance indicators, security indicators (other))

- Way of internet access (performance indicators, security indicators (windows phone))
- Web meeting (performance indicators, tools)
- Working life of active LAN components (performance indicators, additional information)
- Workplace

24/7 service / regular office hours (performance indicators, quantity structure and performance)[c]

IRI: `https://w3id.org/bmontology#SAPBasis_PerformanceIndicators_QuantityStructureAndPerformance_247ServiceRegularOfficeHours`

This is a performance indicator of the SAP basis service, categorized into performance indicators as well as quantity structure and performance. This indicator captures the time per week while the support actively supports the SAP system or its users.

has super-classes Performance Indicator[c] SAP basis[c]

Access points (performance indicators, SSL VPN access)[c]

IRI: `https://w3id.org/bmontology#RemoteAccessService_PerformanceIndicators_SSLVPNAccess_AccessPoints`

This is a performance indicator of the remote access service service, categorized into performance indicators as well as SSL VPN access. This indicator captures the access points for RAS per connection.

has super-classes Performance Indicator[c] Remote access service[c]

Access points (performance indicators, standard mass connection)[c]

IRI: `https://w3id.org/bmontology#RemoteAccessService_PerformanceIndicators_StandardMassConnection_AccessPoints`

This is a performance indicator of the remote access service service, categorized into performance indicators as well as standard mass connection. This indicator captures the access points for RAS per connection.

has super-classes Performance Indicator^{c} Remote access service^{c}

Access points (performance indicators, VPN client)^{c}

IRI: `https://w3id.org/bmontology#RemoteAccessService_PerformanceIndicators_VPNClient_AccessPoints`

This is a performance indicator of the remote access service service, categorized into performance indicators as well as VPN client. This indicator captures the access points for RAS per connection.

has super-classes Performance Indicator^{c} Remote access service^{c}

Access points (performance indicators, VPN tunel to business partners)^{c}

IRI: `https://w3id.org/bmontology#RemoteAccessService_PerformanceIndicators_VPNTunelToBusinessPartners_AccessPoints`

This is a performance indicator of the remote access service service, categorized into performance indicators as well as VPN tunel to business partners. This indicator captures the access points for RAS per connection.

has super-classes Performance Indicator^{c} Remote access service^{c}

ACD system (performance indicators, technology)^{c}

IRI: `https://w3id.org/bmontology#Servicedesk_PerformanceIndicators_Technology_ACDSystem`

This is a performance indicator of the servicedesk service, categorized into performance indicators as well as technology. This indicator captures the used automatic call distribuion (ACD) system.

has super-classes Performance Indicator^{c} Servicedesk^{c} Software resource indicator^{c}

Active solutions in use (performance indicators, general indicators)^c

IRI: `https://w3id.org/bmontology#MobileDevices_PerformanceIndicators_GeneralIndicators_ActiveSolutionsInUse`

This is a performance indicator of the mobile devices service, categorized into performance indicators as well as general indicators. This indicator captures whether active solutions to access organization data are available.

has super-classes Mobile devices^c Performance Indicator^c

Add - Additional hardware components (cost indicators, costs add)^c

IRI: `https://w3id.org/bmontology#IMAC_CostIndicators_CostsAdd_AddAdditionalHardwareComponents`

This is a cost indicator of the IMAC service, categorized into cost indicators as well as costs add. This indicator captures the cots for adding an additional hardware component.

has super-classes Cost Indicator^c Human resource indicator^c IMAC^c

Add - Software (automatically) (cost indicators, costs add)^c

IRI: `https://w3id.org/bmontology#IMAC_CostIndicators_CostsAdd_AddSoftwareAutomatically`

This is a cost indicator of the IMAC service, categorized into cost indicators as well as costs add. This indicator captures the costs for automatically adding software.

has super-classes Cost Indicator^c Human resource indicator^c IMAC^c

Add - Software (manually) (cost indicators, costs add)^c

IRI: `https://w3id.org/bmontology#IMAC_CostIndicators_CostsAdd_AddSoftwareManually`

This is a cost indicator of the IMAC service, categorized into cost indicators as well as costs add. This indicator captures the costs for manually adding software.

has super-classes Cost Indicator^c Human resource indicator^c IMAC^c

Added value of VoIP (performance indicators, performance information)^c

IRI: `https://w3id.org/bmontology#Telephony_PerformanceIndicators_PerformanceInformation_AddedValueOfVoIP`

This is a performance indicator of the telephony service, categorized into performance indicators as well as performance information. This indicator captures the added value of VoIP compared to classical telephony.

has super-classes Performance Indicator^c Telephony^c

Additional backup technologies (performance indicators, quantity structure and performance)^c

IRI: `https://w3id.org/bmontology#Backup_PerformanceIndicators_QuantityStructureAndPerformance_AdditionalBackupTechnologies`

This is a performance indicator of the backup service, categorized into performance indicators as well as quantity structure and performance. This indicator captures additional backup technologies besides the primary used backup technology.

has super-classes Backup^c Performance Indicator^c

Additional information (performance indicators, variant 1 (high availability))^c

IRI: `https://w3id.org/bmontology#Database_PerformanceIndicators_Variant1HighAvailability_AdditionalInformation`

This is a performance indicator of the database service, categorized into performance indicators as well as variant 1 (high availability). This indicator captures whether additional information is available.

has super-classes Database (Variant 1)^c Performance Indicator^c

Additional information (performance indicators, variant 2)[c]

IRI: `https://w3id.org/bmontology#Database_PerformanceIndicators_Variant2_AdditionalInformation`

This is a performance indicator of the database service, categorized into performance indicators as well as variant 2. This indicator captures whether additional information is available.

has super-classes Datenbanken (Variante 2)[c] Performance Indicator[c]

Administration costs (cost indicators, BC: basic system)[c]

IRI: `https://w3id.org/bmontology#SAPModules_CostIndicators_BCBasicSystem_AdministrationCosts`

This is a cost indicator of the SAP modules service, categorized into cost indicators as well as BC: basic system. This indicator captures the yearly administration costs of this module and its submodules.

has super-classes Cost Indicator[c] Human resource indicator[c] SAP modules[c]

Administration costs (cost indicators, co: controlling)[c]

IRI: `https://w3id.org/bmontology#SAPModules_CostIndicators_CoControlling_AdministrationCosts`

This is a cost indicator of the SAP modules service, categorized into cost indicators as well as co: controlling. This indicator captures the yearly administration costs of this module and its submodules.

has super-classes Cost Indicator[c] Human resource indicator[c] SAP modules[c]

Administration costs (cost indicators, CS: customer service)[c]

IRI: `https://w3id.org/bmontology#SAPModules_CostIndicators_CSCustomerService_AdministrationCosts`

This is a cost indicator of the SAP modules service, categorized into cost indicators as well as CS: customer service. This indicator captures the yearly administration costs of this module and its submodules.

has super-classes Cost Indicator^c Human resource indicator^c SAP modules^c

Administration costs (cost indicators, EC: corporate controlling)^c

IRI: `https://w3id.org/bmontology#SAPModules_CostIndicators_ECCorporateControlling_AdministrationCosts`

This is a cost indicator of the SAP modules service, categorized into cost indicators as well as EC: corporate controlling. This indicator captures the yearly administration costs of this module and its submodules.

has super-classes Cost Indicator^c Human resource indicator^c SAP modules^c

Administration costs (cost indicators, FI: finance)^c

IRI: `https://w3id.org/bmontology#SAPModules_CostIndicators_FIFinance_AdministrationCosts`

This is a cost indicator of the SAP modules service, categorized into cost indicators as well as FI: finance. This indicator captures the yearly administration costs of this module and its submodules.

has super-classes Cost Indicator^c Human resource indicator^c SAP modules^c

Administration costs (cost indicators, MM: materials management)^c

IRI: `https://w3id.org/bmontology#SAPModules_CostIndicators_MMMaterialsManagement_AdministrationCosts`

This is a cost indicator of the SAP modules service, categorized into cost indicators as well as MM: materials management. This indicator captures the yearly administration costs of this module and its submodules.

has super-classes Cost Indicator^c Human resource indicator^c SAP modules^c

Administration costs (cost indicators, PM: plant maintenance)^c

IRI: https://w3id.org/bmontology#SAPModules_CostIndicators_PMPlantMaintenance_AdministrationCosts

This is a cost indicator of the SAP modules service, categorized into cost indicators as well as PM: plant maintenance. This indicator captures the yearly administration costs of this module and its submodules.

has super-classes Cost Indicator^c Human resource indicator^c SAP modules^c

Administration costs (cost indicators, PP: production planning and control)^c

IRI: https://w3id.org/bmontology#SAPModules_CostIndicators_PPProductionPlanningAndControl_AdministrationCosts

This is a cost indicator of the SAP modules service, categorized into cost indicators as well as PP: production planning and control. This indicator captures the yearly administration costs of this module and its submodules.

has super-classes Cost Indicator^c Human resource indicator^c SAP modules^c

Administration costs (cost indicators, SD: sales and distribution)^c

IRI: https://w3id.org/bmontology#SAPModules_CostIndicators_SDSalesAndDistribution_AdministrationCosts

This is a cost indicator of the SAP modules service, categorized into cost indicators as well as SD: sales and distribution. This indicator captures the yearly administration costs of this module and its submodules.

has super-classes Cost Indicator^c Human resource indicator^c SAP modules^c

Are SLAs offered (performance indicators, conferencing (incl. video conferencing tools))^c

IRI: https://w3id.org/bmontology#Collaboration_PerformanceIndicators_ConferencingInclVideoConferencingTools_AreSLAsOffered

This is a performance indicator of the collaboration service, categorized into performance indicators as well as conferencing (incl. video conferencing tools). This indicator captures whether service level agreements (SLAs) are offered to assure a certain service quality.

has super-classes Collaboration^c Quality indicator^c

Are SLAs offered (performance indicators, lync and other applications (without telephony))^c

IRI: `https://w3id.org/bmontology#Collaboration_PerformanceIndicators_LyncAndOtherApplicationsWithoutTelephony_AreSLAsOffered`

This is a performance indicator of the collaboration service, categorized into performance indicators as well as lync and other applications (without telephony). This indicator captures whether service level agreements (SLAs) are offered to assure a certain service quality.

has super-classes Collaboration^c Quality indicator^c

Are SLAs offered (performance indicators, sharePoint and other applications)^c

IRI: `https://w3id.org/bmontology#Collaboration_PerformanceIndicators_SharePointAndOtherApplications_AreSLAsOffered`

This is a performance indicator of the collaboration service, categorized into performance indicators as well as sharePoint and other applications. This indicator captures whether service level agreements (SLAs) are offered to assure a certain service quality.

has super-classes Collaboration^c Quality indicator^c

Autonomous installation of apps (performance indicators, security indicators (blackberry))^c

IRI: `https://w3id.org/bmontology#MobileDevices_PerformanceIndicators_SecurityIndicatorsBlackberry_AutonomousInstallationOfApps`

This is a performance indicator of the mobile devices service, categorized into performance indicators as well as security indicators (blackberry). This indicator captures whether users are allowed to install apps autonomously (for both private and commercial purposes).

has super-classes Mobile Devices (Blackberry)^c Performance Indicator^c

Autonomous installation of apps (performance indicators, security indicators (iPhone))^c

IRI: `https://w3id.org/bmontology#MobileDevices_PerformanceIndicators_SecurityIndicatorsIPhone_AutonomousInstallationOfApps`

This is a performance indicator of the mobile devices service, categorized into performance indicators as well as security indicators (iPhone). This indicator captures whether users are allowed to install apps autonomously (for both private and commercial purposes).

has super-classes Mobile Devices (iPhone)^c Performance Indicator^c

Autonomous installation of apps (performance indicators, security indicators (other))^c

IRI: `https://w3id.org/bmontology#MobileDevices_PerformanceIndicators_SecurityIndicatorsOther_AutonomousInstallationOfApps`

This is a performance indicator of the mobile devices service, categorized into performance indicators as well as security indicators (other). This indicator captures whether users are allowed to install apps autonomously (for both private and commercial purposes).

has super-classes Mobile Devices (Others)^c Performance Indicator^c

Autonomous installation of apps (performance indicators, security indicators (windows phone))^c

IRI: `https://w3id.org/bmontology#MobileDevices_PerformanceIndicators_SecurityIndicatorsWindowsPhone_AutonomousInstallationOfApps`

This is a performance indicator of the mobile devices service, categorized into performance indicators as well as security indicators (windows phone). This indicator captures whether users are allowed to install apps autonomously (for both private and commercial purposes).

has super-classes Mobile Devices (Windows Phone)^c Performance Indicator^c

Availability (performance indicators, service level)^c

IRI: `https://w3id.org/bmontology#Servicedesk_PerformanceIndicators_ServiceLevel_Availability`

This is a performance indicator of the servicedesk service, categorized into performance indicators as well as service level. This indicator captures the time slot which the service desk is available in.

has super-classes Quality indicator^c Servicedesk^c

Average frequency of change of a client (performance indicators, performance indicators)^c

IRI: `https://w3id.org/bmontology#IMAC_PerformanceIndicators_PerformanceIndicators_AverageFrequencyOfChangeOfAClient`

This is a performance indicator of the IMAC service, categorized into performance indicators as well as performance indicators. This indicator captures the average time passing between two changes of a device.

has super-classes IMAC^c Performance Indicator^c

Backend and client systems (performance indicators, SSL VPN access)^c

IRI: `https://w3id.org/bmontology#RemoteAccessService_PerformanceIndicators_SSLVPNAccess_BackendAndClientSystems`

This is a performance indicator of the remote access service service, categorized into performance indicators as well as SSL VPN access. This indicator captures the backend and client systems for RAS per connection.

has super-classes Performance Indicator^c Remote access service^c

Backend and client systems (performance indicators, standard mass connection)^c

IRI: `https://w3id.org/bmontology#RemoteAccessService_PerformanceIndicators_StandardMassConnection_BackendAndClientSystems`

This is a performance indicator of the remote access service service, categorized into performance indicators as well as standard mass connection. This indicator captures the backend and client systems for RAS per connection.

has super-classes Hardware resource indicator^c Performance Indicator^c Remote access service^c

Backend and client systems (performance indicators, VPN client)^c

IRI: `https://w3id.org/bmontology#RemoteAccessService_PerformanceIndicators_VPNClient_BackendAndClientSystems`

This is a performance indicator of the remote access service service, categorized into performance indicators as well as VPN client. This indicator captures the backend and client systems for RAS per connection.

has super-classes Hardware resource indicator^c Performance Indicator^c Remote access service^c

Backend and client systems (performance indicators, VPN tunel to business partners)^c

IRI: `https://w3id.org/bmontology#RemoteAccessService_PerformanceIndicators_VPNTunelToBusinessPartners_BackendAndClientSystems`

This is a performance indicator of the remote access service service, categorized into performance indicators as well as VPN tunel to business partners. This indicator captures the backend and client systems for RAS per connection.

has super-classes Hardware resource indicator^c Performance Indicator^c Remote access service^c

Backup^c

IRI: `https://w3id.org/bmontology#BackupIndicator`

Classifies backup indicators

has super-classes Service template dimension for indicator classification^c

has sub-classes Additional backup technologies (performance indicators, quantity structure and performance)^c , Backup software (performance indicators, quantity structure and performance)^c , Backup technology over WAN (performance indicators, quantity structure and performance)^c , Backup volume (performance indicators, quantity structure and performance)^c , Characteristics of persistence (performance indicators, quantity structure and performance)^c , Computer center levy (cost indicators, cost indicators)^c , Copy of backup inventory (performance indicators, quantity structure and performance)^c , Ensured storage volume in data backup system (performance indicators, quantity structure and performance)^c , External services (cost indicators, cost indicators)^c , Guaranteed performance (performance indicators, quantity structure and performance)^c , Hardware (cost indicators, cost indicators)^c , Hardware maintenance (cost indicators, cost indicators)^c , Max. data loss time (performance indicators, quantity structure and performance)^c , Number of backup instances (performance indicators, quantity structure and performance)^c , Number of backup servers (performance indicators, quantity structure and performance)^c , Number of external personnel (FTE) (performance indicators, quantity structure and performance)^c , Number of internal personnel (FTE) (performance indicators, quantity structure and performance)^c , Number of libraries (disk & tapes) (performance indicators, quantity structure and performance)^c , Number of snapshots in primary storage per day (performance indicators, quantity structure and performance)^c , Number of systems to be secured (performance indicators, quantity structure and performance)^c , Number of tape drives (performance indicators, quantity structure and performance)^c , Offsetting Server (cost indicators, cost indicators)^c , Offsetting Storage (cost indicators, cost indicators)^c , Others (cost indicators, cost indicators)^c , Personnel (cost indicators, cost indicators)^c , Primary storage volume to be backed up (performance indicators, quantity structure and performance)^c , Primary used backup technology (cost recording) (performance indicators, quantity structure and performance)^c , Proportion of backup (Agents) (performance indicators, quantity structure and performance)^c , Proportion of backup (Files) (performance indicators, quantity structure and performance)^c , Proportion of backup (NDMP) (performance indicators, quantity structure and performance)^c , SLA for backup available (performance indicators, quantity structure and performance)^c , SLA for recovery available (performance indicators, quantity structure and performance)^c , Software (cost indicators, cost indicators)^c , Software maintenance (cost indicators, cost indicators)^c , Storage period (default) (performance indicators, quantity structure and performance)^c , Type of sourcing (performance indicators, quantity structure and performance)^c , Types of tape drives (performance indicators, quantity structure and performance)^c , Usage of snapshots of primary storage for restore (performance indicators, quantity structure and performance)^c , WAN backup (performance indicators, quantity structure and performance)^c

is disjoint with Basic data^c , Collaboration^c , Database^c , Dedicated server^c , File Service^c , IMAC^c , LAN^c , Mailbox^c , Mobile devices^c , Remote access service^c , SAP basis^c , SAP modules^c , Servicedesk^c , Storage^c , Telephony^c , Terminal server^c , Virtual server^c , WAN^c , Workplace^c

Backup software (performance indicators, quantity structure and performance)^c

IRI: `https://w3id.org/bmontology#Backup_PerformanceIndicators_QuantityStructureAndPerformance_BackupSoftware`

This is a performance indicator of the backup service, categorized into performance indicators as well as quantity structure and performance. This indicator captures the used backup software.

has super-classes Backup^c Performance Indicator^c Software resource indicator^c

Backup strategy (performance indicators, cross-system)^c

IRI: `https://w3id.org/bmontology#VirtualServer_PerformanceIndicators_CrossSystem_BackupStrategy`

This is a performance indicator of the virtual server service, categorized into performance indicators as well as cross-system. This indciator captures whether a backup is performed on a regular basis.

has super-classes Performance Indicator^c Virtual server^c

Backup strategy (performance indicators, quantity structure (large))^c

IRI: `https://w3id.org/bmontology#DedicatedServer_PerformanceIndicators_QuantityStructureLarge_BackupStrategy`

This is a performance indicator of the dedicated server service, categorized into performance indicators as well as quantity structure (large). This indciator captures whether a backup is performed on a regular basis.

has super-classes Dedicated server (large)^c Performance Indicator^c

Backup strategy (performance indicators, quantity structure (medium))^c

IRI: `https://w3id.org/bmontology#DedicatedServer_PerformanceIndicators_QuantityStructureMedium_BackupStrategy`

This is a performance indicator of the dedicated server service, categorized into performance indicators as well as quantity structure (medium). This indciator captures whether a backup is performed on a regular basis.

has super-classes Dedicated server (medium)^c Performance Indicator^c

Backup strategy (performance indicators, quantity structure (small))^c

IRI: `https://w3id.org/bmontology#DedicatedServer_PerformanceIndicators_QuantityStructureSmall_BackupStrategy`

This is a performance indicator of the dedicated server service, categorized into performance indicators as well as quantity structure (small). This indciator captures whether a backup is performed on a regular basis.

has super-classes Dedicated server (small)^c Performance Indicator^c

Backup strategy (performance indicators, quantity structure and performance)^c

IRI: `https://w3id.org/bmontology#SAPBasis_PerformanceIndicators_QuantityStructureAndPerformance_BackupStrategy`

This is a performance indicator of the SAP basis service, categorized into performance indicators as well as quantity structure and performance. This indciator captures whether a backup is performed on a regular basis.

has super-classes Performance Indicator^c SAP basis^c

Backup strategy (performance indicators, quantity structure and performance)^c

IRI: `https://w3id.org/bmontology#TerminalServer_PerformanceIndicators_QuantityStructureAndPerformance_BackupStrategy`

This is a performance indicator of the terminal server service, categorized into performance indicators as well as quantity structure and performance. This indciator captures whether a backup is performed on a regular basis.

has super-classes Performance Indicator^c Terminal server^c

Backup strategy (performance indicators, quantity structure)^c

IRI: `https://w3id.org/bmontology#FileService_PerformanceIndicators_QuantityStructure_BackupStrategy`

This is a performance indicator of the file service service, categorized into performance indicators as well as quantity structure. This indciator captures whether a backup is performed on a regular basis.

has super-classes File Service^c Performance Indicator^c

Backup strategy (performance indicators, quantity structure)^c

IRI: `https://w3id.org/bmontology#Mailbox_PerformanceIndicators_QuantityStructure_BackupStrategy`

This is a performance indicator of the mailbox service, categorized into performance indicators as well as quantity structure. This indciator captures whether a backup is performed on a regular basis.

has super-classes Mailbox^c Performance Indicator^c

Backup strategy (performance indicators, variant 1 (high availability))^c

IRI: `https://w3id.org/bmontology#Database_PerformanceIndicators_Variant1HighAvailability_BackupStrategy`

This is a performance indicator of the database service, categorized into performance indicators as well as variant 1 (high availability). This indciator captures whether a backup is performed on a regular basis.

has super-classes Database (Variant 1)^c Performance Indicator^c

Backup strategy (performance indicators, variant 2)^c

IRI: `https://w3id.org/bmontology#Database_PerformanceIndicators_Variant2_BackupStrategy`

This is a performance indicator of the database service, categorized into performance indicators as well as variant 2. This indciator captures whether a backup is performed on a regular basis.

has super-classes Datenbanken (Variante 2)^c Performance Indicator^c

Backup technology over WAN (performance indicators, quantity structure and performance)^c

IRI: `https://w3id.org/bmontology#Backup_PerformanceIndicators_QuantityStructureAndPerformance_BackupTechnologyOverWAN`

This is a performance indicator of the backup service, categorized into performance indicators as well as quantity structure and performance. This indicator captures the technology used for backing up over WAN.

has super-classes Backup^c Performance Indicator^c

Backup volume (performance indicators, quantity structure and performance)^c

IRI: `https://w3id.org/bmontology#Backup_PerformanceIndicators_QuantityStructureAndPerformance_BackupVolume`

This is a performance indicator of the backup service, categorized into performance indicators as well as quantity structure and performance. This indicator captures the storage volume per week.

has super-classes Backup^c Quantity indicator^c

Bandwidth management (performance indicators, quantity structure and performance)^c

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureAndPerformance_BandwidthManagement`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure and performance. This indicator captures whether an internal bandwidth management for WAN is available.

has super-classes Performance Indicator^c WAN^c

Basic data^c

IRI: `https://w3id.org/bmontology#BasicDataIndicator`

Classifies basic data indicators

has super-classes Service template dimension for indicator classification^c

has sub-classes Costs of development and training of employees (IT costs, basic data)^c , Depreciation period (performance indicators, basic data)^c , Development and project engineering of the IT (IT and development, basic data)^c , Electricity costs of computer centers (data center levy, basic data)^c , Existence of a process for for emergency management (IT and development, basic data)^c , Existence of knowledge management in IT (IT and development, basic data)^c , Hight unit computer center (data center levy, basic data)^c , IT costs Change (projects) (IT costs, basic data)^c , IT costs Run (line activities) (IT costs, basic data)^c , IT costs applications (IT costs, basic data)^c , IT costs management (IT costs, basic data)^c , IT costs of external performance (IT costs, basic data)^c , IT costs of infrastructure (IT costs, basic data)^c , IT costs of internal performance (IT costs, basic data)^c , IT investment (IT costs, basic data)^c , IT involved in purchasing process (IT and development, basic data)^c , IT personnel costs (IT costs, basic data)^c , IT total costs (IT costs, basic data)^c , IT trends (IT and development, basic data)^c , Indicate your most important projects (IT and development, basic data)^c , Indicator scope (general organization data, basic data)^c , Investment volume (general organization data, basic data)^c , Legal form of the organization (performance indicators, basic data)^c , Number of IT developers (FTE) (performance indicators, basic data)^c , Number of IT users (performance indicators, basic data)^c , Number of computer centers (computer center levy, basic data)^c , Number of countries managed by the IT (performance indicators, basic data)^c , Number of employees (general organization data, basic data)^c , Number of external IT employees (FTE) (performance indicators, basic data)^c , Number of internal IT employees (FTE) (performance indicators, basic data)^c , Number of working students / intern (performance indicators, basic data)^c , Organizational form of IT (performance indicators, basic data)^c , PUE (Power Usage Effectiveness) (data center levy, basic data)^c , Redundancy of computer centers (IT and development, basic data)^c , Revenue (general organization data, basic data)^c , Software Asset Management (SAM) (IT and development, basic data)^c , Structure of IT in the organization (performance indicators, basic data)^c , Total area of computer centers (data center levy, basic data)^c , Total costs per computer center (data center levy, basic data)^c

is disjoint with Backup^c , Collaboration^c , Database^c , Dedicated server^c , File Service^c , IMAC^c , LAN^c , Mailbox^c , Mobile devices^c , Remote access service^c , SAP basis^c , SAP modules^c , Servicedesk^c , Storage^c , Telephony^c , Terminal server^c , Virtual server^c , WAN^c , Workplace^c

Batch processing (performance indicators, additional information)^c

IRI: `https://w3id.org/bmontology#SAPBasis_PerformanceIndicators_AdditionalInformation_BatchProcessing`

This is a performance indicator of the SAP basis service, categorized into performance indicators as well as additional information. This indicator captures the daily steps of the batch processing.

has super-classes Performance Indicator^c SAP basis^c Software resource indicator^c

Benchmark^c

IRI: `https://w3id.org/bmontology#Benchmark`

Represents an individual benchmark

has super-classes eventhas reporting^{op} onlyQuestionnaire of an individual benchmark^c has reporting^{op} exactly 1 Questionnaire of an individual benchmark^c has Label^{dp} somestringhas type^{dp} min 1has type^{dp} max 2

is in domain of has reporting^{op} , has type^{dp} , is benchmark of^{op}

is in range of has benchmark^{op} , is reporting for^{op}

Bring your own device (performance indicators, general indicators)^c

IRI: `https://w3id.org/bmontology#MobileDevices_PerformanceIndicators_GeneralIndicators_BringYourOwnDevice`

This is a performance indicator of the mobile devices service, categorized into performance indicators as well as general indicators. This indicator captures whether support for Bring-Your-Own-Device is available.

has super-classes Mobile devices^c Performance Indicator^c

Cabling Gbit over copper (performance indicators, additional information)^c

IRI: `https://w3id.org/bmontology#LAN_PerformanceIndicators_AdditionalInformation_CablingGbitOverCopper`

This is a performance indicator of the LAN service, categorized into performance indicators as well as additional information. This indicator captures whether cabling for Gbit using copper is available.

has super-classes Hardware resource indicator^c LAN^c Performance Indicator^c

Category performance (performance indicators, quantity structure and performance)^c

IRI: `https://w3id.org/bmontology#Storage_PerformanceIndicators_QuantityStructureAndPerformance_CategoryPerformance`

This is a performance indicator of the storage service, categorized into performance indicators as well as quantity structure and performance. This indicator captures the performance of the available storage system.

has super-classes Performance Indicator^c Storage^c

Change/Delete - Total (cost indicators, costs change)^c

IRI: `https://w3id.org/bmontology#IMAC_CostIndicators_CostsChange_ChangeDeleteTotal`

This is a cost indicator of the IMAC service, categorized into cost indicators as well as costs change. This indicator captures the total costs of Change/Delete.

has super-classes Cost Indicator^c Human resource indicator^c IMAC^c

Characteristics of LAN (performance indicators, additional information)^c

IRI: `https://w3id.org/bmontology#LAN_PerformanceIndicators_AdditionalInformation_CharacteristicsOfLAN`

This is a performance indicator of the LAN service, categorized into performance indicators as well as additional information. This indicator captures the characteristics of the LAN area.

has super-classes Hardware resource indicator^c LAN^c Performance Indicator^c

Characteristics of persistence (performance indicators, quantity structure and performance)^c

IRI: `https://w3id.org/bmontology#Backup_PerformanceIndicators_QuantityStructureAndPerformance_CharacteristicsOfPersistence`

This is a performance indicator of the backup service, categorized into performance indicators as well as quantity structure and performance. This indicator captures whether data is checked for redundancy before being persisted.

has super-classes Backup^c Performance Indicator^c

Client software (cost indicators, SSL VPN access)^c

IRI: `https://w3id.org/bmontology#RemoteAccessService_CostIndicators_SSLVPNAccess_ClientSoftware`

This is a cost indicator of the remote access service service, categorized into cost indicators as well as SSL VPN access. This indicator captures the costs for the decentralized hardware, incl. Hardware service and software for RAS per connection.

has super-classes Cost Indicator^c Remote access service^c Software resource indicator^c

Client software (cost indicators, standard mass connection)^c

IRI: `https://w3id.org/bmontology#RemoteAccessService_CostIndicators_StandardMassConnection_ClientSoftware`

This is a cost indicator of the remote access service service, categorized into cost indicators as well as standard mass connection. This indicator captures the client software costs including maintenance for RAS per connection.

has super-classes Cost Indicator^c Remote access service^c Software resource indicator^c

Client software (cost indicators, VPN client)^c

IRI: `https://w3id.org/bmontology#RemoteAccessService_CostIndicators_VPNClient_ClientSoftware`

This is a cost indicator of the remote access service service, categorized into cost indicators as well as VPN client. This indicator captures the client software costs including maintenance for RAS per connection.

has super-classes Cost Indicator^c Remote access service^c Software resource indicator^c

Client software (cost indicators, VPN tunel to business partners)^c

IRI: `https://w3id.org/bmontology#RemoteAccessService_CostIndicators_VPNTunelToBusinessPartners_ClientSoftware`

This is a cost indicator of the remote access service service, categorized into cost indicators as well as VPN tunel to business partners. This indicator captures the client software costs including maintenance for RAS per connection.

has super-classes Cost Indicator^c Remote access service^c Software resource indicator^c

Collaboration^c

IRI: `https://w3id.org/bmontology#CollaborationIndicator`

Classifies collaboration indicators

has super-classes Service template dimension for indicator classification^c

has sub-classes Are SLAs offered (performance indicators, conferencing (incl. video conferencing tools))^c , Are SLAs offered (performance indicators, lync and other applications (without telephony))^c , Are SLAs offered (performance indicators, sharePoint and other applications)^c , Document collaboration (performance indicators, tools)^c , External services (cost indicators, conferencing (incl. video conferencing tools))^c , External services (cost indicators, lync and other applications (without telephony))^c , External services (cost indicators, sharePoint and other applications)^c , Hardware (cost indicators, conferencing (incl. video conferencing tools))^c , Hardware (cost indicators, lync and other applications (without telephony))^c , Hardware (cost indicators, sharePoint and other applications)^c , Hardware maintenance (cost indicators, conferencing (incl. video conferencing tools))^c , Hardware maintenance (cost indicators, lync and other applications (without telephony))^c , Hardware maintenance (cost indicators, sharePoint and other applications)^c , How is the infrastructure integration regulated (performance indicators, conferencing (incl. video conferencing tools))^c , How is the infrastructure integration regulated (performance indicators, lync and other applications (without telephony))^c , How is the infrastructure integration regulated (performance indicators, sharePoint and other applications)^c , Instant messaging (performance indicators, tools)^c , Number of external personnel (FTE) (performance indicators, conferencing (incl. video conferencing tools))^c , Number of external personnel (FTE) (performance indicators, lync and other applications (without telephony))^c , Number of external personnel (FTE) (performance indicators, sharePoint and other applications)^c , Number of internal personnel (FTE) (performance indicators, conferencing (incl. video conferencing tools))^c , Number of internal personnel (FTE) (performance indicators, lync and other applications (without telephony))^c , Number of internal personnel (FTE) (performance indicators, sharePoint and other applications)^c , Number of users (performance indicators, conferencing (incl. video conferencing tools))^c , Number of users (performance indicators, lync and other applications (without telephony))^c , Number of users (performance indicators, sharePoint and other applications)^c , Offetting backup (cost indicators, conferencing (incl. video conferencing tools))^c , Offetting backup (cost indicators, lync and other applications (without telephony))^c , Offetting backup (cost indicators, sharePoint and other applications)^c , Offsetting Server (cost indicators, conferencing (incl. video conferencing tools))^c , Offsetting Server (cost indicators, lync and other applications (without telephony))^c , Offsetting Server (cost indicators, sharePoint and other applications)^c , Offsetting Storage (cost indicators, conferencing (incl. video conferencing tools))^c , Offsetting Storage (cost indicators, lync and other applications (without telephony))^c , Offsetting Storage (cost indicators, sharePoint and other applications)^c , Others (cost indicators, conferencing (incl. video conferencing tools))^c , Others (cost indicators, lync and other applications (without telephony))^c , Others (cost indicators, sharePoint and other applications)^c , Personnel (cost indicators, conferencing (incl. video conferencing tools))^c , Personnel (cost indicators, lync and other applications (without telephony))^c , Personnel (cost indicators, sharePoint and other applications)^c , Social Enterprise Collaboration (performance indicators, tools)^c , Social Media Collaboration (performance indicators, tools)^c , Software (cost indicators, conferencing (incl. video conferencing tools))^c , Software (cost indicators, lync and other applications (without telephony))^c , Software (cost indicators, sharePoint and other applications)^c , Software maintenance (cost indicators, conferencing (incl. video conferencing tools))^c , Software maintenance (cost indicators, lync and other applications (without telephony))^c , Software maintenance (cost indicators, sharePoint and other applications)^c , Usage scenarios (performance indicators, conferencing (incl. video conferencing tools))^c , Usage scenarios (performance indicators, lync and other applications (without telephony))^c , Usage scenarios (performance indicators, sharePoint and other applications)^c , Video conferencing (performance indicators, tools)^c , Web meeting (performance indicators, tools)^c

is disjoint with Backup^c , Basic data^c , Database^c , Dedicated server^c , File Service^c , IMAC^c , LAN^c , Mailbox^c , Mobile devices^c , Remote access service^c , SAP basis^c , SAP modules^c , Servicedesk^c , Storage^c , Telephony^c , Terminal server^c , Virtual server^c , WAN^c , Workplace^c

Computer center levy (cost indicators, cost indicator (medium))^c

IRI: `https://w3id.org/bmontology#DedicatedServer_CostIndicators_CostIndicatorMedium_ComputerCenterLevy`

This is a cost indicator of the dedicated server service, categorized into cost indicators as well as cost indicator (medium). This indicator captures the infrastructure cost and the computer center levy for the dedicated server module.

has super-classes Cost Indicator^c Dedicated server (medium)^c Hardware resource indicator^c

Computer center levy (cost indicators, cost indicators (large))^c

IRI: `https://w3id.org/bmontology#DedicatedServer_CostIndicators_CostIndicatorsLarge_ComputerCenterLevy`

This is a cost indicator of the dedicated server service, categorized into cost indicators as well as cost indicators (large). This indicator captures the infrastructure cost and the computer center levy for the dedicated server module.

has super-classes Cost Indicator^c Dedicated server (large)^c Hardware resource indicator^c

Computer center levy (cost indicators, cost indicators (small))^c

IRI: `https://w3id.org/bmontology#DedicatedServer_CostIndicators_CostIndicatorsSmall_ComputerCenterLevy`

This is a cost indicator of the dedicated server service, categorized into cost indicators as well as cost indicators (small). This indicator captures the infrastructure cost and the computer center levy for the dedicated server module.

has super-classes Cost Indicator^c Dedicated server (small)^c Hardware resource indicator^c

Computer center levy (cost indicators, cost indicators)^c

IRI: `https://w3id.org/bmontology#Backup_CostIndicators_CostIndicators_ComputerCenterLevy`

This is a cost indicator of the backup service, categorized into cost indicators as well as cost indicators. This indicator captures the infrastructure costs and the computer center levy for the backup module.

has super-classes Backup^c Cost Indicator^c Hardware resource indicator^c

Computer center levy (cost indicators, high)^c

IRI: `https://w3id.org/bmontology#Storage_CostIndicators_High_ComputerCenterLevy`

This is a cost indicator of the storage service, categorized into cost indicators as well as high. This indicator captures the infrastructure costs and the computer center levy for the storage module.

has super-classes Cost Indicator^c Hardware resource indicator^c Storage (High)^c

Computer center levy (cost indicators, low)^c

IRI: `https://w3id.org/bmontology#Storage_CostIndicators_Low_ComputerCenterLevy`

This is a cost indicator of the storage service, categorized into cost indicators as well as low. This indicator captures the infrastructure costs and the computer center levy for the storage module.

has super-classes Cost Indicator^c Hardware resource indicator^c Storage (Low)^c

Computer center levy (cost indicators, medium)^c

IRI: `https://w3id.org/bmontology#Storage_CostIndicators_Medium_ComputerCenterLevy`

This is a cost indicator of the storage service, categorized into cost indicators as well as medium. This indicator captures the infrastructure costs and the computer center levy for the storage module.

has super-classes Cost Indicator^c Hardware resource indicator^c Storage (Medium)^c

Computer center levy (cost indicators, total costs of host systems)^c

IRI: `https://w3id.org/bmontology#VirtualServer_CostIndicators_TotalCostsOfHostSystems_ComputerCenterLevy`

This is a cost indicator of the virtual server service, categorized into cost indicators as well as total costs of host systems. This indicator captures the infrastructure costs and the computer center levy for host systems.

has super-classes Cost Indicator^c Hardware resource indicator^c Virtual server^c

Contract term WAN (performance indicators, quantity structure and performance)^c

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureAndPerformance_ContractTermWAN`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure and performance. This indicator captures the contract term (for averaging the initial setup costs) for WAN in months.

has super-classes Performance Indicator^c WAN^c

Contractual regulation regarding the usage of data volume (performance indicators, general indicators)^c

IRI: `https://w3id.org/bmontology#MobileDevices_PerformanceIndicators_GeneralIndicators_ContractualRegulationRegardingTheUsageOfDataVolume`

This is a performance indicator of the mobile devices service, categorized into performance indicators as well as general indicators. This indicator captures the type of contractual regulation regarding the usage of data volume.

has super-classes Mobile devices^c Performance Indicator^c

Copy of backup inventory (performance indicators, quantity structure and performance)^c

IRI: `https://w3id.org/bmontology#Backup_PerformanceIndicators_QuantityStructureAndPerformance_CopyOfBackupInventory`

This is a performance indicator of the backup service, categorized into performance indicators as well as quantity structure and performance. This indicator captures whether backup copies exist.

has super-classes Backup^c Performance Indicator^c

Cost Indicator^c

IRI: `https://w3id.org/bmontology#CostIndicator`

Classifies cost indicators

has super-classes Type dimension for indicator classification^c

has sub-classes Add - Additional hardware components (cost indicators, costs add)^c , Add - Software (automatically) (cost indicators, costs add)^c , Add - Software (manually) (cost indicators, costs add)^c , Administration costs (cost indicators, BC: basic system)^c , Administration costs (cost indicators, CS: customer service)^c , Administration costs (cost indicators, EC: corporate controlling)^c , Administration costs (cost indicators, FI: finance)^c , Administration costs (cost indicators, MM: materials management)^c , Administration costs (cost indicators, PM: plant maintenance)^c , Administration costs (cost indicators, PP: production planning and control)^c , Administration costs (cost indicators, SD: sales and distribution)^c , Administration costs (cost indicators, co: controlling)^c , Change/Delete - Total (cost indicators, costs change)^c , Client software (cost indicators, SSL VPN access)^c , Client software (cost indicators, VPN client)^c , Client software (cost indicators, VPN tunel to business partners)^c , Client software (cost indicators, standard mass connection)^c , Computer center levy (cost indicators, cost indicator (medium))^c , Computer center levy (cost indicators, cost indicators (large))^c , Computer center levy (cost indicators, cost indicators (small))^c , Computer center levy (cost indicators, cost indicators)^c , Computer center levy (cost indicators, high)^c , Computer center levy (cost indicators, low)^c , Computer center levy (cost indicators, medium)^c , Computer center levy (cost indicators, total costs of host systems)^c , Costs APA (cost indicators, WAN APA)^c , Costs Brazil (cost indicators, WAN SA)^c , Costs China (cost indicators, WAN APA)^c , Costs EMEA (cost indicators, WAN EMEA)^c , Costs Germany (cost indicators, WAN EMEA)^c , Costs India (cost indicators, WAN APA)^c , Costs Mexico (cost indicators, WAN NA)^c , Costs NA (cost indicators, WAN NA)^c , Costs Russia (cost indicators, WAN EMEA)^c , Costs SA (cost indicators, WAN SA)^c , Costs South Africa (cost indicators, WAN EMEA)^c , Costs Turkey (cost indicators, WAN EMEA)^c , Costs USA (cost indicators, WAN NA)^c , Costs of development and training of employees (IT costs, basic data)^c , Costs other APA (cost indicators, WAN APA)^c , Costs other EMEA (cost indicators, WAN EMEA)^c , Costs other NA (cost indicators, WAN NA)^c , Costs other SA (cost indicators, WAN SA)^c , Costs other countries (cost indicators, WAN other countries)^c , Electricity costs of computer centers (data center levy, basic data)^c , External services (cost indicators, SSL VPN access)^c , External services (cost indicators, VPN client)^c , External services (cost indicators, VPN tunel to business partners)^c , External services (cost indicators, WLAN)^c , External services (cost indicators, active components)^c , External services (cost indicators, blackberry)^c , External services (cost indicators, classical telephony)^c , External services (cost indicators, conferencing (incl. video conferencing tools))^c , External services (cost indicators, cost indicator (medium))^c , External services (cost indicators, cost indicators (large))^c , External services (cost indicators, cost indicators (small))^c , External services (cost indicators, cost indicators)^c , External services (cost indicators, desktop)^c , External services (cost indicators, high)^c , External services (cost indicators, iPhone)^c , External services (cost indicators, laptop)^c , External services (cost indicators, low)^c , External services (cost indicators, lync and other applications (without telephony))^c , External services (cost indicators, medium)^c , External services (cost indicators, monitoring and administration environment)^c , External services (cost indicators, others)^c , External services (cost indicators, security environment)^c , External services (cost indicators, sharePoint and other applications)^c , External services (cost indicators, standard mass connection)^c , External services (cost indicators, total costs of guest systems)^c , External services (cost indicators, total costs of host systems)^c , External services (cost indicators, total costs)^c , External services (cost indicators, total costs)^c , External services (cost indicators, total costs)^c , External services (cost indicators, total costs)^c , External services (cost indicators, total costs)^c , External services (cost indicators, variant 1 (high availability))^c , External services (cost indicators, variant 2)^c , External services (cost indicators, voIP)^c , External services (cost indicators, windows phone)^c , Hardware (cost indicators, WLAN)^c , Hardware (cost indicators, active components)^c , Hardware (cost indicators, blackberry)^c , Hardware (cost indicators, classical telephony)^c , Hardware (cost indicators, conferencing (incl. video conferencing tools))^c , Hardware (cost indicators, cost indicator (medium))^c , Hardware (cost indicators, cost indicators (large))^c , Hardware (cost indicators, cost indicators (small))^c , Hardware (cost indicators, cost indicators)^c , Hardware (cost indicators, desktop)^c , Hardware (cost indicators, high)^c , Hardware (cost indicators, iPhone)^c , Hardware (cost indicators, laptop)^c , Hardware (cost indicators, low)^c , Hardware (cost indicators, lync and other applications (without telephony))^c , Hardware (cost indicators, medium)^c , Hardware (cost indicators, monitoring and administration environment)^c , Hardware (cost indicators, others)^c , Hardware (cost indicators, security environment)^c , Hardware (cost indicators, sharePoint and other applications)^c , Hardware (cost indicators, total costs of host systems)^c , Hardware (cost indicators, total costs)^c , Hardware (cost indicators, total costs)^c , Hardware (cost indicators, total costs)^c , Hardware (cost indicators, total costs)^c , Hardware (cost indicators, variant 1 (high availability))^c , Hardware (cost indicators, variant 2)^c , Hardware (cost indicators, voIP)^c , Hardware (cost indicators, windows phone)^c , Hardware maintenance (cost indicators, WLAN)^c , Hardware maintenance (cost indicators, active components)^c , Hardware maintenance (cost indicators, blackberry)^c , Hardware maintenance (cost indicators, classical telephony)^c , Hardware maintenance (cost indicators, conferencing (incl. video conferencing tools))^c , Hardware maintenance (cost indicators, cost indicator (medium))^c , Hardware maintenance (cost indicators, cost indicators (large))^c , Hardware maintenance (cost indicators, cost indicators (small))^c , Hardware maintenance (cost indicators, cost indicators)^c , Hardware maintenance (cost indicators, high)^c , Hardware maintenance (cost indicators, iPhone)^c , Hardware maintenance (cost indicators, low)^c , Hardware maintenance (cost indicators, lync and other applications (without telephony))^c , Hardware maintenance (cost indicators, medium)^c , Hardware maintenance (cost indicators, monitoring and administration environment)^c , Hardware maintenance (cost indicators, others)^c , Hardware maintenance (cost indicators, security environment)^c , Hardware maintenance (cost indicators, sharePoint and other applications)^c , Hardware maintenance (cost indicators, total costs of host systems)^c , Hardware maintenance (cost indicators, total costs)^c , Hardware maintenance (cost indicators, total costs)^c , Hardware maintenance (cost indicators, total costs)^c , Hardware maintenance (cost indicators, total costs)^c , Hardware maintenance (cost indicators, variant 1 (high availability))^c , Hardware maintenance (cost indicators, variant 2)^c , Hardware maintenance (cost indicators, voIP)^c , Hardware maintenance (cost indicators, windows phone)^c , IT costs Change (projects) (IT costs, basic data)^c , IT costs Run (line activities) (IT costs, basic data)^c , IT costs applications (IT costs, basic data)^c , IT costs management (IT costs, basic data)^c , IT costs of external performance (IT costs, basic data)^c , IT costs of infrastructure (IT costs, basic data)^c , IT costs of internal performance (IT costs, basic data)^c , IT investment (IT costs, basic data)^c , IT personnel costs (IT costs, basic data)^c , IT total costs (IT costs, basic data)^c , Infrastructure - backend (cost indicators, SSL VPN access)^c , Infrastructure - backend (cost indicators, VPN client)^c , Infrastructure - backend (cost indicators, VPN tunel to business partners)^c , Infrastructure - backend (cost indicators, standard mass connection)^c , Infrastructure - decentral (cost indicators, SSL VPN access)^c , Infrastructure - decentral (cost indicators, VPN client)^c , Infrastructure - decentral (cost indicators, VPN tunel to business partners)^c , Infrastructure - decentral (cost indicators, standard mass connection)^c , Install - Desktop (cost indicators, costs install)^c , Install - Laptop (cost indicators, costs install)^c , Install - Thin client (cost indicators, costs install)^c , License costs (cost indicators, total costs)^c , Maintenance (cost indicators, desktop)^c , Maintenance (cost indicators, laptop)^c , Maintenance costs (cost indicators, BC: basic system)^c , Maintenance costs (cost indicators, CS: customer service)^c , Maintenance costs (cost indicators, EC: corporate controlling)^c , Maintenance costs (cost indicators, FI: finance)^c , Maintenance costs (cost indicators, MM: materials management)^c , Maintenance costs (cost indicators, PM: plant maintenance)^c , Maintenance costs (cost indicators, PP: production planning and control)^c , Maintenance costs (cost indicators, SD: sales and distribution)^c , Maintenance costs (cost indicators, co: controlling)^c , Maintenance costs service desk tool (cost indicators, total costs)^c , Move - Logical (cost indicators, costs move)^c , Move - Physical (cost indicators, costs move)^c , Offetting backup (cost indicators, classical telephony)^c , Offetting backup (cost indicators, conferencing (incl. video conferencing tools))^c , Offetting backup (cost indicators, lync and other applications (without telephony))^c , Offetting backup (cost indicators, sharePoint and other applications)^c , Offetting backup (cost indicators, total costs)^c , Offetting backup (cost indicators, total costs)^c , Offetting backup (cost indicators, total costs)^c , Offetting backup (cost indicators, variant 1 (high availability))^c , Offetting backup (cost indicators, variant 2)^c , Offetting backup (cost indicators, voIP)^c , Offsetting Install (cost indicators, desktop)^c , Offsetting Install (cost indicators, laptop)^c , Offsetting Server (cost indicators, blackberry)^c , Offsetting Server (cost indicators, classical telephony)^c , Offsetting Server (cost indicators, conferencing (incl. video conferencing tools))^c , Offsetting Server (cost indicators, cost indicators)^c , Offsetting Server (cost indicators, high)^c , Offsetting Server (cost indicators, iPhone)^c , Offsetting Server (cost indicators, low)^c , Offsetting Server (cost indicators, lync and other applications (without telephony))^c , Offsetting Server (cost indicators, medium)^c , Offsetting Server (cost indicators, others)^c , Offsetting Server (cost indicators, sharePoint and other applications)^c , Offsetting Server (cost indicators, total costs)^c , Offsetting Server (cost indicators, total costs)^c , Offsetting Server (cost indicators, total costs)^c , Offsetting Server (cost indicators, total costs)^c , Offsetting Server (cost indicators, variant 1 (high availability))^c , Offsetting Server (cost indicators, variant 2)^c , Offsetting Server (cost indicators, voIP)^c , Offsetting Server (cost indicators, windows phone)^c , Offsetting Storage (cost indicators, classical telephony)^c , Offsetting Storage (cost indicators, conferencing (incl. video conferencing tools))^c , Offsetting Storage (cost indicators, cost indicators)^c , Offsetting Storage (cost indicators, lync and other applications (without telephony))^c , Offsetting Storage (cost indicators, sharePoint and other applications)^c , Offsetting Storage (cost indicators, total costs)^c , Offsetting Storage (cost indicators, total costs)^c , Offsetting Storage (cost indicators, total costs)^c , Offsetting Storage (cost indicators, total costs)^c , Offsetting Storage (cost indicators, variant 1 (high availability))^c , Offsetting Storage (cost indicators, variant 2)^c , Offsetting Storage (cost indicators, voIP)^c , Others (cost indicators, SSL VPN access)^c , Others (cost indicators, VPN client)^c , Others (cost indicators, VPN tunel to business partners)^c , Others (cost indicators, WLAN)^c , Others (cost indicators, active components)^c , Others (cost indicators, blackberry)^c , Others (cost indicators, classical telephony)^c , Others (cost indicators, conferencing (incl. video conferencing tools))^c , Others (cost indicators, cost indicator (medium))^c , Others (cost indicators, cost indicators (large))^c , Others (cost indicators, cost indicators (small))^c , Others (cost indicators, cost indicators)^c , Others (cost indicators, desktop)^c , Others (cost indicators, high)^c , Others (cost indicators, iPhone)^c , Others (cost indicators, laptop)^c , Others (cost indicators, low)^c , Others (cost indicators, lync and other applications (without telephony))^c , Others (cost indicators, medium)^c , Others (cost indicators, monitoring and administration environment)^c , Others (cost indicators, others)^c , Others (cost indicators, security environment)^c , Others (cost indicators, sharePoint and other applications)^c , Others (cost indicators, standard mass connection)^c , Others (cost indicators, total costs of guest systems)^c , Others (cost indicators, total costs of host systems)^c , Others (cost indicators, total costs)^c , Others (cost indicators, total costs)^c , Others (cost indicators, total costs)^c , Others (cost indicators, total costs)^c , Others (cost indicators, total costs)^c , Others (cost indicators, variant 1 (high availability))^c , Others (cost indicators, variant 2)^c , Others (cost indicators, voIP)^c , Others (cost indicators, windows phone)^c , Personnel (cost indicators, SSL VPN access)^c , Personnel (cost indicators, VPN client)^c , Personnel (cost indicators, VPN tunel to business partners)^c , Personnel (cost indicators, WLAN)^c , Personnel (cost indicators, active components)^c , Personnel (cost indicators, blackberry)^c , Personnel (cost indicators, classical telephony)^c , Personnel (cost indicators, conferencing (incl. video conferencing tools))^c , Personnel (cost indicators, cost indicator (medium))^c , Personnel (cost indicators, cost indicators (large))^c , Personnel (cost indicators, cost indicators (small))^c , Personnel (cost indicators, cost indicators)^c , Personnel (cost indicators, desktop)^c , Personnel (cost indicators, high)^c , Personnel (cost indicators, iPhone)^c , Personnel (cost indicators, laptop)^c , Personnel (cost indicators, low)^c , Personnel (cost indicators, lync and other applications (without telephony))^c , Personnel (cost indicators, medium)^c , Personnel (cost indicators, monitoring and administration environment)^c , Personnel (cost indicators, others)^c , Personnel (cost indicators, security environment)^c , Personnel (cost indicators, sharePoint and other applications)^c , Personnel (cost indicators, standard mass connection)^c , Personnel (cost indicators, total costs of guest systems)^c , Personnel (cost indicators, total costs of host systems)^c , Personnel (cost indicators, total costs)^c , Personnel (cost indicators, total costs)^c , Personnel (cost indicators, total costs)^c , Personnel (cost indicators, total costs)^c , Personnel (cost indicators, variant 1 (high availability))^c , Personnel (cost indicators, variant 2)^c , Personnel (cost indicators, voIP)^c , Personnel (cost indicators, windows phone)^c , Personnel employee service desk management (cost indicators, total costs)^c , Personnel service desk agents (first level) (cost indicators, total costs)^c , Platform (cost indicators, others)^c , Portion of costs in service desk for other modules (cost indicators, total costs)^c , Software (cost indicators, WLAN)^c , Software (cost indicators, active components)^c , Software (cost indicators, blackberry)^c , Software (cost indicators, classical telephony)^c , Software (cost indicators, conferencing (incl. video conferencing tools))^c , Software (cost indicators, cost indicator (medium))^c , Software (cost indicators, cost indicators (large))^c , Software (cost indicators, cost indicators (small))^c , Software (cost indicators, cost indicators)^c , Software (cost indicators, desktop)^c , Software (cost indicators, high)^c , Software (cost indicators, iPhone)^c , Software (cost indicators, laptop)^c , Software (cost indicators, low)^c , Software (cost indicators, lync and other applications (without telephony))^c , Software (cost indicators, medium)^c , Software (cost indicators, monitoring and administration environment)^c , Software (cost indicators, others)^c , Software (cost indicators, security environment)^c , Software (cost indicators, sharePoint and other applications)^c , Software (cost indicators, total costs of guest systems)^c , Software (cost indicators, total costs of host systems)^c , Software (cost indicators, total costs)^c , Software (cost indicators, total costs)^c , Software (cost indicators, total costs)^c , Software (cost indicators, total costs)^c , Software (cost indicators, variant 1 (high availability))^c , Software (cost indicators, variant 2)^c , Software (cost indicators, voIP)^c , Software (cost indicators, windows phone)^c , Software maintenance (cost indicators, WLAN)^c , Software maintenance (cost indicators, active components)^c , Software maintenance (cost indicators, blackberry)^c , Software maintenance (cost indicators, classical telephony)^c , Software maintenance (cost indicators, conferencing (incl. video conferencing tools))^c , Software maintenance (cost indicators, cost indicator (medium))^c , Software maintenance (cost indicators, cost indicators (large))^c , Software maintenance (cost indicators, cost indicators (small))^c , Software maintenance (cost indicators, cost indicators)^c , Software maintenance (cost indicators, high)^c , Software maintenance (cost indicators, iPhone)^c , Software maintenance (cost indicators, low)^c , Software maintenance (cost indicators, lync and other applications (without telephony))^c , Software maintenance (cost indicators, medium)^c , Software maintenance (cost indicators, monitoring and administration environment)^c , Software maintenance (cost indicators, others)^c , Software maintenance (cost indicators, security environment)^c , Software maintenance (cost indicators, sharePoint and other applications)^c , Software maintenance (cost indicators, total costs of guest systems)^c , Software maintenance (cost indicators, total costs of host systems)^c , Software maintenance (cost indicators, total costs)^c , Software maintenance (cost indicators, total costs)^c , Software maintenance (cost indicators, total costs)^c , Software maintenance (cost indicators, total costs)^c , Software maintenance (cost indicators, variant 1 (high availability))^c , Software maintenance (cost indicators, variant 2)^c , Software maintenance (cost indicators, voIP)^c , Software maintenance (cost indicators, windows phone)^c , Total costs per computer center (data center levy, basic data)^c

is disjoint with Performance Indicator^c

Cost rate FTE (performance indicators, SSL VPN access)^c

IRI: `https://w3id.org/bmontology#RemoteAccessService_PerformanceIndicators_SSLVPNAccess_CostRateFTE`

This is a performance indicator of the remote access service service, categorized into performance indicators as well as SSL VPN access. This indicator captures the cost rate per FTE for RAS per connection.

has super-classes Human resource indicator^c Performance Indicator^c Remote access service^c

Cost rate FTE (performance indicators, standard mass connection)^c

IRI: `https://w3id.org/bmontology#RemoteAccessService_PerformanceIndicators_StandardMassConnection_CostRateFTE`

This is a performance indicator of the remote access service service, categorized into performance indicators as well as standard mass connection. This indicator captures the cost rate per FTE for RAS per connection.

has super-classes Human resource indicator^c Performance Indicator^c Remote access service^c

Cost rate FTE (performance indicators, VPN client)^c

IRI: `https://w3id.org/bmontology#RemoteAccessService_PerformanceIndicators_VPNClient_CostRateFTE`

This is a performance indicator of the remote access service service, categorized into performance indicators as well as VPN client. This indicator captures the cost rate per FTE for RAS per connection.

has super-classes Human resource indicator^c Performance Indicator^c Remote access service^c

Cost rate FTE (performance indicators, VPN tunel to business partners)^c

IRI: `https://w3id.org/bmontology#RemoteAccessService_PerformanceIndicators_VPNTunelToBusinessPartners_CostRateFTE`

This is a performance indicator of the remote access service service, categorized into performance indicators as well as VPN tunel to business partners. This indicator captures the cost rate per FTE for RAS per connection.

has super-classes Performance Indicator^c Remote access service^c

Costs APA (cost indicators, WAN APA)^c

IRI: `https://w3id.org/bmontology#WAN_CostIndicators_WANAPA_CostsAPA`

This is a cost indicator of the WAN service, categorized into cost indicators as well as WAN APA. This indicator captures the costs of WAN per country/region.

has super-classes Cost Indicator^c WAN^c

Costs Brazil (cost indicators, WAN SA)^c

IRI: `https://w3id.org/bmontology#WAN_CostIndicators_WANSA_CostsBrazil`

This is a cost indicator of the WAN service, categorized into cost indicators as well as WAN SA. This indicator captures the costs for WAN per country/region.

has super-classes Cost Indicator^c WAN^c

Costs China (cost indicators, WAN APA)^c

IRI: `https://w3id.org/bmontology#WAN_CostIndicators_WANAPA_CostsChina`

This is a cost indicator of the WAN service, categorized into cost indicators as well as WAN APA. This indicator captures the costs for WAN per country/region.

has super-classes Cost Indicator^c WAN^c

Costs EMEA (cost indicators, WAN EMEA)^c

IRI: `https://w3id.org/bmontology#WAN_CostIndicators_WANEMEA_CostsEMEA`

This is a cost indicator of the WAN service, categorized into cost indicators as well as WAN EMEA. This indicator captures the costs of WAN per country/region.

has super-classes Cost Indicator^c WAN^c

Costs Germany (cost indicators, WAN EMEA)^c

IRI: `https://w3id.org/bmontology#WAN_CostIndicators_WANEMEA_CostsGermany`

This is a cost indicator of the WAN service, categorized into cost indicators as well as WAN EMEA. This indicator captures the costs for WAN per country/region.

has super-classes Cost Indicator^c WAN^c

Costs India (cost indicators, WAN APA)^c

IRI: `https://w3id.org/bmontology#WAN_CostIndicators_WANAPA_CostsIndia`

This is a cost indicator of the WAN service, categorized into cost indicators as well as WAN APA. This indicator captures the costs for WAN per country/region.

has super-classes Cost Indicator^c WAN^c

Costs Mexico (cost indicators, WAN NA)^c

IRI: `https://w3id.org/bmontology#WAN_CostIndicators_WANNA_CostsMexico`

This is a cost indicator of the WAN service, categorized into cost indicators as well as WAN NA. This indicator captures the costs for WAN per country/region.

has super-classes Cost Indicator^c WAN^c

Costs NA (cost indicators, WAN NA)^c

IRI: `https://w3id.org/bmontology#WAN_CostIndicators_WANNA_CostsNA`

This is a cost indicator of the WAN service, categorized into cost indicators as well as WAN NA. This indicator captures the costs of WAN per country/region.

has super-classes Cost Indicator^c WAN^c

Costs of development and training of employees (IT costs, basic data)^c

IRI: `https://w3id.org/bmontology#BasicData_ITCosts_BasicData_CostsOfDevelopmentAndTrainingOfEmployees`

This is a cost indicator of the basic data service, categorized into IT costs as well as basic data. This indicator captures the costs for software involved in the storage module.

has super-classes Basic data^c Cost Indicator^c Human resource indicator^c

Costs other APA (cost indicators, WAN APA)^c

IRI: `https://w3id.org/bmontology#WAN_CostIndicators_WANAPA_CostsOtherAPA`

This is a cost indicator of the WAN service, categorized into cost indicators as well as WAN APA. This indicator captures the costs for WAN per country/region.

has super-classes Cost Indicator^c WAN^c

Costs other countries (cost indicators, WAN other countries)^c

IRI: `https://w3id.org/bmontology#WAN_CostIndicators_WANOtherCountries_CostsOtherCountries`

This is a cost indicator of the WAN service, categorized into cost indicators as well as WAN other countries. This indicator captures the costs for WAN per country/region.

has super-classes Cost Indicator^c WAN^c

Costs other EMEA (cost indicators, WAN EMEA)^c

IRI: `https://w3id.org/bmontology#WAN_CostIndicators_WANEMEA_CostsOtherEMEA`

This is a cost indicator of the WAN service, categorized into cost indicators as well as WAN EMEA. This indicator captures the costs for WAN per country/region.

has super-classes Cost Indicator^c WAN^c

Costs other NA (cost indicators, WAN NA)^c

IRI: `https://w3id.org/bmontology#WAN_CostIndicators_WANNA_CostsOtherNA`

This is a cost indicator of the WAN service, categorized into cost indicators as well as WAN NA. This indicator captures the costs for WAN per country/region.

has super-classes Cost Indicator^c WAN^c

Costs other SA (cost indicators, WAN SA)^c

IRI: `https://w3id.org/bmontology#WAN_CostIndicators_WANSA_CostsOtherSA`

This is a cost indicator of the WAN service, categorized into cost indicators as well as WAN SA. This indicator captures the costs for WAN per country/region.

has super-classes Cost Indicator^c WAN^c

Costs Russia (cost indicators, WAN EMEA)^c

IRI: `https://w3id.org/bmontology#WAN_CostIndicators_WANEMEA_CostsRussia`

This is a cost indicator of the WAN service, categorized into cost indicators as well as WAN EMEA. This indicator captures the costs for WAN per country/region.

has super-classes Cost Indicator^c WAN^c

Costs SA (cost indicators, WAN SA)^c

IRI: `https://w3id.org/bmontology#WAN_CostIndicators_WANSA_CostsSA`

This is a cost indicator of the WAN service, categorized into cost indicators as well as WAN SA. This indicator captures the costs of WAN per country/region.

has super-classes Cost Indicator^c WAN^c

Costs South Africa (cost indicators, WAN EMEA)^c

IRI: `https://w3id.org/bmontology#WAN_CostIndicators_WANEMEA_CostsSouthAfrica`

This is a cost indicator of the WAN service, categorized into cost indicators as well as WAN EMEA. This indicator captures the costs for WAN per country/region.

has super-classes Cost Indicator^c WAN^c

Costs Turkey (cost indicators, WAN EMEA)^c

IRI: `https://w3id.org/bmontology#WAN_CostIndicators_WANEMEA_CostsTurkey`

This is a cost indicator of the WAN service, categorized into cost indicators as well as WAN EMEA. This indicator captures the costs for WAN per country/region.

has super-classes Cost Indicator^c WAN^c

Costs USA (cost indicators, WAN NA)^c

IRI: `https://w3id.org/bmontology#WAN_CostIndicators_WANNA_CostsUSA`

This is a cost indicator of the WAN service, categorized into cost indicators as well as WAN NA. This indicator captures the costs for WAN per country/region.

has super-classes Cost Indicator^c WAN^c

CRM (performance indicators, quantity structure and performance (blackberry))^c

IRI: `https://w3id.org/bmontology#MobileDevices_PerformanceIndicators_QuantityStructureAndPerformanceBlackberry_CRM`

This is a performance indicator of the mobile devices service, categorized into performance indicators as well as quantity structure and performance (blackberry). This indicator captures whether the platform offers CRM.

has super-classes Mobile Devices (Blackberry)^c Performance Indicator^c Software resource indicator^c

CRM (performance indicators, quantity structure and performance (iPhone))^c

IRI: `https://w3id.org/bmontology#MobileDevices_PerformanceIndicators_QuantityStructureAndPerformanceIPhone_CRM`

This is a performance indicator of the mobile devices service, categorized into performance indicators as well as quantity structure and performance (iPhone). This indicator captures whether the platform offers CRM.

has super-classes Mobile Devices (iPhone)^c Performance Indicator^c Software resource indicator^c

CRM (performance indicators, quantity structure and performance (other))^c

IRI: `https://w3id.org/bmontology#MobileDevices_PerformanceIndicators_QuantityStructureAndPerformanceOther_CRM`

This is a performance indicator of the mobile devices service, categorized into performance indicators as well as quantity structure and performance (other). This indicator captures whether the platform offers CRM.

has super-classes Mobile Devices (Others)^c Performance Indicator^c Software resource indicator^c

CRM (performance indicators, quantity structure and performance (windows phone))^c

IRI: `https://w3id.org/bmontology#MobileDevices_PerformanceIndicators_QuantityStructureAndPerformanceWindowsPhone_CRM`

This is a performance indicator of the mobile devices service, categorized into performance indicators as well as quantity structure and performance (windows phone). This indicator captures whether the platform offers CRM.

has super-classes Mobile Devices (Windows Phone)^c Performance Indicator^c Software resource indicator^c

Customer (Number of users) (performance indicators, general)^c

IRI: `https://w3id.org/bmontology#SAPModules_PerformanceIndicators_General_CustomerNumberOfUsers`

This is a performance indicator of the SAP modules service, categorized into performance indicators as well as general. This indicator captures the number of users using SAP.

has super-classes Quantity indicator^c SAP modules^c

Data encryption (performance indicators, security indicators (blackberry))^c

IRI: `https://w3id.org/bmontology#MobileDevices_PerformanceIndicators_SecurityIndicatorsBlackberry_DataEncryption`

This is a performance indicator of the mobile devices service, categorized into performance indicators as well as security indicators (blackberry). This indicator captures whether data is encrypted on the device.

has super-classes Mobile Devices (Blackberry)^c Performance Indicator^c

Data encryption (performance indicators, security indicators (iPhone))^c

IRI: `https://w3id.org/bmontology#MobileDevices_PerformanceIndicators_SecurityIndicatorsIPhone_DataEncryption`

This is a performance indicator of the mobile devices service, categorized into performance indicators as well as security indicators (iPhone). This indicator captures whether data is encrypted on the device.

has super-classes Mobile Devices (iPhone)^c Performance Indicator^c

Data encryption (performance indicators, security indicators (other))^c

IRI: `https://w3id.org/bmontology#MobileDevices_PerformanceIndicators_SecurityIndicatorsOther_DataEncryption`

This is a performance indicator of the mobile devices service, categorized into performance indicators as well as security indicators (other). This indicator captures whether data is encrypted on the device.

has super-classes Mobile Devices (Others)^c Performance Indicator^c

Data encryption (performance indicators, security indicators (windows phone))^c

IRI: `https://w3id.org/bmontology#MobileDevices_PerformanceIndicators_SecurityIndicatorsWindowsPhone_DataEncryption`

This is a performance indicator of the mobile devices service, categorized into performance indicators as well as security indicators (windows phone). This indicator captures whether data is encrypted on the device.

has super-classes Mobile Devices (Windows Phone)^c Performance Indicator^c

Database^c

IRI: `https://w3id.org/bmontology#DatabaseIndicator`

Classifies database indicators

has super-classes Service template dimension for indicator classification^c

has sub-classes Database (Variant 1)^c , Datenbanken (Variante 2)^c

is disjoint with Backup^c , Basic data^c , Collaboration^c , Dedicated server^c , File Service^c , IMAC^c , LAN^c , Mailbox^c , Mobile devices^c , Remote access service^c , SAP basis^c , SAP modules^c , Servicedesk^c , Storage^c , Telephony^c , Terminal server^c , Virtual server^c , WAN^c , Workplace^c

Database (Variant 1)^c

IRI: `https://w3id.org/bmontology#Database_Variant1HighAvailability_Indicator`

Classifies database indicators for database systems being particularly important for the organization and thus having high availability

has super-classes Database^c

has sub-classes Additional information (performance indicators, variant 1 (high availability))^c , Backup strategy (performance indicators, variant 1 (high availability))^c , Database in use (performance indicators, variant 1 (high availability))^c , Database systems (performance indicators, variant 1 (high availability))^c , Ensured availability (performance indicators, variant 1 (high availability))^c , External services (cost indicators, variant 1 (high availability))^c , Hardware (cost indicators, variant 1 (high availability))^c , Hardware maintenance (cost indicators, variant 1 (high availability))^c , Number of database version (performance indicators, variant 1 (high availability))^c , Number of databases (performance indicators, variant 1 (high availability))^c , Number of external personnel (FTE) (performance indicators, variant 1 (high availability))^c , Number of internal personnel (FTE) (performance indicators, variant 1 (high availability))^c , Offetting backup (cost indicators, variant 1 (high availability))^c , Offsetting Server (cost indicators, variant 1 (high availability))^c , Offsetting Storage (cost indicators, variant 1 (high availability))^c , Operating system in use (performance indicators, variant 1 (high availability))^c , Others (cost indicators, variant 1 (high availability))^c , Patch cycles (performance indicators, variant 1 (high availability))^c , Personnel (cost indicators, variant 1 (high availability))^c , Software (cost indicators, variant 1 (high availability))^c , Software maintenance (cost indicators, variant 1 (high availability))^c , Storage volume (performance indicators, variant 1 (high availability))^c , Type of sourcing (performance indicators, variant 1 (high availability))^c , Usage of BLOB files (performance indicators, variant 1 (high availability))^c

Database in use (performance indicators, variant 1 (high availability))^c

IRI: `https://w3id.org/bmontology#Database_PerformanceIndicators_Variant1HighAvailability_DatabaseInUse`

This is a performance indicator of the database service, categorized into performance indicators as well as variant 1 (high availability). This indicator captures which database is mainly used.

has super-classes Database (Variant 1)^c Performance Indicator^c Software resource indicator^c

Database in use (performance indicators, variant 2)^c

IRI: `https://w3id.org/bmontology#Database_PerformanceIndicators_Variant2_DatabaseInUse`

This is a performance indicator of the database service, categorized into performance indicators as well as variant 2. This indicator captures which database is mainly used.

has super-classes Datenbanken (Variante 2)^c Performance Indicator^c Software resource indicator^c

Database systems (performance indicators, variant 1 (high availability))^c

IRI: `https://w3id.org/bmontology#Database_PerformanceIndicators_Variant1HighAvailability_DatabaseSystems`

This is a performance indicator of the database service, categorized into performance indicators as well as variant 1 (high availability). This indicator captures the number of database instances used within the organization.

has super-classes Database (Variant 1)^c Performance Indicator^c Software resource indicator^c

Database systems (performance indicators, variant 2)^c

IRI: `https://w3id.org/bmontology#Database_PerformanceIndicators_Variant2_DatabaseSystems`

This is a performance indicator of the database service, categorized into performance indicators as well as variant 2. This indicator captures the number of database instances used within the organization.

has super-classes Datenbanken (Variante 2)^c Performance Indicator^c Software resource indicator^c

Datenbanken (Variante 2)^c

IRI: `https://w3id.org/bmontology#Database_Variant2_Indicator`

Classifies database indicators for database systems without especially high availability

has super-classes Database^c

has sub-classes Additional information (performance indicators, variant 2)^c , Backup strategy (performance indicators, variant 2)^c , Database in use (performance indicators, variant 2)^c , Database systems (performance indicators, variant 2)^c , Ensured availability (performance indicators, variant 2)^c , External services (cost indicators, variant 2)^c , Hardware (cost indicators, variant 2)^c , Hardware maintenance (cost indicators, variant 2)^c , High availability (performance indicators, variant 2)^c , Number of database version (performance indicators, variant 2)^c , Number of databases (performance indicators, variant 2)^c , Number of external personnel (FTE) (performance indicators, variant 2)^c , Number of internal personnel (FTE) (performance indicators, variant 2)^c , Offetting backup (cost indicators, variant 2)^c , Offsetting Server (cost indicators, variant 2)^c , Offsetting Storage (cost indicators, variant 2)^c , Operating system in use (performance indicators, variant 2)^c , Others (cost indicators, variant 2)^c , Patch cycles (performance indicators, variant 2)^c , Personnel (cost indicators, variant 2)^c , Software (cost indicators, variant 2)^c , Software maintenance (cost indicators, variant 2)^c , Storage volume (performance indicators, variant 2)^c , Type of sourcing (performance indicators, variant 2)^c , Usage of BLOB files (performance indicators, variant 2)^c

DB size (performance indicators, additional information)^c

IRI: `https://w3id.org/bmontology#SAPBasis_PerformanceIndicators_AdditionalInformation_DBSize`

This is a performance indicator of the SAP basis service, categorized into performance indicators as well as additional information. This indicator captures the available database size (maximum) for the SAP system excluding the backup (whole system line (ERP + HR) is considered).

has super-classes Quantity indicator^c SAP basis^c Software resource indicator^c

Dedicated or shared service desk (performance indicators, quantity structure and performance)^c

IRI: `https://w3id.org/bmontology#Servicedesk_PerformanceIndicators_QuantityStructureAndPerformance_DedicatedOrSharedServiceDesk`

This is a performance indicator of the servicedesk service, categorized into performance indicators as well as quantity structure and performance. This indicator captures whether a dedicated or a shared service desk is used.

has super-classes Performance Indicator^c Servicedesk^c

Dedicated server^c

IRI: `https://w3id.org/bmontology#DedicatedServerIndicator`

Classifies dedicated server indicators

has super-classes Service template dimension for indicator classification^c

has sub-classes Dedicated server (large)^c , Dedicated server (medium)^c , Dedicated server (small)^c

is disjoint with Backup^c , Basic data^c , Collaboration^c , Database^c , File Service^c , IMAC^c , LAN^c , Mailbox^c , Mobile devices^c , Remote access service^c , SAP basis^c , SAP modules^c , Servicedesk^c , Storage^c , Telephony^c , Terminal server^c , Virtual server^c , WAN^c , Workplace^c

Dedicated server (large)^c

IRI: `https://w3id.org/bmontology#DedicatedServer_Large_Indicator`

Classifies server indicators for servers having more than 7 cores

has super-classes Dedicated server^c

has sub-classes Backup strategy (performance indicators, quantity structure (large))^c , Computer center levy (cost indicators, cost indicators (large))^c , Ensured availability (performance indicators, quantity structure (large))^c , External services (cost indicators, cost indicators (large))^c , Hardware (cost indicators, cost indicators (large))^c , Hardware maintenance (cost indicators, cost indicators (large))^c , Number of external personnel (FTE) (performance indicators, quantity structure (large))^c , Number of internal personnel (FTE) (performance indicators, quantity structure (large))^c , Number of servers (performance indicators, quantity structure (large))^c , Others (cost indicators, cost indicators (large))^c , Patch cycles (performance indicators, quantity structure (large))^c , Personnel (cost indicators, cost indicators (large))^c , Software (cost indicators, cost indicators (large))^c , Software maintenance (cost indicators, cost indicators (large))^c , Type of sourcing (performance indicators, quantity structure (large))^c

Dedicated server (medium)^c

IRI: `https://w3id.org/bmontology#DedicatedServer_Medium_Indicator`

Classifies server indicators for servers having up 3-7 cores

has super-classes Dedicated server^c

has sub-classes Backup strategy (performance indicators, quantity structure (medium))^c , Computer center levy (cost indicators, cost indicator (medium))^c , Ensured availability (performance indicators, quantity structure (medium))^c , External services (cost indicators, cost indicator (medium))^c , Hardware (cost indicators, cost indicator (medium))^c , Hardware maintenance (cost indicators, cost indicator (medium))^c , Number of external personnel (FTE) (performance indicators, quantity structure (medium))^c , Number of internal personnel (FTE) (performance indicators, quantity structure (medium))^c , Number of servers (platform-specific) (performance indicators, quantity structure (medium))^c , Others (cost indicators, cost indicator (medium))^c , Patch cycles (performance indicators, quantity structure (medium))^c , Personnel (cost indicators, cost indicator (medium))^c , Software (cost indicators, cost indicator (medium))^c , Software maintenance (cost indicators, cost indicator (medium))^c , Type of sourcing (performance indicators, quantity structure (medium))^c

Dedicated server (small)^c

IRI: `https://w3id.org/bmontology#DedicatedServer_Small_Indicator`

Classifies server indicators for servers having up to 2 cores

has super-classes Dedicated server^c

has sub-classes Backup strategy (performance indicators, quantity structure (small))^c , Computer center levy (cost indicators, cost indicators (small))^c , Ensured availability (performance indicators, quantity structure (small))^c , External services (cost indicators, cost indicators (small))^c , Hardware (cost indicators, cost indicators (small))^c , Hardware maintenance (cost indicators, cost indicators (small))^c , Number of external personnel (FTE) (performance indicators, quantity structure (small))^c , Number of internal personnel (FTE) (performance indicators, quantity structure (small))^c , Number of servers (performance indicators, quantity structure (small))^c , Others (cost indicators, cost indicators (small))^c , Patch cycles (performance indicators, quantity structure (small))^c , Personnel (cost indicators, cost indicators (small))^c , Software (cost indicators, cost indicators (small))^c , Software maintenance (cost indicators, cost indicators (small))^c , Type of sourcing (performance indicators, quantity structure (small))^c

Degree of coverage (performance indicators, general)^c

IRI: `https://w3id.org/bmontology#SAPModules_PerformanceIndicators_General_DegreeOfCoverage`

This is a performance indicator of the SAP modules service, categorized into performance indicators as well as general. This indicator captures the degree of coverage of the SAP landscape.

has super-classes Performance Indicator^c SAP modules^c

Degree of maturity of the module (performance indicators, BC: basic system)^c

IRI: `https://w3id.org/bmontology#SAPModules_PerformanceIndicators_BCBasicSystem_DegreeOfMaturityOfTheModule`

This is a performance indicator of the SAP modules service, categorized into performance indicators as well as BC: basic system. This indicator captures teh degree of maturity of the module.

has super-classes Performance Indicator^c SAP modules^c

Degree of maturity of the module (performance indicators, co: controlling)^c

IRI: `https://w3id.org/bmontology#SAPModules_PerformanceIndicators_CoControlling_DegreeOfMaturityOfTheModule`

This is a performance indicator of the SAP modules service, categorized into performance indicators as well as co: controlling. This indicator captures teh degree of maturity of the module.

has super-classes Performance Indicator^c SAP modules^c

Degree of maturity of the module (performance indicators, CS: customer service)^c

IRI: `https://w3id.org/bmontology#SAPModules_PerformanceIndicators_CSCustomerService_DegreeOfMaturityOfTheModule`

This is a performance indicator of the SAP modules service, categorized into performance indicators as well as CS: customer service. This indicator captures teh degree of maturity of the module.

has super-classes Performance Indicator^c SAP modules^c

Degree of maturity of the module (performance indicators, EC: corporate controlling)^c

IRI: `https://w3id.org/bmontology#SAPModules_PerformanceIndicators_ECCorporateControlling_DegreeOfMaturityOfTheModule`

This is a performance indicator of the SAP modules service, categorized into performance indicators as well as EC: corporate controlling. This indicator captures teh degree of maturity of the module.

has super-classes Performance Indicator^c SAP modules^c

Degree of maturity of the module (performance indicators, FI: finance)^c

IRI: https://w3id.org/bmontology#SAPModules_PerformanceIndicators_FIFinance_DegreeOfMaturityOfTheModule

This is a performance indicator of the SAP modules service, categorized into performance indicators as well as FI: finance. This indicator captures teh degree of maturity of the module.

has super-classes Performance Indicator^c SAP modules^c

Degree of maturity of the module (performance indicators, MM: materials management)^c

IRI: https://w3id.org/bmontology#SAPModules_PerformanceIndicators_MMMaterialsManagement_DegreeOfMaturityOfTheModule

This is a performance indicator of the SAP modules service, categorized into performance indicators as well as MM: materials management. This indicator captures teh degree of maturity of the module.

has super-classes Performance Indicator^c SAP modules^c

Degree of maturity of the module (performance indicators, PM: plant maintenance)^c

IRI: https://w3id.org/bmontology#SAPModules_PerformanceIndicators_PMPlantMaintenance_DegreeOfMaturityOfTheModule

This is a performance indicator of the SAP modules service, categorized into performance indicators as well as PM: plant maintenance. This indicator captures teh degree of maturity of the module.

has super-classes Performance Indicator^c SAP modules^c

Degree of maturity of the module (performance indicators, PP: production planning and control)^c

IRI: `https://w3id.org/bmontology#SAPModules_PerformanceIndicators_PPProductionPlanningAndControl_DegreeOfMaturityOfTheModule`

This is a performance indicator of the SAP modules service, categorized into performance indicators as well as PP: production planning and control. This indicator captures teh degree of maturity of the module.

has super-classes Performance Indicator^c SAP modules^c

Degree of maturity of the module (performance indicators, SD: sales and distribution)^c

IRI: `https://w3id.org/bmontology#SAPModules_PerformanceIndicators_SDSalesAndDistribution_DegreeOfMaturityOfTheModule`

This is a performance indicator of the SAP modules service, categorized into performance indicators as well as SD: sales and distribution. This indicator captures teh degree of maturity of the module.

has super-classes Performance Indicator^c SAP modules^c

Degree of maturity SAP ERP (performance indicators, general)^c

IRI: `https://w3id.org/bmontology#SAPModules_PerformanceIndicators_General_DegreeOfMaturitySAPERP`

This is a performance indicator of the SAP modules service, categorized into performance indicators as well as general. This indicator captures the degree of maturity of SAP ERP.

has super-classes Performance Indicator^c SAP modules^c

Degree of virtualization (performance indicators, cross-system)^c

IRI: `https://w3id.org/bmontology#VirtualServer_PerformanceIndicators_CrossSystem_DegreeOfVirtualization`

This is a performance indicator of the virtual server service, categorized into performance indicators as well as cross-system. This indicator captures the degree of virtualization in the organization.

has super-classes Performance Indicator^c Virtual server^c

Delivery time (performance indicators, service level of IMAC processes)^c

IRI: `https://w3id.org/bmontology#IMAC_PerformanceIndicators_ServiceLevelOfIMACProcesses_DeliveryTime`

This is a performance indicator of the IMAC service, categorized into performance indicators as well as service level of IMAC processes. This indicator captures the number of days passing between ordering hardware and ist usage by IT users.

has super-classes IMAC^c Quality indicator^c

Depreciation period (performance indicators, basic data)^c

IRI: `https://w3id.org/bmontology#BasicData_PerformanceIndicators_BasicData_DepreciationPeriod`

This is a performance indicator of the basic data service, categorized into performance indicators as well as basic data. This indicator captures the primary depreciation period in your organization.

has super-classes Basic data^c Performance Indicator^c

Depreciation period (performance indicators, quantity structure and performance (blackberry))^c

IRI: `https://w3id.org/bmontology#MobileDevices_PerformanceIndicators_QuantityStructureAndPerformanceBlackberry_DepreciationPeriod`

This is a performance indicator of the mobile devices service, categorized into performance indicators as well as quantity structure and performance (blackberry). This indicator captures the number of months required for the depreciation at the corresponding platform.

has super-classes Mobile Devices (Blackberry)^c Performance Indicator^c

Depreciation period (performance indicators, quantity structure and performance (iPhone))^c

IRI: https://w3id.org/bmontology#MobileDevices_PerformanceIndicators_QuantityStructureAndPerformanceIPhone_DepreciationPeriod

This is a performance indicator of the mobile devices service, categorized into performance indicators as well as quantity structure and performance (iPhone). This indicator captures the number of months required for the depreciation at the corresponding platform.

has super-classes Mobile Devices (iPhone)^c Performance Indicator^c

Depreciation period (performance indicators, quantity structure and performance (other))^c

IRI: https://w3id.org/bmontology#MobileDevices_PerformanceIndicators_QuantityStructureAndPerformanceOther_DepreciationPeriod

This is a performance indicator of the mobile devices service, categorized into performance indicators as well as quantity structure and performance (other). This indicator captures the number of months required for the depreciation at the corresponding platform.

has super-classes Mobile Devices (Others)^c Performance Indicator^c

Depreciation period (performance indicators, quantity structure and performance (windows phone))^c

IRI: https://w3id.org/bmontology#MobileDevices_PerformanceIndicators_QuantityStructureAndPerformanceWindowsPhone_DepreciationPeriod

This is a performance indicator of the mobile devices service, categorized into performance indicators as well as quantity structure and performance (windows phone). This indicator captures the number of months required for the depreciation at the corresponding platform.

has super-classes Mobile Devices (Windows Phone)^c Performance Indicator^c

Depth authorization concept (performance indicators, quantity structure)^c

IRI: `https://w3id.org/bmontology#FileService_PerformanceIndicators_QuantityStructure_DepthAuthorizationConcept`

This is a performance indicator of the file service service, categorized into performance indicators as well as quantity structure. This indicator captures the depth of the authorization concept by the number of ist layers.

has super-classes File Service^c Performance Indicator^c

Development and project engineering of the IT (IT and development, basic data)^c

IRI: `https://w3id.org/bmontology#BasicData_ITAndDevelopment_BasicData_DevelopmentAndProjectEngineeringOfTheIT`

This is an indicator of the basic data service, categorized into IT and development as well as basic data. This indicator captures which development techniques are used by the IT.

has super-classes Basic data^c

Dialog processing (performance indicators, additional information)^c

IRI: `https://w3id.org/bmontology#SAPBasis_PerformanceIndicators_AdditionalInformation_DialogProcessing`

This is a performance indicator of the SAP basis service, categorized into performance indicators as well as additional information. This indicator captures the maximum number of database and user dialogs per day.

has super-classes Performance Indicator^c SAP basis^c

Dialog response time (performance indicators, additional information)^c

IRI: `https://w3id.org/bmontology#SAPBasis_PerformanceIndicators_AdditionalInformation_DialogResponseTime`

This is a performance indicator of the SAP basis service, categorized into performance indicators as well as additional information. This indicator captures the average response time to dialogs including the database processing time.

has super-classes Performance Indicator^c SAP basis^c

Distribution of tertiary cabling (performance indicators, additional information)^c

IRI: `https://w3id.org/bmontology#LAN_PerformanceIndicators_AdditionalInformation_DistributionOfTertiaryCabling`

This is a performance indicator of the LAN service, categorized into performance indicators as well as additional information. This indicator captures the description of the distribution of tertiary cabling.

has super-classes Hardware resource indicator^c LAN^c Performance Indicator^c

Distribution of tickets (performance indicators, quantity structure and performance)^c

IRI: `https://w3id.org/bmontology#Servicedesk_PerformanceIndicators_QuantityStructureAndPerformance_DistributionOfTickets`

This is a performance indicator of the servicedesk service, categorized into performance indicators as well as quantity structure and performance. This indicator captures the distribution (percent) of tickets.

has super-classes Performance Indicator^c Servicedesk^c

Document collaboration (performance indicators, tools)^c

IRI: `https://w3id.org/bmontology#Collaboration_PerformanceIndicators_Tools_DocumentCollaboration`

This is a performance indicator of the collaboration service, categorized into performance indicators as well as tools. This indicator captures whether this kind of collaboration is used in the organization.

has super-classes Collaboration^c Performance Indicator^c Software resource indicator^c

Duration until image is available (performance indicators, service level of IMAC processes)[c]

IRI: `https://w3id.org/bmontology#IMAC_PerformanceIndicators_ServiceLevelOfIMACProcesses_DurationUntilImageIsAvailable`

This is a performance indicator of the IMAC service, categorized into performance indicators as well as service level of IMAC processes. This indicator captures the number of days passing until a new software image is available for available hardware.

has super-classes IMAC[c] Quality indicator[c]

Duration until mass rollout of patch installations at clients are freed (performance indicators, service level of IMAC processes)[c]

IRI: `https://w3id.org/bmontology#IMAC_PerformanceIndicators_ServiceLevelOfIMACProcesses_DurationUntilMassRolloutOfPatchInstallationsAtClientsAreFreed`

This is a performance indicator of the IMAC service, categorized into performance indicators as well as service level of IMAC processes. This indicator captures the number of days passing between the mass rollout and the patch installation of clients.

has super-classes IMAC[c] Quality indicator[c]

Duration until patch publication (performance indicators, service level of IMAC processes)[c]

IRI: `https://w3id.org/bmontology#IMAC_PerformanceIndicators_ServiceLevelOfIMACProcesses_DurationUntilPatchPublication`

This is a performance indicator of the IMAC service, categorized into performance indicators as well as service level of IMAC processes. This indicator captures the number of days passing until a patch is released.

has super-classes IMAC[c] Quality indicator[c]

Dynamics of changes (performance indicators, general)[c]

IRI: `https://w3id.org/bmontology#SAPModules_PerformanceIndicators_General_DynamicsOfChanges`

This is a performance indicator of the SAP modules service, categorized into performance indicators as well as general. This indicator captures the innovative capacity of the organization.

has super-classes Performance Indicator[c] SAP modules[c]

Effort of external administration (FTE) (performance indicators, BC: basic system)[c]

IRI: `https://w3id.org/bmontology#SAPModules_PerformanceIndicators_BCBasicSystem_EffortOfExternalAdministrationFTE`

This is a performance indicator of the SAP modules service, categorized into performance indicators as well as BC: basic system. This indicator captures the effort required for administrating the module by external FTE.

has super-classes Human resource indicator[c] Performance Indicator[c] SAP modules[c]

Effort of external administration (FTE) (performance indicators, co: controlling)[c]

IRI: `https://w3id.org/bmontology#SAPModules_PerformanceIndicators_CoControlling_EffortOfExternalAdministrationFTE`

This is a performance indicator of the SAP modules service, categorized into performance indicators as well as co: controlling. This indicator captures the effort required for administrating the module by external FTE.

has super-classes Human resource indicator[c] Performance Indicator[c] SAP modules[c]

Effort of external administration (FTE) (performance indicators, CS: customer service)[c]

IRI: `https://w3id.org/bmontology#SAPModules_PerformanceIndicators_CSCustomerService_EffortOfExternalAdministrationFTE`

This is a performance indicator of the SAP modules service, categorized into performance indicators as well as CS: customer service. This indicator captures the effort required for administrating the module by external FTE.

has super-classes Human resource indicator^c Performance Indicator^c SAP modules^c

Effort of external administration (FTE) (performance indicators, EC: corporate controlling)^c

IRI: `https://w3id.org/bmontology#SAPModules_PerformanceIndicators_ECCorporateControlling_EffortOfExternalAdministrationFTE`

This is a performance indicator of the SAP modules service, categorized into performance indicators as well as EC: corporate controlling. This indicator captures the effort required for administrating the module by external FTE.

has super-classes Human resource indicator^c Performance Indicator^c SAP modules^c

Effort of external administration (FTE) (performance indicators, FI: finance)^c

IRI: `https://w3id.org/bmontology#SAPModules_PerformanceIndicators_FIFinance_EffortOfExternalAdministrationFTE`

This is a performance indicator of the SAP modules service, categorized into performance indicators as well as FI: finance. This indicator captures the effort required for administrating the module by external FTE.

has super-classes Human resource indicator^c Performance Indicator^c SAP modules^c

Effort of external administration (FTE) (performance indicators, MM: materials management)^c

IRI: `https://w3id.org/bmontology#SAPModules_PerformanceIndicators_MMMaterialsManagement_EffortOfExternalAdministrationFTE`

This is a performance indicator of the SAP modules service, categorized into performance indicators as well as MM: materials management. This indicator captures the effort required for administrating the module by external FTE.

has super-classes Human resource indicator^c Performance Indicator^c SAP modules^c

Effort of external administration (FTE) (performance indicators, PM: plant maintenance)^c

IRI: `https://w3id.org/bmontology#SAPModules_PerformanceIndicators_PMPlantMaintenance_EffortOfExternalAdministrationFTE`

This is a performance indicator of the SAP modules service, categorized into performance indicators as well as PM: plant maintenance. This indicator captures the effort required for administrating the module by external FTE.

has super-classes Human resource indicator^c Performance Indicator^c SAP modules^c

Effort of external administration (FTE) (performance indicators, PP: production planning and control)^c

IRI: `https://w3id.org/bmontology#SAPModules_PerformanceIndicators_PPProductionPlanningAndControl_EffortOfExternalAdministrationFTE`

This is a performance indicator of the SAP modules service, categorized into performance indicators as well as PP: production planning and control. This indicator captures the effort required for administrating the module by external FTE.

has super-classes Human resource indicator^c Performance Indicator^c SAP modules^c

Effort of external administration (FTE) (performance indicators, SD: sales and distribution)^c

IRI: `https://w3id.org/bmontology#SAPModules_PerformanceIndicators_SDSalesAndDistribution_EffortOfExternalAdministrationFTE`

This is a performance indicator of the SAP modules service, categorized into performance indicators as well as SD: sales and distribution. This indicator captures the effort required for administrating the module by external FTE.

has super-classes Human resource indicator^c Performance Indicator^c SAP modules^c

Effort of external maintenance (FTE) (performance indicators, BC: basic system)^c

IRI: `https://w3id.org/bmontology#SAPModules_PerformanceIndicators_BCBasicSystem_EffortOfExternalMaintenanceFTE`

This is a performance indicator of the SAP modules service, categorized into performance indicators as well as BC: basic system. This indicator captures the effort required for maintaining the module by external FTE.

has super-classes Human resource indicator^c Performance Indicator^c SAP modules^c

Effort of external maintenance (FTE) (performance indicators, co: controlling)^c

IRI: `https://w3id.org/bmontology#SAPModules_PerformanceIndicators_CoControlling_EffortOfExternalMaintenanceFTE`

This is a performance indicator of the SAP modules service, categorized into performance indicators as well as co: controlling. This indicator captures the effort required for maintaining the module by external FTE.

has super-classes Human resource indicator^c Performance Indicator^c SAP modules^c

Effort of external maintenance (FTE) (performance indicators, CS: customer service)^c

IRI: `https://w3id.org/bmontology#SAPModules_PerformanceIndicators_CSCustomerService_EffortOfExternalMaintenanceFTE`

This is a performance indicator of the SAP modules service, categorized into performance indicators as well as CS: customer service. This indicator captures the effort required for maintaining the module by external FTE.

has super-classes Human resource indicator^c Performance Indicator^c SAP modules^c

Effort of external maintenance (FTE) (performance indicators, EC: corporate controlling)[c]

IRI: `https://w3id.org/bmontology#SAPModules_PerformanceIndicators_ECCorporateControlling_EffortOfExternalMaintenanceFTE`

This is a performance indicator of the SAP modules service, categorized into performance indicators as well as EC: corporate controlling. This indicator captures the effort required for maintaining the module by external FTE.

has super-classes Human resource indicator[c] Performance Indicator[c] SAP modules[c]

Effort of external maintenance (FTE) (performance indicators, FI: finance)[c]

IRI: `https://w3id.org/bmontology#SAPModules_PerformanceIndicators_FIFinance_EffortOfExternalMaintenanceFTE`

This is a performance indicator of the SAP modules service, categorized into performance indicators as well as FI: finance. This indicator captures the effort required for maintaining the module by external FTE.

has super-classes Human resource indicator[c] Performance Indicator[c] SAP modules[c]

Effort of external maintenance (FTE) (performance indicators, MM: materials management)[c]

IRI: `https://w3id.org/bmontology#SAPModules_PerformanceIndicators_MMMaterialsManagement_EffortOfExternalMaintenanceFTE`

This is a performance indicator of the SAP modules service, categorized into performance indicators as well as MM: materials management. This indicator captures the effort required for maintaining the module by external FTE.

has super-classes Human resource indicator[c] Performance Indicator[c] SAP modules[c]

Effort of external maintenance (FTE) (performance indicators, PM: plant maintenance)^c

IRI: `https://w3id.org/bmontology#SAPModules_PerformanceIndicators_PMPlantMaintenance_EffortOfExternalMaintenanceFTE`

This is a performance indicator of the SAP modules service, categorized into performance indicators as well as PM: plant maintenance. This indicator captures the effort required for maintaining the module by external FTE.

has super-classes Human resource indicator^c Performance Indicator^c SAP modules^c

Effort of external maintenance (FTE) (performance indicators, PP: production planning and control)^c

IRI: `https://w3id.org/bmontology#SAPModules_PerformanceIndicators_PPProductionPlanningAndControl_EffortOfExternalMaintenanceFTE`

This is a performance indicator of the SAP modules service, categorized into performance indicators as well as PP: production planning and control. This indicator captures the effort required for maintaining the module by external FTE.

has super-classes Human resource indicator^c Performance Indicator^c SAP modules^c

Effort of external maintenance (FTE) (performance indicators, SD: sales and distribution)^c

IRI: `https://w3id.org/bmontology#SAPModules_PerformanceIndicators_SDSalesAndDistribution_EffortOfExternalMaintenanceFTE`

This is a performance indicator of the SAP modules service, categorized into performance indicators as well as SD: sales and distribution. This indicator captures the effort required for maintaining the module by external FTE.

has super-classes Human resource indicator^c Performance Indicator^c SAP modules^c

Effort of in-house development (performance indicators, BC: basic system)^c

IRI: `https://w3id.org/bmontology#SAPModules_PerformanceIndicators_BCBasicSystem_EffortOfInHouseDevelopment`

This is a performance indicator of the SAP modules service, categorized into performance indicators as well as BC: basic system. This indicator captures the number of man-year flown into the development of this module (incl. Submodules).

has super-classes Human resource indicator^c Performance Indicator^c SAP modules^c

Effort of in-house development (performance indicators, co: controlling)^c

IRI: `https://w3id.org/bmontology#SAPModules_PerformanceIndicators_CoControlling_EffortOfInHouseDevelopment`

This is a performance indicator of the SAP modules service, categorized into performance indicators as well as co: controlling. This indicator captures the number of man-year flown into the development of this module (incl. Submodules).

has super-classes Human resource indicator^c Performance Indicator^c SAP modules^c

Effort of in-house development (performance indicators, CS: customer service)^c

IRI: `https://w3id.org/bmontology#SAPModules_PerformanceIndicators_CSCustomerService_EffortOfInHouseDevelopment`

This is a performance indicator of the SAP modules service, categorized into performance indicators as well as CS: customer service. This indicator captures the number of man-year flown into the development of this module (incl. Submodules).

has super-classes Human resource indicator^c Performance Indicator^c SAP modules^c

Effort of in-house development (performance indicators, EC: corporate controlling)^c

IRI: `https://w3id.org/bmontology#SAPModules_PerformanceIndicators_ECCorporateControlling_EffortOfInHouseDevelopment`

This is a performance indicator of the SAP modules service, categorized into performance indicators as well as EC: corporate controlling. This indicator captures the number of man-year flown into the development of this module (incl. Submodules).

has super-classes Human resource indicator^c Performance Indicator^c SAP modules^c

Effort of in-house development (performance indicators, FI: finance)^c

IRI: `https://w3id.org/bmontology#SAPModules_PerformanceIndicators_FIFinance_EffortOfInHouseDevelopment`

This is a performance indicator of the SAP modules service, categorized into performance indicators as well as FI: finance. This indicator captures the number of man-year flown into the development of this module (incl. Submodules).

has super-classes Human resource indicator^c Performance Indicator^c SAP modules^c

Effort of in-house development (performance indicators, MM: materials management)^c

IRI: `https://w3id.org/bmontology#SAPModules_PerformanceIndicators_MMMaterialsManagement_EffortOfInHouseDevelopment`

This is a performance indicator of the SAP modules service, categorized into performance indicators as well as MM: materials management. This indicator captures the number of man-year flown into the development of this module (incl. Submodules).

has super-classes Human resource indicator^c Performance Indicator^c SAP modules^c

Effort of in-house development (performance indicators, PM: plant maintenance)^c

IRI: `https://w3id.org/bmontology#SAPModules_PerformanceIndicators_PMPlantMaintenance_EffortOfInHouseDevelopment`

This is a performance indicator of the SAP modules service, categorized into performance indicators as well as PM: plant maintenance. This indicator captures the number of man-year flown into the development of this module (incl. Submodules).

has super-classes Human resource indicator^c Performance Indicator^c SAP modules^c

Effort of in-house development (performance indicators, PP: production planning and control)^c

IRI: `https://w3id.org/bmontology#SAPModules_PerformanceIndicators_PPProductionPlanningAndControl_EffortOfInHouseDevelopment`

This is a performance indicator of the SAP modules service, categorized into performance indicators as well as PP: production planning and control. This indicator captures the number of man-year flown into the development of this module (incl. Submodules).

has super-classes Human resource indicator^c Performance Indicator^c SAP modules^c

Effort of in-house development (performance indicators, SD: sales and distribution)^c

IRI: `https://w3id.org/bmontology#SAPModules_PerformanceIndicators_SDSalesAndDistribution_EffortOfInHouseDevelopment`

This is a performance indicator of the SAP modules service, categorized into performance indicators as well as SD: sales and distribution. This indicator captures the number of man-year flown into the development of this module (incl. Submodules).

has super-classes Human resource indicator^c Performance Indicator^c SAP modules^c

Effort of internal administration (FTE) (performance indicators, BC: basic system)[c]

IRI: `https://w3id.org/bmontology#SAPModules_PerformanceIndicators_BCBasicSystem_EffortOfInternalAdministrationFTE`

This is a performance indicator of the SAP modules service, categorized into performance indicators as well as BC: basic system. This indicator captures the effort required for administrating the module by external FTE.

has super-classes Human resource indicator[c] Performance Indicator[c] SAP modules[c]

Effort of internal administration (FTE) (performance indicators, co: controlling)[c]

IRI: `https://w3id.org/bmontology#SAPModules_PerformanceIndicators_CoControlling_EffortOfInternalAdministrationFTE`

This is a performance indicator of the SAP modules service, categorized into performance indicators as well as co: controlling. This indicator captures the effort required for administrating the module by external FTE.

has super-classes Human resource indicator[c] Performance Indicator[c] SAP modules[c]

Effort of internal administration (FTE) (performance indicators, CS: customer service)[c]

IRI: `https://w3id.org/bmontology#SAPModules_PerformanceIndicators_CSCustomerService_EffortOfInternalAdministrationFTE`

This is a performance indicator of the SAP modules service, categorized into performance indicators as well as CS: customer service. This indicator captures the effort required for administrating the module by external FTE.

has super-classes Human resource indicator[c] Performance Indicator[c] SAP modules[c]

Effort of internal administration (FTE) (performance indicators, EC: corporate controlling)[c]

IRI: `https://w3id.org/bmontology#SAPModules_PerformanceIndicators_ECCorporateControlling_EffortOfInternalAdministrationFTE`

This is a performance indicator of the SAP modules service, categorized into performance indicators as well as EC: corporate controlling. This indicator captures the effort required for administrating the module by external FTE.

has super-classes Human resource indicator[c] Performance Indicator[c] SAP modules[c]

Effort of internal administration (FTE) (performance indicators, FI: finance)[c]

IRI: `https://w3id.org/bmontology#SAPModules_PerformanceIndicators_FIFinance_EffortOfInternalAdministrationFTE`

This is a performance indicator of the SAP modules service, categorized into performance indicators as well as FI: finance. This indicator captures the effort required for administrating the module by external FTE.

has super-classes Human resource indicator[c] Performance Indicator[c] SAP modules[c]

Effort of internal administration (FTE) (performance indicators, MM: materials management)[c]

IRI: `https://w3id.org/bmontology#SAPModules_PerformanceIndicators_MMMaterialsManagement_EffortOfInternalAdministrationFTE`

This is a performance indicator of the SAP modules service, categorized into performance indicators as well as MM: materials management. This indicator captures the effort required for administrating the module by external FTE.

has super-classes Human resource indicator[c] Performance Indicator[c] SAP modules[c]

Effort of internal administration (FTE) (performance indicators, PM: plant maintenance)^c

IRI: `https://w3id.org/bmontology#SAPModules_PerformanceIndicators_PMPlantMaintenance_EffortOfInternalAdministrationFTE`

This is a performance indicator of the SAP modules service, categorized into performance indicators as well as PM: plant maintenance. This indicator captures the effort required for administrating the module by external FTE.

has super-classes Human resource indicator^c Performance Indicator^c SAP modules^c

Effort of internal administration (FTE) (performance indicators, PP: production planning and control)^c

IRI: `https://w3id.org/bmontology#SAPModules_PerformanceIndicators_PPProductionPlanningAndControl_EffortOfInternalAdministrationFTE`

This is a performance indicator of the SAP modules service, categorized into performance indicators as well as PP: production planning and control. This indicator captures the effort required for administrating the module by external FTE.

has super-classes Human resource indicator^c Performance Indicator^c SAP modules^c

Effort of internal administration (FTE) (performance indicators, SD: sales and distribution)^c

IRI: `https://w3id.org/bmontology#SAPModules_PerformanceIndicators_SDSalesAndDistribution_EffortOfInternalAdministrationFTE`

This is a performance indicator of the SAP modules service, categorized into performance indicators as well as SD: sales and distribution. This indicator captures the effort required for administrating the module by external FTE.

has super-classes Human resource indicator^c Performance Indicator^c SAP modules^c

Effort of internal maintenance (FTE) (performance indicators, BC: basic system)^c

IRI: `https://w3id.org/bmontology#SAPModules_PerformanceIndicators_BCBasicSystem_EffortOfInternalMaintenanceFTE`

This is a performance indicator of the SAP modules service, categorized into performance indicators as well as BC: basic system. This indicator captures the effort required for maintaining the module by internal FTE.

has super-classes Human resource indicator^c Performance Indicator^c SAP modules^c

Effort of internal maintenance (FTE) (performance indicators, co: controlling)^c

IRI: `https://w3id.org/bmontology#SAPModules_PerformanceIndicators_CoControlling_EffortOfInternalMaintenanceFTE`

This is a performance indicator of the SAP modules service, categorized into performance indicators as well as co: controlling. This indicator captures the effort required for maintaining the module by internal FTE.

has super-classes Human resource indicator^c Performance Indicator^c SAP modules^c

Effort of internal maintenance (FTE) (performance indicators, CS: customer service)^c

IRI: `https://w3id.org/bmontology#SAPModules_PerformanceIndicators_CSCustomerService_EffortOfInternalMaintenanceFTE`

This is a performance indicator of the SAP modules service, categorized into performance indicators as well as CS: customer service. This indicator captures the effort required for maintaining the module by internal FTE.

has super-classes Human resource indicator^c Performance Indicator^c SAP modules^c

Effort of internal maintenance (FTE) (performance indicators, EC: corporate controlling)[c]

IRI: https://w3id.org/bmontology#SAPModules_PerformanceIndicators_ECCorporateControlling_EffortOfInternalMaintenanceFTE

This is a performance indicator of the SAP modules service, categorized into performance indicators as well as EC: corporate controlling. This indicator captures the effort required for maintaining the module by internal FTE.

has super-classes Human resource indicator[c] Performance Indicator[c] SAP modules[c]

Effort of internal maintenance (FTE) (performance indicators, FI: finance)[c]

IRI: https://w3id.org/bmontology#SAPModules_PerformanceIndicators_FIFinance_EffortOfInternalMaintenanceFTE

This is a performance indicator of the SAP modules service, categorized into performance indicators as well as FI: finance. This indicator captures the effort required for maintaining the module by internal FTE.

has super-classes Human resource indicator[c] Performance Indicator[c] SAP modules[c]

Effort of internal maintenance (FTE) (performance indicators, MM: materials management)[c]

IRI: https://w3id.org/bmontology#SAPModules_PerformanceIndicators_MMMaterialsManagement_EffortOfInternalMaintenanceFTE

This is a performance indicator of the SAP modules service, categorized into performance indicators as well as MM: materials management. This indicator captures the effort required for maintaining the module by internal FTE.

has super-classes Human resource indicator[c] Performance Indicator[c] SAP modules[c]

Effort of internal maintenance (FTE) (performance indicators, PM: plant maintenance)^c

IRI: `https://w3id.org/bmontology#SAPModules_PerformanceIndicators_PMPlantMaintenance_EffortOfInternalMaintenanceFTE`

This is a performance indicator of the SAP modules service, categorized into performance indicators as well as PM: plant maintenance. This indicator captures the effort required for maintaining the module by internal FTE.

has super-classes Human resource indicator^c Performance Indicator^c SAP modules^c

Effort of internal maintenance (FTE) (performance indicators, PP: production planning and control)^c

IRI: `https://w3id.org/bmontology#SAPModules_PerformanceIndicators_PPProductionPlanningAndControl_EffortOfInternalMaintenanceFTE`

This is a performance indicator of the SAP modules service, categorized into performance indicators as well as PP: production planning and control. This indicator captures the effort required for maintaining the module by internal FTE.

has super-classes Human resource indicator^c Performance Indicator^c SAP modules^c

Effort of internal maintenance (FTE) (performance indicators, SD: sales and distribution)^c

IRI: `https://w3id.org/bmontology#SAPModules_PerformanceIndicators_SDSalesAndDistribution_EffortOfInternalMaintenanceFTE`

This is a performance indicator of the SAP modules service, categorized into performance indicators as well as SD: sales and distribution. This indicator captures the effort required for maintaining the module by internal FTE.

has super-classes Human resource indicator^c Performance Indicator^c SAP modules^c

Electricity costs of computer centers (data center levy, basic data)^{c}

IRI: `https://w3id.org/bmontology#BasicData_DataCenterLevy_BasicData_ElectricityCostsOfComputerCenters`

This is a cost indicator of the basic data service, categorized into data center levy as well as basic data. This indicator captures the total electricity costs of the computer centers.

has super-classes Basic data^{c} Cost Indicator^{c} Human resource indicator^{c}

Ensured availability (performance indicators, additional information)^{c}

IRI: `https://w3id.org/bmontology#LAN_PerformanceIndicators_AdditionalInformation_EnsuredAvailability`

This is a performance indicator of the LAN service, categorized into performance indicators as well as additional information. This indicator captures whether availability has been ensured in the scope of SLAs.

has super-classes LAN^{c} Quality indicator^{c}

Ensured availability (performance indicators, cross-system)^{c}

IRI: `https://w3id.org/bmontology#VirtualServer_PerformanceIndicators_CrossSystem_EnsuredAvailability`

This is a performance indicator of the virtual server service, categorized into performance indicators as well as cross-system. This indicator captures whether availability has been ensured in the scope of SLAs.

has super-classes Quality indicator^{c} Virtual server^{c}

Ensured availability (performance indicators, quantity structure (large))^{c}

IRI: `https://w3id.org/bmontology#DedicatedServer_PerformanceIndicators_QuantityStructureLarge_EnsuredAvailability`

This is a performance indicator of the dedicated server service, categorized into performance indicators as well as quantity structure (large). This indicator captures whether availability has been ensured in the scope of SLAs.

has super-classes Dedicated server (large)^c Quality indicator^c

Ensured availability (performance indicators, quantity structure (medium))^c

IRI: `https://w3id.org/bmontology#DedicatedServer_PerformanceIndicators_QuantityStructureMedium_EnsuredAvailability`

This is a performance indicator of the dedicated server service, categorized into performance indicators as well as quantity structure (medium). This indicator captures whether availability has been ensured in the scope of SLAs.

has super-classes Dedicated server (medium)^c Quality indicator^c

Ensured availability (performance indicators, quantity structure (small))^c

IRI: `https://w3id.org/bmontology#DedicatedServer_PerformanceIndicators_QuantityStructureSmall_EnsuredAvailability`

This is a performance indicator of the dedicated server service, categorized into performance indicators as well as quantity structure (small). This indicator captures whether availability has been ensured in the scope of SLAs.

has super-classes Dedicated server (small)^c Quality indicator^c

Ensured availability (performance indicators, quantity structure and performance)^c

IRI: `https://w3id.org/bmontology#SAPBasis_PerformanceIndicators_QuantityStructureAndPerformance_EnsuredAvailability`

This is a performance indicator of the SAP basis service, categorized into performance indicators as well as quantity structure and performance. This indicator captures whether availability has been ensured in the scope of SLAs.

has super-classes Quality indicator^c SAP basis^c

Ensured availability (performance indicators, quantity structure and performance)^c

IRI: `https://w3id.org/bmontology#Storage_PerformanceIndicators_QuantityStructureAndPerformance_EnsuredAvailability`

This is a performance indicator of the storage service, categorized into performance indicators as well as quantity structure and performance. This indicator captures whether availability has been ensured in the scope of SLAs.

has super-classes Quality indicator^c Storage^c

Ensured availability (performance indicators, quantity structure and performance)^c

IRI: `https://w3id.org/bmontology#TerminalServer_PerformanceIndicators_QuantityStructureAndPerformance_EnsuredAvailability`

This is a performance indicator of the terminal server service, categorized into performance indicators as well as quantity structure and performance. This indicator captures whether availability has been ensured in the scope of SLAs.

has super-classes Quality indicator^c Terminal server^c

Ensured availability (performance indicators, quantity structure)^c

IRI: `https://w3id.org/bmontology#FileService_PerformanceIndicators_QuantityStructure_EnsuredAvailability`

This is a performance indicator of the file service service, categorized into performance indicators as well as quantity structure. This indicator captures whether availability has been ensured in the scope of SLAs.

has super-classes File Service^c Quality indicator^c

Ensured availability (performance indicators, quantity structure)^c

IRI: `https://w3id.org/bmontology#Mailbox_PerformanceIndicators_QuantityStructure_EnsuredAvailability`

This is a performance indicator of the mailbox service, categorized into performance indicators as well as quantity structure. This indicator captures whether availability has been ensured in the scope of SLAs.

has super-classes Mailbox^c Quality indicator^c

Ensured availability (performance indicators, service level of IMAC processes)^c

IRI: `https://w3id.org/bmontology#IMAC_PerformanceIndicators_ServiceLevelOfIMACProcesses_EnsuredAvailability`

This is a performance indicator of the IMAC service, categorized into performance indicators as well as service level of IMAC processes. This indicator captures whether availability has been ensured in the scope of SLAs.

has super-classes IMAC^c Quality indicator^c

Ensured availability (performance indicators, variant 1 (high availability))^c

IRI: `https://w3id.org/bmontology#Database_PerformanceIndicators_Variant1HighAvailability_EnsuredAvailability`

This is a performance indicator of the database service, categorized into performance indicators as well as variant 1 (high availability). This indicator captures whether availability has been ensured in the scope of SLAs.

has super-classes Database (Variant 1)^c Quality indicator^c

Ensured availability (performance indicators, variant 2)^c

IRI: `https://w3id.org/bmontology#Database_PerformanceIndicators_Variant2_EnsuredAvailability`

This is a performance indicator of the database service, categorized into performance indicators as well as variant 2. This indicator captures whether availability has been ensured in the scope of SLAs.

has super-classes Datenbanken (Variante 2)^c Quality indicator^c

Ensured storage volume in data backup system (performance indicators, quantity structure and performance)^c

IRI: `https://w3id.org/bmontology#Backup_PerformanceIndicators_QuantityStructureAndPerformance_EnsuredStorageVolumeInDataBackupSystem`

This is a performance indicator of the backup service, categorized into performance indicators as well as quantity structure and performance. This indicator captures the sum of ensured storage volume in the data backup system.

has super-classes Backup^c Quantity indicator^c

Equipment of a default workingplace computer (desktop/laptop) (performance indicators, quantity structure and performance)^c

IRI: `https://w3id.org/bmontology#Workplace_PerformanceIndicators_QuantityStructureAndPerformance_EquipmentOfADefaultWorkingplaceComputerDesktoplaptop`

This is a performance indicator of the workplace service, categorized into performance indicators as well as quantity structure and performance. This indicator captures the default equipment regarding hardware and software for a laptop/desktop.

has super-classes Hardware resource indicator^c Performance Indicator^c Workplace^c

Estimated distribution storage architecture DASD (performance indicators, quantity structure and performance)^c

IRI: `https://w3id.org/bmontology#Storage_PerformanceIndicators_QuantityStructureAndPerformance_EstimatedDistributionStorageArchitectureDASD`

This is a performance indicator of the storage service, categorized into performance indicators as well as quantity structure and performance. This indicator captures the distribution of the storage architecture DASD.

has super-classes Performance Indicator^c Storage^c

Estimated distribution storage architecture NAS (performance indicators, quantity structure and performance)^c

IRI: `https://w3id.org/bmontology#Storage_PerformanceIndicators_QuantityStructureAndPerformance_EstimatedDistributionStorageArchitectureNAS`

This is a performance indicator of the storage service, categorized into performance indicators as well as quantity structure and performance. This indicator captures the distribution of the storage architecture NAS.

has super-classes Performance Indicator^c Storage^c

Estimated distribution storage architecture SAN (performance indicators, quantity structure and performance)^c

IRI: `https://w3id.org/bmontology#Storage_PerformanceIndicators_QuantityStructureAndPerformance_EstimatedDistributionStorageArchitectureSAN`

This is a performance indicator of the storage service, categorized into performance indicators as well as quantity structure and performance. This indicator captures the distribution of the storage architecture SAN.

has super-classes Performance Indicator^c Storage^c

Existence of a process for for emergency management (IT and development, basic data)^c

IRI: `https://w3id.org/bmontology#BasicData_ITAndDevelopment_BasicData_ExistenceOfAProcessForForEmergencyManagement`

This is an indicator of the basic data service, categorized into IT and development as well as basic data. This indicator captures whether a process for emergency management is defined.

has super-classes Basic data^c

Existence of knowledge management in IT (IT and development, basic data)^c

IRI: `https://w3id.org/bmontology#BasicData_ITAndDevelopment_BasicData_ExistenceOfKnowledgeManagementInIT`

This is an indicator of the basic data service, categorized into IT and development as well as basic data. This indicator captures whether knowledge management is available in the IT.

has super-classes Basic data^c

External services (cost indicators, active components)^c

IRI: `https://w3id.org/bmontology#LAN_CostIndicators_ActiveComponents_ExternalServices`

This is a cost indicator of the LAN service, categorized into cost indicators as well as active components. This indicator captures the yearly used external services for the module.

has super-classes Cost Indicator^c Human resource indicator^c LAN^c

External services (cost indicators, blackberry)^c

IRI: `https://w3id.org/bmontology#MobileDevices_CostIndicators_Blackberry_ExternalServices`

This is a cost indicator of the mobile devices service, categorized into cost indicators as well as blackberry. This indicator captures the yearly used external services for the module.

has super-classes Cost Indicator^c Human resource indicator^c Mobile Devices (Blackberry)^c

External services (cost indicators, classical telephony)^c

IRI: `https://w3id.org/bmontology#Telephony_CostIndicators_ClassicalTelephony_ExternalServices`

This is a cost indicator of the telephony service, categorized into cost indicators as well as classical telephony. This indicator captures the yearly used external services for the module.

has super-classes Cost Indicator^c Human resource indicator^c Telephony^c

External services (cost indicators, conferencing (incl. video conferencing tools))^c

IRI: `https://w3id.org/bmontology#Collaboration_CostIndicators_ConferencingInclVideoConferencingTools_ExternalServices`

This is a cost indicator of the collaboration service, categorized into cost indicators as well as conferencing (incl. video conferencing tools). This indicator captures the yearly used external services for the module.

has super-classes Collaboration^c Cost Indicator^c Human resource indicator^c

External services (cost indicators, cost indicator (medium))^c

IRI: `https://w3id.org/bmontology#DedicatedServer_CostIndicators_CostIndicatorMedium_ExternalServices`

This is a cost indicator of the dedicated server service, categorized into cost indicators as well as cost indicator (medium). This indicator captures the yearly used external services for the dedicated server module.

has super-classes Cost Indicator^c Dedicated server (medium)^c Human resource indicator^c

External services (cost indicators, cost indicators (large))^c

IRI: `https://w3id.org/bmontology#DedicatedServer_CostIndicators_CostIndicatorsLarge_ExternalServices`

This is a cost indicator of the dedicated server service, categorized into cost indicators as well as cost indicators (large). This indicator captures the yearly used external services for the dedicated server module.

has super-classes Cost Indicator^c Dedicated server (large)^c Human resource indicator^c

External services (cost indicators, cost indicators (small))^c

IRI: https://w3id.org/bmontology#DedicatedServer_CostIndicators_CostIndicatorsSmall_ExternalServices

This is a cost indicator of the dedicated server service, categorized into cost indicators as well as cost indicators (small). This indicator captures the yearly used external services for the dedicated server module.

has super-classes Cost Indicator^c Dedicated server (small)^c Human resource indicator^c

External services (cost indicators, cost indicators)^c

IRI: https://w3id.org/bmontology#Backup_CostIndicators_CostIndicators_ExternalServices

This is a cost indicator of the backup service, categorized into cost indicators as well as cost indicators. This indicator captures the yearly used external services for the backup module.

has super-classes Backup^c Cost Indicator^c Human resource indicator^c

External services (cost indicators, desktop)^c

IRI: https://w3id.org/bmontology#Workplace_CostIndicators_Desktop_ExternalServices

This is a cost indicator of the workplace service, categorized into cost indicators as well as desktop. This indicator captures the yearly used external services for the module.

has super-classes Cost Indicator^c Human resource indicator^c Workplace^c

External services (cost indicators, high)^c

IRI: https://w3id.org/bmontology#Storage_CostIndicators_High_ExternalServices

This is a cost indicator of the storage service, categorized into cost indicators as well as high. This indicator captures the yearly used external services for the storage module.

has super-classes Cost Indicator^c Human resource indicator^c Storage (High)^c

External services (cost indicators, iPhone)^c

IRI: `https://w3id.org/bmontology#MobileDevices_CostIndicators_IPhone_ExternalServices`

This is a cost indicator of the mobile devices service, categorized into cost indicators as well as iPhone. This indicator captures the yearly used external services for the module.

has super-classes Cost Indicator^c Human resource indicator^c Mobile Devices (iPhone)^c

External services (cost indicators, laptop)^c

IRI: `https://w3id.org/bmontology#Workplace_CostIndicators_Laptop_ExternalServices`

This is a cost indicator of the workplace service, categorized into cost indicators as well as laptop. This indicator captures the yearly used external services for the module.

has super-classes Cost Indicator^c Human resource indicator^c Workplace^c

External services (cost indicators, low)^c

IRI: `https://w3id.org/bmontology#Storage_CostIndicators_Low_ExternalServices`

This is a cost indicator of the storage service, categorized into cost indicators as well as low. This indicator captures the yearly used external services for the storage module.

has super-classes Cost Indicator^c Human resource indicator^c Storage (Low)^c

External services (cost indicators, lync and other applications (without telephony))^c

IRI: `https://w3id.org/bmontology#Collaboration_CostIndicators_LyncAndOtherApplicationsWithoutTelephony_ExternalServices`

This is a cost indicator of the collaboration service, categorized into cost indicators as well as lync and other applications (without telephony). This indicator captures the yearly used external services for the module.

has super-classes Collaboration^c Cost Indicator^c Human resource indicator^c

External services (cost indicators, medium)^c

IRI: `https://w3id.org/bmontology#Storage_CostIndicators_Medium_ExternalServices`

This is a cost indicator of the storage service, categorized into cost indicators as well as medium. This indicator captures the yearly used external services for the storage module.

has super-classes Cost Indicator^c Human resource indicator^c Storage (Medium)^c

External services (cost indicators, monitoring and administration environment)^c

IRI: `https://w3id.org/bmontology#LAN_CostIndicators_MonitoringAndAdministrationEnvironment_ExternalServices`

This is a cost indicator of the LAN service, categorized into cost indicators as well as monitoring and administration environment. This indicator captures the yearly used external services for the module.

has super-classes Cost Indicator^c Human resource indicator^c LAN^c

External services (cost indicators, others)^c

IRI: `https://w3id.org/bmontology#MobileDevices_CostIndicators_Others_ExternalServices`

This is a cost indicator of the mobile devices service, categorized into cost indicators as well as others. This indicator captures the yearly used external services for the module.

has super-classes Cost Indicator^c Human resource indicator^c Mobile Devices (Others)^c

External services (cost indicators, security environment)[c]

IRI: `https://w3id.org/bmontology#LAN_CostIndicators_SecurityEnvironment_ExternalServices`

This is a cost indicator of the LAN service, categorized into cost indicators as well as security environment. This indicator captures the yearly used external services for the module.

has super-classes Cost Indicator[c] Human resource indicator[c] LAN[c]

External services (cost indicators, sharePoint and other applications)[c]

IRI: `https://w3id.org/bmontology#Collaboration_CostIndicators_SharePointAndOtherApplications_ExternalServices`

This is a cost indicator of the collaboration service, categorized into cost indicators as well as sharePoint and other applications. This indicator captures the yearly used external services for the module.

has super-classes Collaboration[c] Cost Indicator[c] Human resource indicator[c]

External services (cost indicators, SSL VPN access)[c]

IRI: `https://w3id.org/bmontology#RemoteAccessService_CostIndicators_SSLVPNAccess_ExternalServices`

This is a cost indicator of the remote access service service, categorized into cost indicators as well as SSL VPN access. This indicator captures the yearly used external services for the module.

has super-classes Cost Indicator[c] Human resource indicator[c] Remote access service[c]

External services (cost indicators, standard mass connection)[c]

IRI: `https://w3id.org/bmontology#RemoteAccessService_CostIndicators_StandardMassConnection_ExternalServices`

This is a cost indicator of the remote access service service, categorized into cost indicators as well as standard mass connection. This indicator captures the yearly used external services for the module.

has super-classes Cost Indicator^c Human resource indicator^c Remote access service^c

External services (cost indicators, total costs of guest systems)^c

IRI: `https://w3id.org/bmontology#VirtualServer_CostIndicators_TotalCostsOfGuestSystems_ExternalServices`

This is a cost indicator of the virtual server service, categorized into cost indicators as well as total costs of guest systems. This indicator captures the yearly used external services for host systems.

has super-classes Cost Indicator^c Human resource indicator^c Virtual server^c

External services (cost indicators, total costs of host systems)^c

IRI: `https://w3id.org/bmontology#VirtualServer_CostIndicators_TotalCostsOfHostSystems_ExternalServices`

This is a cost indicator of the virtual server service, categorized into cost indicators as well as total costs of host systems. This indicator captures the yearly used external services for host systems.

has super-classes Cost Indicator^c Human resource indicator^c Virtual server^c

External services (cost indicators, total costs)^c

IRI: `https://w3id.org/bmontology#FileService_CostIndicators_TotalCosts_ExternalServices`

This is a cost indicator of the file service service, categorized into cost indicators as well as total costs. This indicator captures the yearly used external services for the module.

has super-classes Cost Indicator^c File Service^c Human resource indicator^c

External services (cost indicators, total costs)^c

IRI: `https://w3id.org/bmontology#Mailbox_CostIndicators_TotalCosts_ExternalServices`

This is a cost indicator of the mailbox service, categorized into cost indicators as well as total costs. This indicator captures the yearly used external services for the module.

has super-classes Cost Indicator^c Human resource indicator^c Mailbox^c

External services (cost indicators, total costs)^c

IRI: `https://w3id.org/bmontology#SAPBasis_CostIndicators_TotalCosts_ExternalServices`

This is a cost indicator of the SAP basis service, categorized into cost indicators as well as total costs. This indicator captures the yearly used external services for the module.

has super-classes Cost Indicator^c Human resource indicator^c SAP basis^c

External services (cost indicators, total costs)^c

IRI: `https://w3id.org/bmontology#Servicedesk_CostIndicators_TotalCosts_ExternalServices`

This is a cost indicator of the servicedesk service, categorized into cost indicators as well as total costs. This indicator captures the yearly used external services for the module.

has super-classes Cost Indicator^c Human resource indicator^c Servicedesk^c

External services (cost indicators, total costs)^c

IRI: `https://w3id.org/bmontology#TerminalServer_CostIndicators_TotalCosts_ExternalServices`

This is a cost indicator of the terminal server service, categorized into cost indicators as well as total costs. This indicator captures the yearly used external services for the terminal server module.

has super-classes Cost Indicator^c Human resource indicator^c Terminal server^c

External services (cost indicators, variant 1 (high availability))^c

IRI: `https://w3id.org/bmontology#Database_CostIndicators_Variant1HighAvailability_ExternalServices`

This is a cost indicator of the database service, categorized into cost indicators as well as variant 1 (high availability). This indicator captures the yearly used external services for the module.

has super-classes Cost Indicator^c Database (Variant 1)^c Human resource indicator^c

External services (cost indicators, variant 2)^c

IRI: `https://w3id.org/bmontology#Database_CostIndicators_Variant2_ExternalServices`

This is a cost indicator of the database service, categorized into cost indicators as well as variant 2. This indicator captures the yearly used external services for the module.

has super-classes Cost Indicator^c Datenbanken (Variante 2)^c Human resource indicator^c

External services (cost indicators, voIP)^c

IRI: `https://w3id.org/bmontology#Telephony_CostIndicators_VoIP_ExternalServices`

This is a cost indicator of the telephony service, categorized into cost indicators as well as voIP. This indicator captures the yearly used external services for the module.

has super-classes Cost Indicator^c Human resource indicator^c Telephony^c

External services (cost indicators, VPN client)^c

IRI: `https://w3id.org/bmontology#RemoteAccessService_CostIndicators_VPNClient_ExternalServices`

This is a cost indicator of the remote access service service, categorized into cost indicators as well as VPN client. This indicator captures the yearly used external services for the module.

has super-classes Cost Indicator^c Human resource indicator^c Remote access service^c

External services (cost indicators, VPN tunel to business partners)^c

IRI: `https://w3id.org/bmontology#RemoteAccessService_CostIndicators_VPNTunelToBusinessPartners_ExternalServices`

This is a cost indicator of the remote access service service, categorized into cost indicators as well as VPN tunel to business partners. This indicator captures the yearly used external services for the module.

has super-classes Cost Indicator^c Human resource indicator^c Remote access service^c

External services (cost indicators, windows phone)^c

IRI: `https://w3id.org/bmontology#MobileDevices_CostIndicators_WindowsPhone_ExternalServices`

This is a cost indicator of the mobile devices service, categorized into cost indicators as well as windows phone. This indicator captures the yearly used external services for the module.

has super-classes Cost Indicator^c Human resource indicator^c Mobile Devices (Windows Phone)^c

External services (cost indicators, WLAN)^c

IRI: `https://w3id.org/bmontology#LAN_CostIndicators_WLAN_ExternalServices`

This is a cost indicator of the LAN service, categorized into cost indicators as well as WLAN. This indicator captures the yearly used external services for the module.

has super-classes Cost Indicator^c Human resource indicator^c LAN^c

Factor of redundancy (performance indicators, host systems)^c

IRI: `https://w3id.org/bmontology#VirtualServer_PerformanceIndicators_HostSystems_FactorOfRedundancy`

This is a performance indicator of the virtual server service, categorized into performance indicators as well as host systems. This indicator captures how many percentage of physical systems may fail without affecting the performance (i.e., performance is still at 100%).

has super-classes Performance Indicator^c Virtual server^c

File Service^c

IRI: `https://w3id.org/bmontology#FileServiceIndicator`

Classifies file service indicators

has super-classes Service template dimension for indicator classification^c

has sub-classes Backup strategy (performance indicators, quantity structure)^c , Depth authorization concept (performance indicators, quantity structure)^c , Ensured availability (performance indicators, quantity structure)^c , External services (cost indicators, total costs)^c , File service user (performance indicators, quantity structure)^c , Hardware (cost indicators, total costs)^c , Hardware maintenance (cost indicators, total costs)^c , Number of external personnel (FTE) (performance indicators, quantity structure)^c , Number of internal personnel (FTE) (performance indicators, quantity structure)^c , Offetting backup (cost indicators, total costs)^c , Offsetting Server (cost indicators, total costs)^c , Offsetting Storage (cost indicators, total costs)^c , Others (cost indicators, total costs)^c , Personnel (cost indicators, total costs)^c , Software (cost indicators, total costs)^c , Software maintenance (cost indicators, total costs)^c , Total capacity (net) (performance indicators, quantity structure)^c , Type of sourcing (performance indicators, quantity structure)^c , Used capacity (performance indicators, quantity structure)^c

is disjoint with Backup^c , Basic data^c , Collaboration^c , Database^c , Dedicated server^c , IMAC^c , LAN^c , Mailbox^c , Mobile devices^c , Remote access service^c , SAP basis^c , SAP modules^c , Servicedesk^c , Storage^c , Telephony^c , Terminal server^c , Virtual server^c , WAN^c , Workplace^c

File service user (performance indicators, quantity structure)^c

IRI: `https://w3id.org/bmontology#FileService_PerformanceIndicators_QuantityStructure_FileServiceUser`

This is a performance indicator of the file service service, categorized into performance indicators as well as quantity structure. This indicator captures all users using the file service.

has super-classes File Service^c Quantity indicator^c

First level support (performance indicators, included)^c

IRI: `https://w3id.org/bmontology#Servicedesk_PerformanceIndicators_Included_FirstLevelSupport`

This is a performance indicator of the servicedesk service, categorized into performance indicators as well as included. This indicator captures whether the service desk includes a first level support.

has super-classes Performance Indicator^c Servicedesk^c

Frequency Add additional HW components (performance indicators, performance indicators)^c

IRI: `https://w3id.org/bmontology#IMAC_PerformanceIndicators_PerformanceIndicators_FrequencyAddAdditionalHWComponents`

This is a performance indicator of the IMAC service, categorized into performance indicators as well as performance indicators. This indicator captures how often additional hardware components are added.

has super-classes IMAC^c Performance Indicator^c

Frequency Add SW automatically (performance indicators, performance indicators)^c

IRI: `https://w3id.org/bmontology#IMAC_PerformanceIndicators_PerformanceIndicators_FrequencyAddSWAutomatically`

This is a performance indicator of the IMAC service, categorized into performance indicators as well as performance indicators. This indicator captures how often additional software components are added automatically.

has super-classes IMAC^c Performance Indicator^c

Frequency Add SW manually (performance indicators, performance indicators)^c

IRI: `https://w3id.org/bmontology#IMAC_PerformanceIndicators_PerformanceIndicators_FrequencyAddSWManually`

This is a performance indicator of the IMAC service, categorized into performance indicators as well as performance indicators. This indicator captures how often additional software components are added manually.

has super-classes IMAC^c Performance Indicator^c

Frequency of a desktop installation (performance indicators, performance indicators)^c

IRI: `https://w3id.org/bmontology#IMAC_PerformanceIndicators_PerformanceIndicators_FrequencyOfADesktopInstallation`

This is a performance indicator of the IMAC service, categorized into performance indicators as well as performance indicators. This indicator captures the frequency of a installation.

has super-classes IMAC^c Performance Indicator^c

Frequency of a laptop installation (performance indicators, performance indicators)^c

IRI: `https://w3id.org/bmontology#IMAC_PerformanceIndicators_PerformanceIndicators_FrequencyOfALaptopInstallation`

This is a performance indicator of the IMAC service, categorized into performance indicators as well as performance indicators. This indicator captures the frequency of a installation.

has super-classes IMAC^c Performance Indicator^c

Frequency of a thin client installation (performance indicators, performance indicators)^c

IRI: `https://w3id.org/bmontology#IMAC_PerformanceIndicators_PerformanceIndicators_FrequencyOfAThinClientInstallation`

This is a performance indicator of the IMAC service, categorized into performance indicators as well as performance indicators. This indicator captures the frequency of a installation.

has super-classes IMAC^c Performance Indicator^c

Frequency of Change/Delete (performance indicators, performance indicators)^c

IRI: `https://w3id.org/bmontology#IMAC_PerformanceIndicators_PerformanceIndicators_FrequencyOfChangeDelete`

This is a performance indicator of the IMAC service, categorized into performance indicators as well as performance indicators. This indicator captures how often Changes/Deletes are performed.

has super-classes IMAC^c Performance Indicator^c

Frequency of changes (years) (performance indicators, general indicators)^c

IRI: `https://w3id.org/bmontology#MobileDevices_PerformanceIndicators_GeneralIndicators_FrequencyOfChangesYears`

This is a performance indicator of the mobile devices service, categorized into performance indicators as well as general indicators. This indicator captures the frequency of changes in years.

has super-classes Mobile devices^c Performance Indicator^c

Frequency of logical move (performance indicators, performance indicators)^c

IRI: `https://w3id.org/bmontology#IMAC_PerformanceIndicators_PerformanceIndicators_FrequencyOfLogicalMove`

This is a performance indicator of the IMAC service, categorized into performance indicators as well as performance indicators. This indicator captures the frequency of a logical move.

has super-classes IMAC^c Performance Indicator^c

Frequency of password changes (weeks) (performance indicators, security indicators (blackberry))^c

IRI: `https://w3id.org/bmontology#MobileDevices_PerformanceIndicators_SecurityIndicatorsBlackberry_FrequencyOfPasswordChangesWeeks`

This is a performance indicator of the mobile devices service, categorized into performance indicators as well as security indicators (blackberry). This indicator captures the required frequency of password changes in order for users to continue accesing a mobile service.

has super-classes Mobile Devices (Blackberry)^c Performance Indicator^c

Frequency of password changes (weeks) (performance indicators, security indicators (iPhone))^c

IRI: `https://w3id.org/bmontology#MobileDevices_PerformanceIndicators_SecurityIndicatorsIPhone_FrequencyOfPasswordChangesWeeks`

This is a performance indicator of the mobile devices service, categorized into performance indicators as well as security indicators (iPhone). This indicator captures the required frequency of password changes in order for users to continue accesing a mobile service.

has super-classes Mobile Devices (iPhone)^c Performance Indicator^c

Frequency of password changes (weeks) (performance indicators, security indicators (other))^c

IRI: https://w3id.org/bmontology#MobileDevices_PerformanceIndicators_SecurityIndicatorsOther_FrequencyOfPasswordChangesWeeks

This is a performance indicator of the mobile devices service, categorized into performance indicators as well as security indicators (other). This indicator captures the required frequency of password changes in order for users to continue accesing a mobile service.

has super-classes Mobile Devices (Others)^c Performance Indicator^c

Frequency of password changes (weeks) (performance indicators, security indicators (windows phone))^c

IRI: https://w3id.org/bmontology#MobileDevices_PerformanceIndicators_SecurityIndicatorsWindowsPhone_FrequencyOfPasswordChangesWeeks

This is a performance indicator of the mobile devices service, categorized into performance indicators as well as security indicators (windows phone). This indicator captures the required frequency of password changes in order for users to continue accesing a mobile service.

has super-classes Mobile Devices (Windows Phone)^c Performance Indicator^c

Frequency of physical move (performance indicators, performance indicators)^c

IRI: https://w3id.org/bmontology#IMAC_PerformanceIndicators_PerformanceIndicators_FrequencyOfPhysicalMove

This is a performance indicator of the IMAC service, categorized into performance indicators as well as performance indicators. This indicator captures the frequency of a physical move.

has super-classes IMAC^c Performance Indicator^c

Further submodules (performance indicators, BC: basic system)[c]

IRI: `https://w3id.org/bmontology#SAPModules_PerformanceIndicators_BCBasicSystem_FurtherSubmodules`

This is a performance indicator of the SAP modules service, categorized into performance indicators as well as BC: basic system. This indicator captures used submodules.

has super-classes Performance Indicator[c] SAP modules[c]

Further submodules (performance indicators, co: controlling)[c]

IRI: `https://w3id.org/bmontology#SAPModules_PerformanceIndicators_CoControlling_FurtherSubmodules`

This is a performance indicator of the SAP modules service, categorized into performance indicators as well as co: controlling. This indicator captures used submodules.

has super-classes Performance Indicator[c] SAP modules[c]

Further submodules (performance indicators, CS: customer service)[c]

IRI: `https://w3id.org/bmontology#SAPModules_PerformanceIndicators_CSCustomerService_FurtherSubmodules`

This is a performance indicator of the SAP modules service, categorized into performance indicators as well as CS: customer service. This indicator captures used submodules.

has super-classes Performance Indicator[c] SAP modules[c]

Further submodules (performance indicators, EC: corporate controlling)[c]

IRI: `https://w3id.org/bmontology#SAPModules_PerformanceIndicators_ECCorporateControlling_FurtherSubmodules`

This is a performance indicator of the SAP modules service, categorized into performance indicators as well as EC: corporate controlling. This indicator captures used submodules.

has super-classes Performance Indicator^c SAP modules^c

Further submodules (performance indicators, FI: finance)^c

IRI: `https://w3id.org/bmontology#SAPModules_PerformanceIndicators_FIFinance_FurtherSubmodules`

This is a performance indicator of the SAP modules service, categorized into performance indicators as well as FI: finance. This indicator captures used submodules.

has super-classes Performance Indicator^c SAP modules^c

Further submodules (performance indicators, MM: materials management)^c

IRI: `https://w3id.org/bmontology#SAPModules_PerformanceIndicators_MMMaterialsManagement_FurtherSubmodules`

This is a performance indicator of the SAP modules service, categorized into performance indicators as well as MM: materials management. This indicator captures used submodules.

has super-classes Performance Indicator^c SAP modules^c

Further submodules (performance indicators, PM: plant maintenance)^c

IRI: `https://w3id.org/bmontology#SAPModules_PerformanceIndicators_PMPlantMaintenance_FurtherSubmodules`

This is a performance indicator of the SAP modules service, categorized into performance indicators as well as PM: plant maintenance. This indicator captures used submodules.

has super-classes Performance Indicator^c SAP modules^c

Further submodules (performance indicators, PP: production planning and control)^c

IRI: `https://w3id.org/bmontology#SAPModules_PerformanceIndicators_PPProductionPlanningAndControl_FurtherSubmodules`

This is a performance indicator of the SAP modules service, categorized into performance indicators as well as PP: production planning and control. This indicator captures used submodules.

has super-classes Performance Indicator^c SAP modules^c

Further submodules (performance indicators, SD: sales and distribution)^c

IRI: `https://w3id.org/bmontology#SAPModules_PerformanceIndicators_SDSalesAndDistribution_FurtherSubmodules`

This is a performance indicator of the SAP modules service, categorized into performance indicators as well as SD: sales and distribution. This indicator captures used submodules.

has super-classes Performance Indicator^c SAP modules^c

Further usage scenarios (performance indicators, quantity structure and performance (blackberry))^c

IRI: `https://w3id.org/bmontology#MobileDevices_PerformanceIndicators_QuantityStructureAndPerformanceBlackberry_FurtherUsageScenarios`

This is a performance indicator of the mobile devices service, categorized into performance indicators as well as quantity structure and performance (blackberry). This indicator captures whether further usage scenarios are offered on the platform.

has super-classes Mobile Devices (Blackberry)^c Performance Indicator^c

Further usage scenarios (performance indicators, quantity structure and performance (iPhone))^c

IRI: `https://w3id.org/bmontology#MobileDevices_PerformanceIndicators_QuantityStructureAndPerformanceIPhone_FurtherUsageScenarios`

This is a performance indicator of the mobile devices service, categorized into performance indicators as well as quantity structure and performance (iPhone). This indicator captures whether further usage scenarios are offered on the platform.

has super-classes Mobile Devices (iPhone)^c Performance Indicator^c

Further usage scenarios (performance indicators, quantity structure and performance (other))^c

IRI: `https://w3id.org/bmontology#MobileDevices_PerformanceIndicators_QuantityStructureAndPerformanceOther_FurtherUsageScenarios`

This is a performance indicator of the mobile devices service, categorized into performance indicators as well as quantity structure and performance (other). This indicator captures whether further usage scenarios are offered on the platform.

has super-classes Mobile Devices (Others)^c Performance Indicator^c

Further usage scenarios (performance indicators, quantity structure and performance (windows phone))^c

IRI: `https://w3id.org/bmontology#MobileDevices_PerformanceIndicators_QuantityStructureAndPerformanceWindowsPhone_FurtherUsageScenarios`

This is a performance indicator of the mobile devices service, categorized into performance indicators as well as quantity structure and performance (windows phone). This indicator captures whether further usage scenarios are offered on the platform.

has super-classes Mobile Devices (Windows Phone)^c Performance Indicator^c

Governance (performance indicators, general)^c

IRI: `https://w3id.org/bmontology#SAPModules_PerformanceIndicators_General_Governance`

This is a performance indicator of the SAP modules service, categorized into performance indicators as well as general. This indicator captures the role of the IT from an international perspective.

has super-classes Performance Indicator^c SAP modules^c

Guaranteed performance (performance indicators, quantity structure and performance)^c

IRI: `https://w3id.org/bmontology#Backup_PerformanceIndicators_QuantityStructureAndPerformance_GuaranteedPerformance`

This is a performance indicator of the backup service, categorized into performance indicators as well as quantity structure and performance. This indicator captures whether a guaranteed performance has been defined.

has super-classes Backup^c Quality indicator^c

Hardware (cost indicators, active components)^c

IRI: `https://w3id.org/bmontology#LAN_CostIndicators_ActiveComponents_Hardware`

This is a cost indicator of the LAN service, categorized into cost indicators as well as active components. This indicator captures the hardware costs for active components, the security as well as the monitoring and management environments.

has super-classes Cost Indicator^c Hardware resource indicator^c LAN^c

Hardware (cost indicators, blackberry)^c

IRI: `https://w3id.org/bmontology#MobileDevices_CostIndicators_Blackberry_Hardware`

This is a cost indicator of the mobile devices service, categorized into cost indicators as well as blackberry. This indicator captures the hardware costs regarding the mobile devices module.

has super-classes Cost Indicator^c Hardware resource indicator^c Mobile Devices (Blackberry)^c

Hardware (cost indicators, classical telephony)^c

IRI: `https://w3id.org/bmontology#Telephony_CostIndicators_ClassicalTelephony_Hardware`

This is a cost indicator of the telephony service, categorized into cost indicators as well as classical telephony. This indicator captures the hardware costs regarding the telephony module.

has super-classes Cost Indicator^c Hardware resource indicator^c Telephony^c

Hardware (cost indicators, conferencing (incl. video conferencing tools))^c

IRI: `https://w3id.org/bmontology#Collaboration_CostIndicators_ConferencingInclVideoConferencingTools_Hardware`

This is a cost indicator of the collaboration service, categorized into cost indicators as well as conferencing (incl. video conferencing tools). This indicator captures the hardware costs regarding the collaboration module.

has super-classes Collaboration^c Cost Indicator^c Hardware resource indicator^c

Hardware (cost indicators, cost indicator (medium))^c

IRI: `https://w3id.org/bmontology#DedicatedServer_CostIndicators_CostIndicatorMedium_Hardware`

This is a cost indicator of the dedicated server service, categorized into cost indicators as well as cost indicator (medium). This indicator captures the costs of depreciation and leasing including storage costs for the operating system (as long as they are not part of the storage module).

has super-classes Cost Indicator^c Dedicated server (medium)^c Hardware resource indicator^c

Hardware (cost indicators, cost indicators (large))^c

IRI: `https://w3id.org/bmontology#DedicatedServer_CostIndicators_CostIndicatorsLarge_Hardware`

This is a cost indicator of the dedicated server service, categorized into cost indicators as well as cost indicators (large). This indicator captures the costs for hardware involved in the dedicated server module.

has super-classes Cost Indicator^c Dedicated server (large)^c Hardware resource indicator^c

Hardware (cost indicators, cost indicators (small))^c

IRI: `https://w3id.org/bmontology#DedicatedServer_CostIndicators_CostIndicatorsSmall_Hardware`

This is a cost indicator of the dedicated server service, categorized into cost indicators as well as cost indicators (small). This indicator captures the costs for hardware involved in the dedicated server module.

has super-classes Cost Indicator^c Dedicated server (small)^c Hardware resource indicator^c

Hardware (cost indicators, cost indicators)^c

IRI: `https://w3id.org/bmontology#Backup_CostIndicators_CostIndicators_Hardware`

This is a cost indicator of the backup service, categorized into cost indicators as well as cost indicators. This indicator captures the costs for hardware involved in the backup module.

has super-classes Backup^c Cost Indicator^c Hardware resource indicator^c

Hardware (cost indicators, desktop)^c

IRI: `https://w3id.org/bmontology#Workplace_CostIndicators_Desktop_Hardware`

This is a cost indicator of the workplace service, categorized into cost indicators as well as desktop. This indicator captures the costs of desktop hardware to be compared.

has super-classes Cost Indicator^c Hardware resource indicator^c Workplace^c

Hardware (cost indicators, high)^c

IRI: `https://w3id.org/bmontology#Storage_CostIndicators_High_Hardware`

This is a cost indicator of the storage service, categorized into cost indicators as well as high. This indicator captures the costs for hardware involved in the storage module.

has super-classes Cost Indicator^c Hardware resource indicator^c Storage (High)^c

Hardware (cost indicators, iPhone)^c

IRI: `https://w3id.org/bmontology#MobileDevices_CostIndicators_IPhone_Hardware`

This is a cost indicator of the mobile devices service, categorized into cost indicators as well as iPhone. This indicator captures the hardware costs regarding the mobile devices module.

has super-classes Cost Indicator^c Hardware resource indicator^c Mobile Devices (iPhone)^c

Hardware (cost indicators, laptop)^c

IRI: `https://w3id.org/bmontology#Workplace_CostIndicators_Laptop_Hardware`

This is a cost indicator of the workplace service, categorized into cost indicators as well as laptop. This indicator captures the costs of laptop hardware to be compared.

has super-classes Cost Indicator^c Hardware resource indicator^c Workplace^c

Hardware (cost indicators, low)^c

IRI: `https://w3id.org/bmontology#Storage_CostIndicators_Low_Hardware`

This is a cost indicator of the storage service, categorized into cost indicators as well as low. This indicator captures the costs for hardware involved in the storage module.

has super-classes Cost Indicator^c Hardware resource indicator^c Storage (Low)^c

Hardware (cost indicators, lync and other applications (without telephony))^c

IRI: `https://w3id.org/bmontology#Collaboration_CostIndicators_LyncAndOtherApplicationsWithoutTelephony_Hardware`

This is a cost indicator of the collaboration service, categorized into cost indicators as well as lync and other applications (without telephony). This indicator captures the hardware costs regarding the collaboration module.

has super-classes Collaboration^c Cost Indicator^c Hardware resource indicator^c

Hardware (cost indicators, medium)^c

IRI: `https://w3id.org/bmontology#Storage_CostIndicators_Medium_Hardware`

This is a cost indicator of the storage service, categorized into cost indicators as well as medium. This indicator captures the costs for hardware involved in the storage module.

has super-classes Cost Indicator^c Hardware resource indicator^c Storage (Medium)^c

Hardware (cost indicators, monitoring and administration environment)^c

IRI: `https://w3id.org/bmontology#LAN_CostIndicators_MonitoringAndAdministrationEnvironment_Hardware`

This is a cost indicator of the LAN service, categorized into cost indicators as well as monitoring and administration environment. This indicator captures the hardware costs for active components, the security, monitoring and management environments as well as WLAN.

has super-classes Cost Indicator^c Hardware resource indicator^c LAN^c

Hardware (cost indicators, others)^c

IRI: `https://w3id.org/bmontology#MobileDevices_CostIndicators_Others_Hardware`

This is a cost indicator of the mobile devices service, categorized into cost indicators as well as others. This indicator captures the hardware costs regarding the mobile devices module.

has super-classes Cost Indicator^c Hardware resource indicator^c Mobile Devices (Others)^c

Hardware (cost indicators, security environment)^c

IRI: `https://w3id.org/bmontology#LAN_CostIndicators_SecurityEnvironment_Hardware`

This is a cost indicator of the LAN service, categorized into cost indicators as well as security environment. This indicator captures the hardware costs for active components, the security, monitoring and management environments as well as WLAN.

has super-classes Cost Indicator^c Hardware resource indicator^c LAN^c

Hardware (cost indicators, sharePoint and other applications)^c

IRI: `https://w3id.org/bmontology#Collaboration_CostIndicators_SharePointAndOtherApplications_Hardware`

This is a cost indicator of the collaboration service, categorized into cost indicators as well as sharePoint and other applications. This indicator captures the hardware costs regarding the collaboration module.

has super-classes Collaboration^c Cost Indicator^c Hardware resource indicator^c

Hardware (cost indicators, total costs of host systems)^c

IRI: `https://w3id.org/bmontology#VirtualServer_CostIndicators_TotalCostsOfHostSystems_Hardware`

This is a cost indicator of the virtual server service, categorized into cost indicators as well as total costs of host systems. This indicator captures the costs of depreciation and leasing for hardware involved in the virtual server module.

has super-classes Cost Indicator^c Hardware resource indicator^c Virtual server^c

Hardware (cost indicators, total costs)^c

IRI: https://w3id.org/bmontology#FileService_CostIndicators_TotalCosts_Hardware

This is a cost indicator of the file service service, categorized into cost indicators as well as total costs. This indicator captures the hardware costs regarding the file service module.

has super-classes Cost Indicator^c File Service^c Hardware resource indicator^c

Hardware (cost indicators, total costs)^c

IRI: https://w3id.org/bmontology#Mailbox_CostIndicators_TotalCosts_Hardware

This is a cost indicator of the mailbox service, categorized into cost indicators as well as total costs. This indicator captures the hardware costs regarding the mailbox module.

has super-classes Cost Indicator^c Hardware resource indicator^c Mailbox^c

Hardware (cost indicators, total costs)^c

IRI: https://w3id.org/bmontology#SAPBasis_CostIndicators_TotalCosts_Hardware

This is a cost indicator of the SAP basis service, categorized into cost indicators as well as total costs. This indicator captures all depreciations and leasing costs for hardware that are required for operating the SAP basis but are not yet included in other indicators (e.g., server, storage, backup).

has super-classes Cost Indicator^c Hardware resource indicator^c SAP basis^c

Hardware (cost indicators, total costs)^c

IRI: https://w3id.org/bmontology#TerminalServer_CostIndicators_TotalCosts_Hardware

This is a cost indicator of the terminal server service, categorized into cost indicators as well as total costs. This indicator captures the costs for hardware involved in the terminal server module.

has super-classes Cost Indicator^c Hardware resource indicator^c Terminal server^c

Hardware (cost indicators, variant 1 (high availability))^c

IRI: `https://w3id.org/bmontology#Database_CostIndicators_Variant1HighAvailability_Hardware`

This is a cost indicator of the database service, categorized into cost indicators as well as variant 1 (high availability). This indicator captures the total costs for database servers (yearly).

has super-classes Cost Indicator^c Database (Variant 1)^c Hardware resource indicator^c

Hardware (cost indicators, variant 2)^c

IRI: `https://w3id.org/bmontology#Database_CostIndicators_Variant2_Hardware`

This is a cost indicator of the database service, categorized into cost indicators as well as variant 2. This indicator captures the total costs for database servers (yearly).

has super-classes Cost Indicator^c Datenbanken (Variante 2)^c Hardware resource indicator^c

Hardware (cost indicators, voIP)^c

IRI: `https://w3id.org/bmontology#Telephony_CostIndicators_VoIP_Hardware`

This is a cost indicator of the telephony service, categorized into cost indicators as well as voIP. This indicator captures the hardware costs regarding the telephony module.

has super-classes Cost Indicator^c Hardware resource indicator^c Telephony^c

Hardware (cost indicators, windows phone)^c

IRI: `https://w3id.org/bmontology#MobileDevices_CostIndicators_WindowsPhone_Hardware`

This is a cost indicator of the mobile devices service, categorized into cost indicators as well as windows phone. This indicator captures the hardware costs regarding the mobile devices module.

has super-classes Cost Indicator^c Hardware resource indicator^c Mobile Devices (Windows Phone)^c

Hardware (cost indicators, WLAN)^c

IRI: `https://w3id.org/bmontology#LAN_CostIndicators_WLAN_Hardware`

This is a cost indicator of the LAN service, categorized into cost indicators as well as WLAN. This indicator captures the hardware costs for active components, the security, monitoring and management environments as well as WLAN.

has super-classes Cost Indicator^c Hardware resource indicator^c LAN^c

Hardware maintenance (cost indicators, active components)^c

IRI: `https://w3id.org/bmontology#LAN_CostIndicators_ActiveComponents_HardwareMaintenance`

This is a cost indicator of the LAN service, categorized into cost indicators as well as active components. This indicator captures the costs involved in maintaining the hardware.

has super-classes Cost Indicator^c Human resource indicator^c LAN^c

Hardware maintenance (cost indicators, blackberry)^c

IRI: `https://w3id.org/bmontology#MobileDevices_CostIndicators_Blackberry_HardwareMaintenance`

This is a cost indicator of the mobile devices service, categorized into cost indicators as well as blackberry. This indicator captures the costs involved in maintaining the hardware.

has super-classes Cost Indicator^c Human resource indicator^c Mobile Devices (Blackberry)^c

Hardware maintenance (cost indicators, classical telephony)^c

IRI: `https://w3id.org/bmontology#Telephony_CostIndicators_ClassicalTelephony_HardwareMaintenance`

This is a cost indicator of the telephony service, categorized into cost indicators as well as classical telephony. This indicator captures the costs involved in maintaining the hardware.

has super-classes Cost Indicator^c Human resource indicator^c Telephony^c

Hardware maintenance (cost indicators, conferencing (incl. video conferencing tools))^c

IRI: `https://w3id.org/bmontology#Collaboration_CostIndicators_ConferencingInclVideoConferencingTools_HardwareMaintenance`

This is a cost indicator of the collaboration service, categorized into cost indicators as well as conferencing (incl. video conferencing tools). This indicator captures the costs involved in maintaining the hardware.

has super-classes Collaboration^c Cost Indicator^c Human resource indicator^c

Hardware maintenance (cost indicators, cost indicator (medium))^c

IRI: `https://w3id.org/bmontology#DedicatedServer_CostIndicators_CostIndicatorMedium_HardwareMaintenance`

This is a cost indicator of the dedicated server service, categorized into cost indicators as well as cost indicator (medium). This indicator captures the costs involved in maintaining the hardware for the dedicated server module.

has super-classes Cost Indicator^c Dedicated server (medium)^c Human resource indicator^c

Hardware maintenance (cost indicators, cost indicators (large))^c

IRI: `https://w3id.org/bmontology#DedicatedServer_CostIndicators_CostIndicatorsLarge_HardwareMaintenance`

This is a cost indicator of the dedicated server service, categorized into cost indicators as well as cost indicators (large). This indicator captures the costs involved in maintaining the hardware for the dedicated server module.

has super-classes Cost Indicator^c Dedicated server (large)^c Human resource indicator^c

Hardware maintenance (cost indicators, cost indicators (small))^c

IRI: `https://w3id.org/bmontology#DedicatedServer_CostIndicators_CostIndicatorsSmall_HardwareMaintenance`

This is a cost indicator of the dedicated server service, categorized into cost indicators as well as cost indicators (small). This indicator captures the costs involved in maintaining the hardware for the dedicated server module.

has super-classes Cost Indicator^c Dedicated server (small)^c Human resource indicator^c

Hardware maintenance (cost indicators, cost indicators)^c

IRI: `https://w3id.org/bmontology#Backup_CostIndicators_CostIndicators_HardwareMaintenance`

This is a cost indicator of the backup service, categorized into cost indicators as well as cost indicators. This indicator captures the costs involved in maintaining the hardware.

has super-classes Backup^c Cost Indicator^c Human resource indicator^c

Hardware maintenance (cost indicators, high)^c

IRI: `https://w3id.org/bmontology#Storage_CostIndicators_High_HardwareMaintenance`

This is a cost indicator of the storage service, categorized into cost indicators as well as high. This indicator captures the costs involved in maintaining the hardware for the storage module.

has super-classes Cost Indicator^c Human resource indicator^c Storage (High)^c

Hardware maintenance (cost indicators, iPhone)^c

IRI: `https://w3id.org/bmontology#MobileDevices_CostIndicators_IPhone_HardwareMaintenance`

This is a cost indicator of the mobile devices service, categorized into cost indicators as well as iPhone. This indicator captures the costs involved in maintaining the hardware.

has super-classes Cost Indicator^c Human resource indicator^c Mobile Devices (iPhone)^c

Hardware maintenance (cost indicators, low)^c

IRI: `https://w3id.org/bmontology#Storage_CostIndicators_Low_HardwareMaintenance`

This is a cost indicator of the storage service, categorized into cost indicators as well as low. This indicator captures the costs involved in maintaining the hardware for the storage module.

has super-classes Cost Indicator^c Human resource indicator^c Storage (Low)^c

Hardware maintenance (cost indicators, lync and other applications (without telephony))^c

IRI: `https://w3id.org/bmontology#Collaboration_CostIndicators_LyncAndOtherApplicationsWithoutTelephony_HardwareMaintenance`

This is a cost indicator of the collaboration service, categorized into cost indicators as well as lync and other applications (without telephony). This indicator captures the costs involved in maintaining the hardware.

has super-classes Collaboration^c Cost Indicator^c Human resource indicator^c

Hardware maintenance (cost indicators, medium)^c

IRI: `https://w3id.org/bmontology#Storage_CostIndicators_Medium_HardwareMaintenance`

This is a cost indicator of the storage service, categorized into cost indicators as well as medium. This indicator captures the costs involved in maintaining the hardware for the storage module.

has super-classes Cost Indicator^c Human resource indicator^c Storage (Medium)^c

Hardware maintenance (cost indicators, monitoring and administration environment)^c

IRI: `https://w3id.org/bmontology#LAN_CostIndicators_MonitoringAndAdministrationEnvironment_HardwareMaintenance`

This is a cost indicator of the LAN service, categorized into cost indicators as well as monitoring and administration environment. This indicator captures the costs involved in maintaining the hardware.

has super-classes Cost Indicator^c Human resource indicator^c LAN^c

Hardware maintenance (cost indicators, others)^c

IRI: `https://w3id.org/bmontology#MobileDevices_CostIndicators_Others_HardwareMaintenance`

This is a cost indicator of the mobile devices service, categorized into cost indicators as well as others. This indicator captures the costs involved in maintaining the hardware.

has super-classes Cost Indicator^c Human resource indicator^c Mobile Devices (Others)^c

Hardware maintenance (cost indicators, security environment)^c

IRI: `https://w3id.org/bmontology#LAN_CostIndicators_SecurityEnvironment_HardwareMaintenance`

This is a cost indicator of the LAN service, categorized into cost indicators as well as security environment. This indicator captures the costs involved in maintaining the hardware.

has super-classes Cost Indicator^c Human resource indicator^c LAN^c

Hardware maintenance (cost indicators, sharePoint and other applications)^c

IRI: `https://w3id.org/bmontology#Collaboration_CostIndicators_SharePointAndOtherApplications_HardwareMaintenance`

This is a cost indicator of the collaboration service, categorized into cost indicators as well as sharePoint and other applications. This indicator captures the costs involved in maintaining the hardware.

has super-classes Collaboration^c Cost Indicator^c Human resource indicator^c

Hardware maintenance (cost indicators, total costs of host systems)^c

IRI: `https://w3id.org/bmontology#VirtualServer_CostIndicators_TotalCostsOfHostSystems_HardwareMaintenance`

This is a cost indicator of the virtual server service, categorized into cost indicators as well as total costs of host systems. This indicator captures the costs involved in maintaining the hardware for the dedicated server module.

has super-classes Cost Indicator^c Human resource indicator^c Virtual server^c

Hardware maintenance (cost indicators, total costs)^c

IRI: `https://w3id.org/bmontology#FileService_CostIndicators_TotalCosts_HardwareMaintenance`

This is a cost indicator of the file service service, categorized into cost indicators as well as total costs. This indicator captures the costs involved in maintaining the hardware.

has super-classes Cost Indicator^c File Service^c Human resource indicator^c

Hardware maintenance (cost indicators, total costs)^c

IRI: `https://w3id.org/bmontology#Mailbox_CostIndicators_TotalCosts_HardwareMaintenance`

This is a cost indicator of the mailbox service, categorized into cost indicators as well as total costs. This indicator captures the hardware maintenance costs regarding the mailbox module.

has super-classes Cost Indicator^c Human resource indicator^c Mailbox^c

Hardware maintenance (cost indicators, total costs)^c

IRI: `https://w3id.org/bmontology#SAPBasis_CostIndicators_TotalCosts_HardwareMaintenance`

This is a cost indicator of the SAP basis service, categorized into cost indicators as well as total costs. This indicator captures the costs involved in maintaining the hardware.

has super-classes Cost Indicator^c Human resource indicator^c SAP basis^c

Hardware maintenance (cost indicators, total costs)^c

IRI: `https://w3id.org/bmontology#TerminalServer_CostIndicators_TotalCosts_HardwareMaintenance`

This is a cost indicator of the terminal server service, categorized into cost indicators as well as total costs. This indicator captures the costs involved in maintaining the hardware for the terminal server module.

has super-classes Cost Indicator^c Human resource indicator^c Terminal server^c

Hardware maintenance (cost indicators, variant 1 (high availability))^c

IRI: `https://w3id.org/bmontology#Database_CostIndicators_Variant1HighAvailability_HardwareMaintenance`

This is a cost indicator of the database service, categorized into cost indicators as well as variant 1 (high availability). This indicator captures the costs involved in maintaining the hardware.

has super-classes Cost Indicator^c Database (Variant 1)^c Human resource indicator^c

Hardware maintenance (cost indicators, variant 2)^c

IRI: `https://w3id.org/bmontology#Database_CostIndicators_Variant2_HardwareMaintenance`

This is a cost indicator of the database service, categorized into cost indicators as well as variant 2. This indicator captures the costs involved in maintaining the hardware.

has super-classes Cost Indicator^c Datenbanken (Variante 2)^c Human resource indicator^c

Hardware maintenance (cost indicators, voIP)^c

IRI: `https://w3id.org/bmontology#Telephony_CostIndicators_VoIP_HardwareMaintenance`

This is a cost indicator of the telephony service, categorized into cost indicators as well as voIP. This indicator captures the costs involved in maintaining the hardware.

has super-classes Cost Indicator^c Human resource indicator^c Telephony^c

Hardware maintenance (cost indicators, windows phone)^c

IRI: `https://w3id.org/bmontology#MobileDevices_CostIndicators_WindowsPhone_HardwareMaintenance`

This is a cost indicator of the mobile devices service, categorized into cost indicators as well as windows phone. This indicator captures the costs involved in maintaining the hardware.

has super-classes Cost Indicator^c Human resource indicator^c Mobile Devices (Windows Phone)^c

Hardware maintenance (cost indicators, WLAN)^c

IRI: `https://w3id.org/bmontology#LAN_CostIndicators_WLAN_HardwareMaintenance`

This is a cost indicator of the LAN service, categorized into cost indicators as well as WLAN. This indicator captures the costs involved in maintaining the hardware.

has super-classes Cost Indicator^c Human resource indicator^c LAN^c

Hardware resource indicator^c

IRI: `https://w3id.org/bmontology#HardwareResourceIndicator`

Classifies hardware resource indicators

has super-classes Resource dimension for indicator classification^c

has sub-classes Backend and client systems (performance indicators, VPN client)^c , Backend and client systems (performance indicators, VPN tunel to business partners)^c , Backend and client systems (performance indicators, standard mass connection)^c , Cabling Gbit over copper (performance indicators, additional information)^c , Characteristics of LAN (performance indicators, additional information)^c , Computer center levy (cost indicators, cost indicator (medium))^c , Computer center levy (cost indicators, cost indicators (large))^c , Computer center levy (cost indicators, cost indicators (small))^c , Computer center levy (cost indicators, cost indicators)^c , Computer center levy (cost indicators, high)^c , Computer center levy (cost indicators, low)^c , Computer center levy (cost indicators, medium)^c , Computer center levy (cost indicators, total costs of host systems)^c , Distribution of tertiary cabling (performance indicators, additional information)^c , Equipment of a default workingplace computer (desktop/laptop) (performance indicators, quantity structure and performance)^c , Hardware (cost indicators, WLAN)^c , Hardware (cost indicators, active components)^c , Hardware (cost indicators, blackberry)^c , Hardware (cost indicators, classical telephony)^c , Hardware (cost indicators, conferencing (incl. video conferencing tools))^c , Hardware (cost indicators, cost indicator (medium))^c , Hardware (cost indicators, cost indicators (large))^c , Hardware (cost indicators, cost indicators (small))^c , Hardware (cost indicators, cost indicators)^c , Hardware (cost indicators, desktop)^c , Hardware (cost indicators, high)^c , Hardware (cost indicators, iPhone)^c , Hardware (cost indicators, laptop)^c , Hardware (cost indicators, low)^c , Hardware (cost indicators, lync and other applications (without telephony))^c , Hardware (cost indicators, medium)^c , Hardware (cost indicators, monitoring and administration environment)^c , Hardware (cost indicators, others)^c , Hardware (cost indicators, security environment)^c , Hardware (cost indicators, sharePoint and other applications)^c , Hardware (cost indicators, total costs of host systems)^c , Hardware (cost indicators, total costs)^c , Hardware (cost indicators, total costs)^c , Hardware (cost indicators, total costs)^c , Hardware (cost indicators, total costs)^c , Hardware (cost indicators, variant 1 (high availability))^c , Hardware (cost indicators, variant 2)^c , Hardware (cost indicators, voIP)^c , Hardware (cost indicators, windows phone)^c , Hight unit computer center (data center levy, basic data)^c , How is the infrastructure integration regulated (performance indicators, lync and other applications (without telephony))^c , Infrastructure - backend (cost indicators, SSL VPN access)^c , Infrastructure - backend (cost indicators, VPN client)^c , Infrastructure - backend (cost indicators, VPN tunel to business partners)^c , Infrastructure - decentral (cost indicators, SSL VPN access)^c , Infrastructure - decentral (cost indicators, VPN client)^c , Infrastructure - decentral (cost indicators, VPN tunel to business partners)^c , Number of access ports 1 Gbit with PoE (performance indicators, quantity structure)^c , Number of access ports 1 Gbit without PoE (performance indicators, quantity structure)^c , Number of access ports 100Mbit with PoE (performance indicators, quantity structure)^c , Number of access ports 100Mbit without PoE (performance indicators, quantity structure)^c , Offetting backup (cost indicators, classical telephony)^c , Offetting backup (cost indicators, conferencing (incl. video conferencing tools))^c , Offetting backup (cost indicators, lync and other applications (without telephony))^c , Offetting backup (cost indicators, sharePoint and other applications)^c , Offetting backup (cost indicators, total costs)^c , Offetting backup (cost indicators, total costs)^c , Offetting backup (cost indicators, total costs)^c , Offetting backup (cost indicators, variant 1 (high availability))^c , Offetting backup (cost indicators, variant 2)^c , Offetting backup (cost indicators, voIP)^c , Offsetting Server (cost indicators, blackberry)^c , Offsetting Server (cost indicators, classical telephony)^c , Offsetting Server (cost indicators, conferencing (incl. video conferencing tools))^c , Offsetting Server (cost indicators, high)^c , Offsetting Server (cost indicators, iPhone)^c , Offsetting Server (cost indicators, low)^c , Offsetting Server (cost indicators, lync and other applications (without telephony))^c , Offsetting Server (cost indicators, medium)^c , Offsetting Server (cost indicators, others)^c , Offsetting Server (cost indicators, sharePoint and other applications)^c , Offsetting Server (cost indicators, total costs)^c , Offsetting Server (cost indicators, total costs)^c , Offsetting Server (cost indicators, total costs)^c , Offsetting Server (cost indicators, total costs)^c , Offsetting Server (cost indicators, variant 1 (high availability))^c , Offsetting Server (cost indicators, variant 2)^c , Offsetting Server (cost indicators, voIP)^c , Offsetting Server (cost indicators, windows phone)^c , Offsetting Storage (cost indicators, classical telephony)^c , Offsetting Storage (cost indicators, conferencing (incl. video conferencing tools))^c , Offsetting Storage (cost indicators, lync and other applications (without telephony))^c , Offsetting Storage (cost indicators, sharePoint and other applications)^c , Offsetting Storage (cost indicators, total costs)^c , Offsetting Storage (cost indicators, total costs)^c , Offsetting Storage (cost indicators, total costs)^c , Offsetting Storage (cost indicators, total costs)^c , Offsetting Storage (cost indicators, variant 1 (high availability))^c , Offsetting Storage (cost indicators, variant 2)^c , Offsetting Storage (cost indicators, voIP)^c , Operationally used storage volume (performance indicators, quantity structure (medium))^c , Other end devices (performance indicators, others (classical telephony))^c , Other end devices (performance indicators, sourcing (voIP))^c , PUE (Power Usage Effectiveness) (data center levy, basic data)^c , Portion LX port (performance indicators, port information)^c , Portion of access ports with NAC (performance indicators, port information)^c , Redundancy of computer centers (IT and development, basic data)^c , Redundant uplinks of access and distribution switches (performance indicators, performance and architecture)^c , Storage internal/external (performance indicators, quantity structure and performance)^c , Storage volume (performance indicators, variant 1 (high availability))^c , Storage volume (performance indicators, variant 2)^c , Total area of computer centers (data center levy, basic data)^c , Total capacity (gross) incl. reserves (performance indicators, quantity structure (high))^c , Total capacity (gross) incl. reserves (performance indicators, quantity structure (low))^c , Total capacity (gross) incl. reserves (performance indicators, quantity structure (medium))^c , Total capacity (net) (performance indicators, quantity structure)^c , Total capacity (net) incl. reserves (performance indicators, quantity structure (high))^c , Total capacity (net) incl. reserves (performance indicators, quantity structure (low))^c , Total capacity (net) incl. reserves (performance indicators, quantity structure (medium))^c , Total disk storage (performance indicators, guest system)^c , Total disk storage (performance indicators, host systems)^c , Total main memory (RAM) (performance indicators, host systems)^c , Total size of assigned RAM (performance indicators, guest system)^c , Types of tape drives (performance indicators, quantity structure and performance)^c

is disjoint with Human resource indicator^c , Software resource indicator^c

High availability (performance indicators, variant 2)^c

IRI: `https://w3id.org/bmontology#Database_PerformanceIndicators_Variant2_HighAvailability`

This is a performance indicator of the database service, categorized into performance indicators as well as variant 2. This indicator captures whether the system is designed for high availability.

has super-classes Datenbanken (Variante 2)^c Quality indicator^c

Hight unit computer center (data center levy, basic data)^c

IRI: `https://w3id.org/bmontology#BasicData_DataCenterLevy_BasicData_HightUnitComputerCenter`

This is an indicator of the basic data service, categorized into data center levy as well as basic data. This indicator captures the total number hight units in the computer centers.

has super-classes Basic data^c Hardware resource indicator^c

How are end devices purchased (performance indicators, general indicators)^c

IRI: `https://w3id.org/bmontology#MobileDevices_PerformanceIndicators_GeneralIndicators_HowAreEndDevicesPurchased`

This is a performance indicator of the mobile devices service, categorized into performance indicators as well as general indicators. This indicator captures the way devices are provided.

has super-classes Mobile devices^c Performance Indicator^c

How is the infrastructure integration regulated (performance indicators, conferencing (incl. video conferencing tools))^c

IRI: `https://w3id.org/bmontology#Collaboration_PerformanceIndicators_ConferencingInclVideoConferencingTools_HowIsTheInfrastructureIntegrationRegulated`

This is a performance indicator of the collaboration service, categorized into performance indicators as well as conferencing (incl. video conferencing tools). This indicator captures how collaboration tools are involved in the IT infrastructure.

has super-classes Collaboration^c Performance Indicator^c

How is the infrastructure integration regulated (performance indicators, lync and other applications (without telephony))^c

IRI: `https://w3id.org/bmontology#Collaboration_PerformanceIndicators_LyncAndOtherApplicationsWithoutTelephony_HowIsTheInfrastructureIntegrationRegulated`

This is a performance indicator of the collaboration service, categorized into performance indicators as well as lync and other applications (without telephony). This indicator captures how collaboration tools are involved in the IT infrastructure.

has super-classes Collaboration^c Hardware resource indicator^c Performance Indicator^c

How is the infrastructure integration regulated (performance indicators, sharePoint and other applications)^c

IRI: `https://w3id.org/bmontology#Collaboration_PerformanceIndicators_SharePointAndOtherApplications_HowIsTheInfrastructureIntegrationRegulated`

This is a performance indicator of the collaboration service, categorized into performance indicators as well as sharePoint and other applications. This indicator captures how collaboration tools are involved in the IT infrastructure.

has super-classes Collaboration^c Performance Indicator^c

Human resource indicator^c

IRI: `https://w3id.org/bmontology#HumanResourceIndicator`

Classifies human resource indicators

has super-classes Resource dimension for indicator classification^c

has sub-classes Add - Additional hardware components (cost indicators, costs add)^c , Add - Software (automatically) (cost indicators, costs add)^c , Add - Software (manually) (cost indicators, costs add)^c , Administration costs (cost indicators, BC: basic system)^c , Administration costs (cost indicators, CS: customer service)^c , Administration costs (cost indicators, EC: corporate controlling)^c , Administration costs (cost indicators, FI: finance)^c , Administration costs (cost indicators, MM: materials management)^c , Administration costs (cost indicators, PM: plant maintenance)^c , Administration costs (cost indicators, PP: production planning and control)^c , Administration costs (cost indicators, SD: sales and distribution)^c , Administration costs (cost indicators, co: controlling)^c , Change/Delete - Total (cost indicators, costs change)^c , Cost rate FTE (performance indicators, SSL VPN access)^c , Cost rate FTE (performance indicators, VPN client)^c , Cost rate FTE (performance indicators, standard mass connection)^c , Costs of development and training of employees (IT costs, basic data)^c , Effort of external administration (FTE) (performance indicators, BC: basic system)^c , Effort of external administration (FTE) (performance indicators, CS: customer service)^c , Effort of external administration (FTE) (performance indicators, EC: corporate controlling)^c , Effort of external administration (FTE) (performance indicators, FI: finance)^c , Effort of external administration (FTE) (performance indicators, MM: materials management)^c , Effort of external administration (FTE) (performance indicators, PM: plant maintenance)^c , Effort of external administration (FTE) (performance indicators, PP: production planning and control)^c , Effort of external administration (FTE) (performance indicators, SD: sales and distribution)^c , Effort of external administration (FTE) (performance indicators, co: controlling)^c , Effort of external maintenance (FTE) (performance indicators, BC: basic system)^c , Effort of external maintenance (FTE) (performance indicators, CS: customer service)^c , Effort of external maintenance (FTE) (performance indicators, EC: corporate controlling)^c , Effort of external maintenance (FTE) (performance indicators, FI: finance)^c , Effort of external maintenance (FTE) (performance indicators, MM: materials management)^c , Effort of external maintenance (FTE) (performance indicators, PM: plant maintenance)^c , Effort of external maintenance (FTE) (performance indicators, PP: production planning and control)^c , Effort of external maintenance (FTE) (performance indicators, SD: sales and distribution)^c , Effort of external maintenance (FTE) (performance indicators, co: controlling)^c , Effort of in-house development (performance indicators, BC: basic system)^c , Effort of in-house development (performance indicators, CS: customer service)^c , Effort of in-house development (performance indicators, EC: corporate controlling)^c , Effort of in-house development (performance indicators, FI: finance)^c , Effort of in-house development (performance indicators, MM: materials management)^c , Effort of in-house development (performance indicators, PM:

plant maintenance)^c , Effort of in-house development (performance indicators, PP: production planning and control)^c , Effort of in-house development (performance indicators, SD: sales and distribution)^c , Effort of in-house development (performance indicators, co: controlling)^c , Effort of internal administration (FTE) (performance indicators, BC: basic system)^c , Effort of internal administration (FTE) (performance indicators, CS: customer service)^c , Effort of internal administration (FTE) (performance indicators, EC: corporate controlling)^c , Effort of internal administration (FTE) (performance indicators, FI: finance)^c , Effort of internal administration (FTE) (performance indicators, MM: materials management)^c , Effort of internal administration (FTE) (performance indicators, PM: plant maintenance)^c , Effort of internal administration (FTE) (performance indicators, PP: production planning and control)^c , Effort of internal administration (FTE) (performance indicators, SD: sales and distribution)^c , Effort of internal administration (FTE) (performance indicators, co: controlling)^c , Effort of internal maintenance (FTE) (performance indicators, BC: basic system)^c , Effort of internal maintenance (FTE) (performance indicators, CS: customer service)^c , Effort of internal maintenance (FTE) (performance indicators, EC: corporate controlling)^c , Effort of internal maintenance (FTE) (performance indicators, FI: finance)^c , Effort of internal maintenance (FTE) (performance indicators, MM: materials management)^c , Effort of internal maintenance (FTE) (performance indicators, PM: plant maintenance)^c , Effort of internal maintenance (FTE) (performance indicators, PP: production planning and control)^c , Effort of internal maintenance (FTE) (performance indicators, SD: sales and distribution)^c , Effort of internal maintenance (FTE) (performance indicators, co: controlling)^c , Electricity costs of computer centers (data center levy, basic data)^c , External services (cost indicators, SSL VPN access)^c , External services (cost indicators, VPN client)^c , External services (cost indicators, VPN tunel to business partners)^c , External services (cost indicators, WLAN)^c , External services (cost indicators, active components)^c , External services (cost indicators, blackberry)^c , External services (cost indicators, classical telephony)^c , External services (cost indicators, conferencing (incl. video conferencing tools))^c , External services (cost indicators, cost indicator (medium))^c , External services (cost indicators, cost indicators (large))^c , External services (cost indicators, cost indicators (small))^c , External services (cost indicators, cost indicators)^c , External services (cost indicators, desktop)^c , External services (cost indicators, high)^c , External services (cost indicators, iPhone)^c , External services (cost indicators, laptop)^c , External services (cost indicators, low)^c , External services (cost indicators, lync and other applications (without telephony))^c , External services (cost indicators, medium)^c , External services (cost indicators, monitoring and administration environment)^c , External services (cost indicators, others)^c , External services (cost indicators, security environment)^c , External services (cost indicators, sharePoint and other applications)^c , External services (cost indicators, standard mass connection)^c , External services (cost indicators, total costs of guest systems)^c , External services (cost indicators, total costs of host systems)^c , External services (cost indicators, total costs)^c , External services (cost indicators, total costs)^c , External services (cost indicators, total costs)^c , External services (cost indicators, total costs)^c , External services (cost indicators, total costs)^c , External services (cost indicators, variant 1 (high availability))^c , External services (cost indicators, variant 2)^c , External services (cost indicators, voIP)^c , External services (cost indicators, windows phone)^c , Hardware maintenance (cost indicators, WLAN)^c , Hardware maintenance (cost indicators, active components)^c , Hardware maintenance (cost indicators, blackberry)^c , Hardware maintenance (cost indicators, classical telephony)^c , Hardware maintenance (cost indicators, conferencing (incl. video conferencing tools))^c , Hardware maintenance (cost indicators, cost indicator (medium))^c , Hardware maintenance (cost indicators, cost indicators (large))^c , Hardware maintenance (cost indicators, cost indicators (small))^c , Hardware maintenance (cost indicators, cost indicators)^c , Hardware maintenance (cost indicators, high)^c , Hardware maintenance (cost indicators, iPhone)^c , Hardware maintenance (cost indicators, low)^c , Hardware maintenance (cost indicators, lync and other applications (without telephony))^c , Hardware maintenance (cost indicators, medium)^c , Hardware maintenance (cost indicators, monitoring and administration environment)^c , Hardware maintenance (cost indicators, others)^c , Hardware maintenance (cost indicators, security environment)^c , Hardware maintenance (cost indicators, sharePoint and other applications)^c , Hardware maintenance (cost indicators, total costs of host systems)^c , Hardware maintenance (cost indicators, total costs)^c , Hardware maintenance (cost indicators, total costs)^c , Hardware maintenance (cost indicators, total costs)^c , Hardware maintenance (cost indicators, total costs)^c , Hardware maintenance (cost indicators, variant 1 (high availability))^c , Hardware maintenance (cost indicators, variant 2)^c , Hardware maintenance (cost indicators, voIP)^c , Hardware maintenance (cost indicators, windows phone)^c , IT personnel costs (IT costs, basic data)^c , Infrastructure - backend (cost indicators, standard mass connection)^c , Infrastructure - decentral (cost indicators, standard mass connection)^c , Install - Desktop (cost indicators, costs install)^c , Install - Laptop (cost indicators, costs install)^c , Install - Thin client (cost indicators, costs install)^c , Maintenance costs (cost indicators, BC: basic system)^c , Maintenance costs (cost indicators, CS: customer service)^c , Maintenance costs (cost indicators, EC: corporate controlling)^c , Maintenance costs (cost indicators, FI: finance)^c , Maintenance costs (cost indicators, MM: materials management)^c , Maintenance costs (cost indicators, PM: plant maintenance)^c , Maintenance costs (cost indicators, PP: production planning and control)^c , Maintenance costs (cost indicators, SD: sales and distribution)^c , Maintenance costs (cost indicators, co: controlling)^c , Move - Logical (cost indicators, costs move)^c , Move - Physical (cost indicators, costs move)^c , Number of external personnel (FTE) (performance indicators, variant 1 (high availability))^c , Number of external personnel (FTE) (performance indicators, variant 2)^c , Number of internal personnel (FTE) (performance indicators, variant 1 (high availability))^c , Number of internal personnel (FTE) (performance indicators, variant 2)^c , Offsetting Install (cost indicators, desktop)^c , Offsetting Install (cost indicators, laptop)^c , Offsetting Server (cost indicators, cost indicators)^c , Offsetting Storage (cost indicators, cost indicators)^c , Personnel (cost indicators, SSL VPN access)^c , Personnel (cost indicators, VPN client)^c , Personnel (cost indicators, VPN tunel to business partners)^c , Personnel (cost indicators, WLAN)^c , Personnel (cost indicators, active components)^c , Personnel (cost indicators, blackberry)^c , Personnel (cost indicators, classical telephony)^c , Personnel (cost indicators, conferencing (incl. video conferencing tools))^c , Personnel (cost indicators, cost indicator (medium))^c , Personnel (cost indicators, cost indicators (large))^c , Personnel (cost indicators, cost indicators (small))^c , Personnel (cost indicators, cost indicators)^c , Personnel (cost indicators, desktop)^c , Personnel (cost indicators, high)^c , Personnel (cost indicators, iPhone)^c , Personnel (cost indicators, laptop)^c , Personnel (cost indicators, low)^c , Personnel (cost indicators, lync and other applications (without telephony))^c , Personnel (cost indicators, medium)^c , Personnel (cost indicators, monitoring and administration environment)^c , Personnel (cost indicators, others)^c , Personnel (cost indicators, security environment)^c , Personnel (cost indicators, sharePoint and other applications)^c , Personnel (cost indicators, standard mass connection)^c , Personnel (cost indicators, total costs of guest systems)^c , Personnel (cost indicators, total costs of host systems)^c , Personnel (cost indicators, total costs)^c , Personnel (cost indicators, total costs)^c , Personnel (cost indicators, total costs)^c , Personnel (cost indicators, total costs)^c , Personnel (cost indicators, variant 1 (high availability))^c , Personnel (cost indicators, variant 2)^c , Personnel (cost indicators, voIP)^c , Personnel (cost indicators, windows phone)^c , Personnel employee service desk management (cost indicators, total costs)^c , Personnel service desk agents (first level) (cost indicators, total costs)^c , Software maintenance (cost indicators, WLAN)^c , Software maintenance (cost indicators, active components)^c , Software maintenance (cost indicators, blackberry)^c , Software maintenance (cost indicators, classical telephony)^c , Software maintenance (cost indicators, conferencing (incl. video conferencing tools))^c , Software maintenance (cost indicators, cost indicator (medium))^c , Software maintenance (cost indicators, cost indicators (large))^c , Software maintenance (cost indicators, cost indicators (small))^c , Software maintenance (cost indicators, cost indicators)^c , Software maintenance (cost indicators, high)^c , Software maintenance (cost indicators, iPhone)^c , Software maintenance (cost indicators, low)^c , Software maintenance (cost indicators, lync and other applications (without telephony))^c , Software maintenance (cost indicators, medium)^c , Software maintenance (cost indicators, monitoring and administration environment)^c , Software maintenance (cost indicators, others)^c , Software maintenance (cost indicators, security environment)^c , Software maintenance (cost indicators, sharePoint and other applications)^c , Software maintenance (cost indicators, total costs of guest systems)^c , Software maintenance (cost indicators, total costs of host systems)^c , Software maintenance (cost indicators, total costs)^c , Software maintenance (cost indicators, total costs)^c , Software maintenance (cost indicators, total costs)^c , Software maintenance (cost indicators, total costs)^c , Software maintenance (cost indicators, variant 1 (high availability))^c , Software maintenance (cost indicators, variant 2)^c , Software maintenance (cost indicators, voIP)^c , Software maintenance (cost indicators, windows phone)^c , Total costs per computer center (data center levy, basic data)^c

is disjoint with Hardware resource indicator^c , Software resource indicator^c

IMAC^c

IRI: `https://w3id.org/bmontology#IMACIndicator`

Classifies IMAC (install, move, add, change) indicators

has super-classes Service template dimension for indicator classification^c

has sub-classes Add - Additional hardware components (cost indicators, costs add)^c , Add - Software (automatically) (cost indicators, costs add)^c , Add - Software (manually) (cost indicators, costs add)^c , Average frequency of change of a client (performance indicators, performance indicators)^c , Change/Delete - Total (cost indicators, costs change)^c , Delivery time (performance indicators, service level of IMAC processes)^c , Duration until image is available (performance indicators, service level of IMAC processes)^c , Duration until mass rollout of patch installations at clients are freed (performance indicators, service level of IMAC processes)^c , Duration until patch publication (performance indicators, service level of IMAC processes)^c , Ensured availability (performance indicators, service level of IMAC processes)^c , Frequency Add SW automatically (performance indicators, performance indicators)^c , Frequency Add SW manually (performance indicators, performance indicators)^c , Frequency Add additional HW components (performance indicators, performance indicators)^c , Frequency of Change/Delete (performance indicators, performance indicators)^c , Frequency of a desktop installation (performance indicators, performance indicators)^c , Frequency of a laptop installation (performance indicators, performance indicators)^c , Frequency of a thin client installation (performance indicators, performance indicators)^c , Frequency of logical move (performance indicators, performance indicators)^c , Frequency of physical move (performance indicators, performance indicators)^c , IMAC completion according to SLA (performance indicators, service level of IMAC processes)^c , Install - Desktop (cost indicators, costs install)^c , Install - Laptop (cost indicators, costs install)^c , Install - Thin client (cost indicators, costs install)^c , Move - Logical (cost indicators, costs move)^c , Move - Physical (cost indicators, costs move)^c , Number of devices (performance indicators, performance indicators)^c , Number of distributed packages per year (performance indicators, service level of IMAC processes)^c , Number of external personnel (FTE) (performance indicators, performance indicators)^c , Number of internal personnel (FTE) (performance indicators, performance indicators)^c , Recovery time (performance indicators, service level of IMAC processes)^c , Response time in hours IMAC (performance indicators, service level of IMAC processes)^c , Time for service providers (performance indicators, service level of IMAC processes)^c , Type of sourcing (performance indicators, performance indicators)^c

is disjoint with Backup^c , Basic data^c , Collaboration^c , Database^c , Dedicated server^c , File Service^c , LAN^c , Mailbox^c , Mobile devices^c , Remote access service^c , SAP basis^c , SAP modules^c , Servicedesk^c , Storage^c , Telephony^c , Terminal server^c , Virtual server^c , WAN^c , Workplace^c

IMAC completion according to SLA (performance indicators, service level of IMAC processes)^c

IRI: `https://w3id.org/bmontology#IMAC_PerformanceIndicators_ServiceLevelOfIMACProcesses_IMACCompletionAccordingToSLA`

This is a performance indicator of the IMAC service, categorized into performance indicators as well as service level of IMAC processes. This indicator captures how many days are required to complete an install, move, add, change/delete request (seperated by install, move, add, change).

has super-classes IMAC^c Quality indicator^c

Indicate your most important projects (IT and development, basic data)^c

IRI: `https://w3id.org/bmontology#BasicData_ITAndDevelopment_BasicData_IndicateYourMostImportantProjects`

This is an indicator of the basic data service, categorized into IT and development as well as basic data. This indicator captures the most important and largest IT projects in the IT that are in implementation/planning state.

has super-classes Basic data^c

Indicator^c

IRI: `https://w3id.org/bmontology#Indicator`

Represents indicators at the most generic level

has super-classes information objecthas Label^{dp} somestring

has sub-classes Resource dimension for indicator classification^c , Service template dimension for indicator classification^c , Type dimension for indicator classification^c

is in domain of has indicator categorizaion^{op} , has indicator measurement^{op}

is in range of categorizes indicator^{op} , measures indicator^{op}

is disjoint with Questionnaire of an individual benchmark^c

Indicator Declaration^c

IRI: `https://w3id.org/bmontology#IndicatorDeclaration`

Provides the value of an indicator within a participation

has super-classes regionis region forexactly 1 Indicator^c

has sub-classes Indicator declaration of a boolean value^{c} , Indicator declaration of a decimal value^{c} , Indicator declaration of a string value^{c}

is in domain of has Value^{dp} , is indicator declaration of^{op} , measures indicator^{op}

is in range of has indicator declaration^{op} , has indicator measurement^{op}

Indicator declaration of a boolean value^{c}

IRI: `https://w3id.org/bmontology#BooleanIndicatorDeclaration`

Provides a boolean value of an indicator within a participation

has super-classes Indicator Declaration^{c} has Value^{dp} onlybooleanhas Value^{dp} exactly 1

is disjoint with Indicator declaration of a decimal value^{c} , Indicator declaration of a string value^{c}

Indicator declaration of a decimal value^{c}

IRI: `https://w3id.org/bmontology#DecimalIndicatorDeclaration`

Provides a decimal value of an indicator within a participation

has super-classes Indicator Declaration^{c} has Value^{dp} onlydecimalhas Value^{dp} exactly 1

is disjoint with Indicator declaration of a boolean value^{c} , Indicator declaration of a string value^{c}

Indicator declaration of a string value^{c}

IRI: `https://w3id.org/bmontology#StringIndicatorDeclaration`

Provides a string value of an indicator within a participation

has super-classes Indicator Declaration^{c} has Value^{dp} onlystringhas Value^{dp} exactly 1

is disjoint with Indicator declaration of a boolean value^{c} , Indicator declaration of a decimal value^{c}

Indicator scope (general organization data, basic data)^c

IRI: `https://w3id.org/bmontology#BasicData_GeneralOrganizationData_BasicData_IndicatorScope`

This is an indicator of the basic data service, categorized into general organization data as well as basic data. This indicator captures the scope of the indicators within the basic data service.

has super-classes Basic data^c

Information about admin environment (performance indicators, performance and architecture)^c

IRI: `https://w3id.org/bmontology#LAN_PerformanceIndicators_PerformanceAndArchitecture_InformationAboutAdminEnvironment`

This is a performance indicator of the LAN service, categorized into performance indicators as well as performance and architecture. This indicator captures information with respect to the administration area.

has super-classes LAN^c Performance Indicator^c Software resource indicator^c

Infrastructure - backend (cost indicators, SSL VPN access)^c

IRI: `https://w3id.org/bmontology#RemoteAccessService_CostIndicators_SSLVPNAccess_InfrastructureBackend`

This is a cost indicator of the remote access service service, categorized into cost indicators as well as SSL VPN access. This indicator captures the backend hardware costs including hardware service and software for RAS per connection.

has super-classes Cost Indicator^c Hardware resource indicator^c Remote access service^c

Infrastructure - backend (cost indicators, standard mass connection)^c

IRI: `https://w3id.org/bmontology#RemoteAccessService_CostIndicators_StandardMassConnection_InfrastructureBackend`

This is a cost indicator of the remote access service service, categorized into cost indicators as well as standard mass connection. This indicator captures the backend hardware costs including hardware service and software for RAS per connection.

has super-classes Cost Indicator^c Human resource indicator^c Remote access service^c

Infrastructure - backend (cost indicators, VPN client)^c

IRI: `https://w3id.org/bmontology#RemoteAccessService_CostIndicators_VPNClient_InfrastructureBackend`

This is a cost indicator of the remote access service service, categorized into cost indicators as well as VPN client. This indicator captures the backend hardware costs including hardware service and software for RAS per connection.

has super-classes Cost Indicator^c Hardware resource indicator^c Remote access service^c

Infrastructure - backend (cost indicators, VPN tunel to business partners)^c

IRI: `https://w3id.org/bmontology#RemoteAccessService_CostIndicators_VPNTunelToBusinessPartners_InfrastructureBackend`

This is a cost indicator of the remote access service service, categorized into cost indicators as well as VPN tunel to business partners. This indicator captures the backend hardware costs including hardware service and software for RAS per connection.

has super-classes Cost Indicator^c Hardware resource indicator^c Remote access service^c

Infrastructure - decentral (cost indicators, SSL VPN access)^c

IRI: `https://w3id.org/bmontology#RemoteAccessService_CostIndicators_SSLVPNAccess_InfrastructureDecentral`

This is a cost indicator of the remote access service service, categorized into cost indicators as well as SSL VPN access. This indicator captures the costs for the decentralized hardware, incl. Hardware service and software for RAS per connection.

has super-classes Cost Indicator^c Hardware resource indicator^c Remote access service^c

Infrastructure - decentral (cost indicators, standard mass connection)^c

IRI: https://w3id.org/bmontology#RemoteAccessService_CostIndicators_StandardMassConnection_InfrastructureDecentral

This is a cost indicator of the remote access service service, categorized into cost indicators as well as standard mass connection. This indicator captures the costs for the decentralized hardware, incl. Hardware service and software for RAS per connection.

has super-classes Cost Indicator^c Human resource indicator^c Remote access service^c

Infrastructure - decentral (cost indicators, VPN client)^c

IRI: https://w3id.org/bmontology#RemoteAccessService_CostIndicators_VPNClient_InfrastructureDecentral

This is a cost indicator of the remote access service service, categorized into cost indicators as well as VPN client. This indicator captures the costs for the decentralized hardware, incl. Hardware service and software for RAS per connection.

has super-classes Cost Indicator^c Hardware resource indicator^c Remote access service^c

Infrastructure - decentral (cost indicators, VPN tunel to business partners)^c

IRI: https://w3id.org/bmontology#RemoteAccessService_CostIndicators_VPNTunelToBusinessPartners_InfrastructureDecentral

This is a cost indicator of the remote access service service, categorized into cost indicators as well as VPN tunel to business partners. This indicator captures the costs for the decentralized hardware, incl. Hardware service and software for RAS per connection.

has super-classes Cost Indicator^c Hardware resource indicator^c Remote access service^c

Install - Desktop (cost indicators, costs install)^c

IRI: https://w3id.org/bmontology#IMAC_CostIndicators_CostsInstall_InstallDesktop

This is a cost indicator of the IMAC service, categorized into cost indicators as well as costs install. This indicator captures the total costs of the installation of a desktop.

has super-classes Cost Indicator^c Human resource indicator^c IMAC^c

Install - Laptop (cost indicators, costs install)^c

IRI: `https://w3id.org/bmontology#IMAC_CostIndicators_CostsInstall_InstallLaptop`

This is a cost indicator of the IMAC service, categorized into cost indicators as well as costs install. This indicator captures the total costs of the installation of a laptop.

has super-classes Cost Indicator^c Human resource indicator^c IMAC^c

Install - Thin client (cost indicators, costs install)^c

IRI: `https://w3id.org/bmontology#IMAC_CostIndicators_CostsInstall_InstallThinClient`

This is a cost indicator of the IMAC service, categorized into cost indicators as well as costs install. This indicator captures the total costs of the installation of a thin client.

has super-classes Cost Indicator^c Human resource indicator^c IMAC^c

Installation supported by automation (performance indicators, cross-system)^c

IRI: `https://w3id.org/bmontology#VirtualServer_PerformanceIndicators_CrossSystem_InstallationSupportedByAutomation`

This is a performance indicator of the virtual server service, categorized into performance indicators as well as cross-system. This indicator captures whether automation solutions (e.g., CHEF) for the configuration of host systems/guest systems are used.

has super-classes Performance Indicator^c Virtual server^c

Instant messaging (performance indicators, tools)^c

IRI: `https://w3id.org/bmontology#Collaboration_PerformanceIndicators_Tools_InstantMessaging`

This is a performance indicator of the collaboration service, categorized into performance indicators as well as tools. This indicator captures whether this kind of collaboration is used in the organization.

has super-classes Collaboration^c Performance Indicator^c Software resource indicator^c

Interface self service (performance indicators, technology)^c

IRI: `https://w3id.org/bmontology#Servicedesk_PerformanceIndicators_Technology_InterfaceSelfService`

This is a performance indicator of the servicedesk service, categorized into performance indicators as well as technology. This indicator captures the system used for the interface self service.

has super-classes Performance Indicator^c Servicedesk^c

Interfaces (performance indicators, general)^c

IRI: `https://w3id.org/bmontology#SAPModules_PerformanceIndicators_General_Interfaces`

This is a performance indicator of the SAP modules service, categorized into performance indicators as well as general. This indicator captures a self-assessment of the dimensions: quantity, criticality and types of interfaces.

has super-classes Performance Indicator^c SAP modules^c

Internationality (performance indicators, general)^c

IRI: `https://w3id.org/bmontology#SAPModules_PerformanceIndicators_General_Internationality`

This is a performance indicator of the SAP modules service, categorized into performance indicators as well as general. This indicator captures the areas where SAP is used.

has super-classes Performance Indicator^c SAP modules^c

Internet access (performance indicators, quantity structure and performance (blackberry))^c

IRI: `https://w3id.org/bmontology#MobileDevices_PerformanceIndicators_QuantityStructureAndPerformanceBlackberry_InternetAccess`

This is a performance indicator of the mobile devices service, categorized into performance indicators as well as quantity structure and performance (blackberry). This indicator captures whether the platform offers internet access.

has super-classes Mobile Devices (Blackberry)^c Performance Indicator^c

Internet access (performance indicators, quantity structure and performance (iPhone))^c

IRI: `https://w3id.org/bmontology#MobileDevices_PerformanceIndicators_QuantityStructureAndPerformanceIPhone_InternetAccess`

This is a performance indicator of the mobile devices service, categorized into performance indicators as well as quantity structure and performance (iPhone). This indicator captures whether the platform offers internet access.

has super-classes Mobile Devices (iPhone)^c Performance Indicator^c

Internet access (performance indicators, quantity structure and performance (other))^c

IRI: `https://w3id.org/bmontology#MobileDevices_PerformanceIndicators_QuantityStructureAndPerformanceOther_InternetAccess`

This is a performance indicator of the mobile devices service, categorized into performance indicators as well as quantity structure and performance (other). This indicator captures whether the platform offers internet access.

has super-classes Mobile Devices (Others)^c Performance Indicator^c

Internet access (performance indicators, quantity structure and performance (windows phone))^c

IRI: `https://w3id.org/bmontology#MobileDevices_PerformanceIndicators_QuantityStructureAndPerformanceWindowsPhone_InternetAccess`

This is a performance indicator of the mobile devices service, categorized into performance indicators as well as quantity structure and performance (windows phone). This indicator captures whether the platform offers internet access.

has super-classes Mobile Devices (Windows Phone)^c Performance Indicator^c

Intranet access (performance indicators, quantity structure and performance (blackberry))^c

IRI: `https://w3id.org/bmontology#MobileDevices_PerformanceIndicators_QuantityStructureAndPerformanceBlackberry_IntranetAccess`

This is a performance indicator of the mobile devices service, categorized into performance indicators as well as quantity structure and performance (blackberry). This indicator captures whether the platform offers internet access.

has super-classes Mobile Devices (Blackberry)^c Performance Indicator^c

Intranet access (performance indicators, quantity structure and performance (iPhone))^c

IRI: `https://w3id.org/bmontology#MobileDevices_PerformanceIndicators_QuantityStructureAndPerformanceIPhone_IntranetAccess`

This is a performance indicator of the mobile devices service, categorized into performance indicators as well as quantity structure and performance (iPhone). This indicator captures whether the platform offers internet access.

has super-classes Mobile Devices (iPhone)^c Performance Indicator^c

Intranet access (performance indicators, quantity structure and performance (other))^c

IRI: `https://w3id.org/bmontology#MobileDevices_PerformanceIndicators_QuantityStructureAndPerformanceOther_IntranetAccess`

This is a performance indicator of the mobile devices service, categorized into performance indicators as well as quantity structure and performance (other). This indicator captures whether the platform offers internet access.

has super-classes Mobile Devices (Others)^c Performance Indicator^c

Intranet access (performance indicators, quantity structure and performance (windows phone))^c

IRI: `https://w3id.org/bmontology#MobileDevices_PerformanceIndicators_QuantityStructureAndPerformanceWindowsPhone_IntranetAccess`

This is a performance indicator of the mobile devices service, categorized into performance indicators as well as quantity structure and performance (windows phone). This indicator captures whether the platform offers internet access.

has super-classes Mobile Devices (Windows Phone)^c Performance Indicator^c

Introsion detection systems (performance indicators, additional information)^c

IRI: `https://w3id.org/bmontology#LAN_PerformanceIndicators_AdditionalInformation_IntrosionDetectionSystems`

This is a performance indicator of the LAN service, categorized into performance indicators as well as additional information. This indicator captures whether intrusion detection systems are used.

has super-classes LAN^c Performance Indicator^c Software resource indicator^c

Investment volume (general organization data, basic data)^c

IRI: `https://w3id.org/bmontology#BasicData_GeneralOrganizationData_BasicData_InvestmentVolume`

This is an indicator of the basic data service, categorized into general organization data as well as basic data. This indicator captures the investment volume of all organizational units which is managed by the IT.

has super-classes Basic data[c]

Is the module used in production (performance indicators, BC: basic system)[c]

IRI: `https://w3id.org/bmontology#SAPModules_PerformanceIndicators_BCBasicSystem_IsTheModuleUsedInProduction`

This is a performance indicator of the SAP modules service, categorized into performance indicators as well as BC: basic system. This indicator captures to what degree the module is used in production in the organization.

has super-classes Performance Indicator[c] SAP modules[c]

Is the module used in production (performance indicators, co: controlling)[c]

IRI: `https://w3id.org/bmontology#SAPModules_PerformanceIndicators_CoControlling_IsTheModuleUsedInProduction`

This is a performance indicator of the SAP modules service, categorized into performance indicators as well as co: controlling. This indicator captures whether the module is used in production.

has super-classes Performance Indicator[c] SAP modules[c]

Is the module used in production (performance indicators, CS: customer service)[c]

IRI: `https://w3id.org/bmontology#SAPModules_PerformanceIndicators_CSCustomerService_IsTheModuleUsedInProduction`

This is a performance indicator of the SAP modules service, categorized into performance indicators as well as CS: customer service. This indicator captures whether the module is used in production.

has super-classes Performance Indicator^c SAP modules^c

Is the module used in production (performance indicators, EC: corporate controlling)^c

IRI: `https://w3id.org/bmontology#SAPModules_PerformanceIndicators_ECCorporateControlling_IsTheModuleUsedInProduction`

This is a performance indicator of the SAP modules service, categorized into performance indicators as well as EC: corporate controlling. This indicator captures whether the module is used in production.

has super-classes Performance Indicator^c SAP modules^c

Is the module used in production (performance indicators, FI: finance)^c

IRI: `https://w3id.org/bmontology#SAPModules_PerformanceIndicators_FIFinance_IsTheModuleUsedInProduction`

This is a performance indicator of the SAP modules service, categorized into performance indicators as well as FI: finance. This indicator captures whether the module is used in production.

has super-classes Performance Indicator^c SAP modules^c

Is the module used in production (performance indicators, MM: materials management)^c

IRI: `https://w3id.org/bmontology#SAPModules_PerformanceIndicators_MMMaterialsManagement_IsTheModuleUsedInProduction`

This is a performance indicator of the SAP modules service, categorized into performance indicators as well as MM: materials management. This indicator captures whether the module is used in production.

has super-classes Performance Indicator^c SAP modules^c

Is the module used in production (performance indicators, PM: plant maintenance)[c]

IRI: `https://w3id.org/bmontology#SAPModules_PerformanceIndicators_PMPlantMaintenance_IsTheModuleUsedInProduction`

This is a performance indicator of the SAP modules service, categorized into performance indicators as well as PM: plant maintenance. This indicator captures whether the module is used in production.

has super-classes Performance Indicator[c] SAP modules[c]

Is the module used in production (performance indicators, PP: production planning and control)[c]

IRI: `https://w3id.org/bmontology#SAPModules_PerformanceIndicators_PPProductionPlanningAndControl_IsTheModuleUsedInProduction`

This is a performance indicator of the SAP modules service, categorized into performance indicators as well as PP: production planning and control. This indicator captures whether the module is used in production.

has super-classes Performance Indicator[c] SAP modules[c]

Is the module used in production (performance indicators, SD: sales and distribution)[c]

IRI: `https://w3id.org/bmontology#SAPModules_PerformanceIndicators_SDSalesAndDistribution_IsTheModuleUsedInProduction`

This is a performance indicator of the SAP modules service, categorized into performance indicators as well as SD: sales and distribution. This indicator captures whether the module is used in production.

has super-classes Performance Indicator[c] SAP modules[c]

IT costs applications (IT costs, basic data)[c]

IRI: `https://w3id.org/bmontology#BasicData_ITCosts_BasicData_ITCostsApplications`

This is a cost indicator of the basic data service, categorized into IT costs as well as basic data. This indicator captures all costs of the area of applications.

has super-classes Basic data^c Cost Indicator^c Software resource indicator^c

IT costs Change (projects) (IT costs, basic data)^c

IRI: `https://w3id.org/bmontology#BasicData_ITCosts_BasicData_ITCostsChangeProjects`

This is a cost indicator of the basic data service, categorized into IT costs as well as basic data. This indicator captures the costs of all IT projects.

has super-classes Basic data^c Cost Indicator^c

IT costs management (IT costs, basic data)^c

IRI: `https://w3id.org/bmontology#BasicData_ITCosts_BasicData_ITCostsManagement`

This is a cost indicator of the basic data service, categorized into IT costs as well as basic data. This indicator captures all costs of the area of management.

has super-classes Basic data^c Cost Indicator^c

IT costs of external performance (IT costs, basic data)^c

IRI: `https://w3id.org/bmontology#BasicData_ITCosts_BasicData_ITCostsOfExternalPerformance`

This is a cost indicator of the basic data service, categorized into IT costs as well as basic data. This indicator captures the costs of externally provided services.

has super-classes Basic data^c Cost Indicator^c

IT costs of infrastructure (IT costs, basic data)^c

IRI: `https://w3id.org/bmontology#BasicData_ITCosts_BasicData_ITCostsOfInfrastructure`

This is a cost indicator of the basic data service, categorized into IT costs as well as basic data. This indicator captures all costs of the area of infrastructure.

has super-classes Basic data^c Cost Indicator^c

IT costs of internal performance (IT costs, basic data)^c

IRI: `https://w3id.org/bmontology#BasicData_ITCosts_BasicData_ITCostsOfInternalPerformance`

This is a cost indicator of the basic data service, categorized into IT costs as well as basic data. This indicator captures the costs of internally provided services.

has super-classes Basic data^c Cost Indicator^c

IT costs Run (line activities) (IT costs, basic data)^c

IRI: `https://w3id.org/bmontology#BasicData_ITCosts_BasicData_ITCostsRunLineActivities`

This is a cost indicator of the basic data service, categorized into IT costs as well as basic data. This indicator captures the costs for IT line activities.

has super-classes Basic data^c Cost Indicator^c

IT investment (IT costs, basic data)^c

IRI: `https://w3id.org/bmontology#BasicData_ITCosts_BasicData_ITInvestment`

This is a cost indicator of the basic data service, categorized into IT costs as well as basic data. This indicator captures the investments for the whole IT.

has super-classes Basic data^c Cost Indicator^c

IT involved in purchasing process (IT and development, basic data)^c

IRI: `https://w3id.org/bmontology#BasicData_ITAndDevelopment_BasicData_ITInvolvedInPurchasingProcess`

This is an indicator of the basic data service, categorized into IT and development as well as basic data. This indicator captures whether the IT is involved in the purchasing process of IT related products.

has super-classes Basic data^c

IT personnel costs (IT costs, basic data)^c

IRI: `https://w3id.org/bmontology#BasicData_ITCosts_BasicData_ITPersonnelCosts`

This is a cost indicator of the basic data service, categorized into IT costs as well as basic data. This indicator captures all costs of the area of personnel.

has super-classes Basic data^c Cost Indicator^c Human resource indicator^c

IT service questionnaire^c

IRI: `https://w3id.org/bmontology#ITService`

Represents a questionnaire classified as IT service

has super-classes Questionnaire of an individual benchmark^c

is disjoint with Service segment questionnaire^c

IT total costs (IT costs, basic data)^c

IRI: `https://w3id.org/bmontology#BasicData_ITCosts_BasicData_ITTotalCosts`

This is a cost indicator of the basic data service, categorized into IT costs as well as basic data. This indicator captures the total costs of the IT within an organization.

has super-classes Basic data^c Cost Indicator^c

IT trends (IT and development, basic data)^c

IRI: `https://w3id.org/bmontology#BasicData_ITAndDevelopment_BasicData_ITTrends`

This is an indicator of the basic data service, categorized into IT and development as well as basic data. This indicator captures hot topics of the IT.

has super-classes Basic data^c

Knowledge management (performance indicators, technology)^c

IRI: `https://w3id.org/bmontology#Servicedesk_PerformanceIndicators_Technology_KnowledgeManagement`

This is a performance indicator of the servicedesk service, categorized into performance indicators as well as technology. This indicator captures which Knowledge Management System is used within the organization.

has super-classes Performance Indicator^c Servicedesk^c Software resource indicator^c

LAN^c

IRI: `https://w3id.org/bmontology#LANIndicator`

Classifies LAN indicators

has super-classes Service template dimension for indicator classification^c

has sub-classes Cabling Gbit over copper (performance indicators, additional information)^c , Characteristics of LAN (performance indicators, additional information)^c , Distribution of tertiary cabling (performance indicators, additional information)^c , Ensured availability (performance indicators, additional information)^c , External services (cost indicators, WLAN)^c , External services (cost indicators, active components)^c , External services (cost indicators, monitoring and administration environment)^c , External services (cost indicators, security environment)^c , Hardware (cost indicators, WLAN)^c , Hardware (cost indicators, active components)^c , Hardware (cost indicators, monitoring and administration environment)^c , Hardware (cost indicators, security environment)^c , Hardware maintenance (cost indicators, WLAN)^c , Hardware maintenance (cost indicators, active components)^c , Hardware maintenance (cost indicators, monitoring and administration environment)^c , Hardware maintenance (cost indicators, security environment)^c , Information about admin environment (performance indicators, performance and architecture)^c , Introsion detection systems (performance indicators, additional information)^c , Number of WLAN controller (performance indicators, WLAN)^c , Number of access point (performance indicators, WLAN)^c , Number of access ports 1 Gbit with PoE (performance indicators, quantity structure)^c , Number of access ports 1 Gbit without

PoE (performance indicators, quantity structure)^c , Number of access ports 100Mbit with PoE (performance indicators, quantity structure)^c , Number of access ports 100Mbit without PoE (performance indicators, quantity structure)^c , Number of connected devices using access ports (performance indicators, quantity structure)^c , Number of external personnel (FTE) (performance indicators, quantity structure)^c , Number of external personnel WLAN (FTE) (performance indicators, WLAN)^c , Number of internal personnel (FTE) (performance indicators, quantity structure)^c , Number of internal personnel WLAN (FTE) (performance indicators, WLAN)^c , Number of other access ports (performance indicators, quantity structure)^c , Others (cost indicators, WLAN)^c , Others (cost indicators, active components)^c , Others (cost indicators, monitoring and administration environment)^c , Others (cost indicators, security environment)^c , Personnel (cost indicators, WLAN)^c , Personnel (cost indicators, active components)^c , Personnel (cost indicators, monitoring and administration environment)^c , Personnel (cost indicators, security environment)^c , Portion LX port (performance indicators, port information)^c , Portion QoS for VoIP (Portion of ports) (performance indicators, port information)^c , Portion QoS for video (Portion of ports) (performance indicators, port information)^c , Portion of access ports with NAC (performance indicators, port information)^c , Redundant uplinks of access and distribution switches (performance indicators, performance and architecture)^c , Software (cost indicators, WLAN)^c , Software (cost indicators, active components)^c , Software (cost indicators, monitoring and administration environment)^c , Software (cost indicators, security environment)^c , Software maintenance (cost indicators, WLAN)^c , Software maintenance (cost indicators, active components)^c , Software maintenance (cost indicators, monitoring and administration environment)^c , Software maintenance (cost indicators, security environment)^c , Type of sourcing (performance indicators, additional information)^c , Voice over WLAN (performance indicators, WLAN)^c , Working life of active LAN components (performance indicators, additional information)^c

is disjoint with Backup^c , Basic data^c , Collaboration^c , Database^c , Dedicated server^c , File Service^c , IMAC^c , Mailbox^c , Mobile devices^c , Remote access service^c , SAP basis^c , SAP modules^c , Servicedesk^c , Storage^c , Telephony^c , Terminal server^c , Virtual server^c , WAN^c , Workplace^c

Legal form of the organization (performance indicators, basic data)^c

IRI: `https://w3id.org/bmontology#BasicData_PerformanceIndicators_BasicData_LegalFormOfTheOrganization`

This is a performance indicator of the basic data service, categorized into performance indicators as well as basic data. This indicator captures the legal form of the organization.

has super-classes Basic data^c Performance Indicator^c

License costs (cost indicators, total costs)^c

IRI: `https://w3id.org/bmontology#SAPBasis_CostIndicators_TotalCosts_LicenseCosts`

This is a cost indicator of the SAP basis service, categorized into cost indicators as well as total costs. This indicator captures the licence costs for other tools used with SAP.

has super-classes Cost Indicator^c SAP basis^c Software resource indicator^c

Location of first level support (performance indicators, quantity structure and performance)^c

IRI: `https://w3id.org/bmontology#Servicedesk_PerformanceIndicators_QuantityStructureAndPerformance_LocationOfFirstLevelSupport`

This is a performance indicator of the servicedesk service, categorized into performance indicators as well as quantity structure and performance. This indicator captures where the 1st level support is located.

has super-classes Performance Indicator^c Servicedesk^c

Mailbox^c

IRI: `https://w3id.org/bmontology#MailboxIndicator`

Classifies mailbox indicators

has super-classes Service template dimension for indicator classification^c

has sub-classes Backup strategy (performance indicators, quantity structure)^c , Ensured availability (performance indicators, quantity structure)^c , External services (cost indicators, total costs)^c , Hardware (cost indicators, total costs)^c , Hardware maintenance (cost indicators, total costs)^c , Mailbox - Usage of mailbox archiving (performance indicators, quantity structure)^c , Mailbox - operating mode (performance indicators, quantity structure)^c , Name of the mailsystem (performance indicators, quantity structure)^c , Number of external personnel (FTE) (performance indicators, quantity structure)^c , Number of internal personnel (FTE) (performance indicators, quantity structure)^c , Number of mailboxes (performance indicators, quantity structure)^c , Number of mailservers (performance indicators, quantity structure)^c , Number of users Mail (performance indicators, quantity structure)^c

, Offetting backup (cost indicators, total costs)^c , Offsetting Server (cost indicators, total costs)^c , Offsetting Storage (cost indicators, total costs)^c , Others (cost indicators, total costs)^c , Personnel (cost indicators, total costs)^c , Software (cost indicators, total costs)^c , Software maintenance (cost indicators, total costs)^c , Total storage size of mailboxes (performance indicators, quantity structure)^c , Type of sourcing (performance indicators, quantity structure)^c

is disjoint with Backup^c , Basic data^c , Collaboration^c , Database^c , Dedicated server^c , File Service^c , IMAC^c , LAN^c , Mobile devices^c , Remote access service^c , SAP basis^c , SAP modules^c , Servicedesk^c , Storage^c , Telephony^c , Terminal server^c , Virtual server^c , WAN^c , Workplace^c

Mailbox - operating mode (performance indicators, quantity structure)^c

IRI: `https://w3id.org/bmontology#Mailbox_PerformanceIndicators_QuantityStructure_MailboxOperatingMode`

This is a performance indicator of the mailbox service, categorized into performance indicators as well as quantity structure. This indicator captures the operating mode of the mailbox.

has super-classes Mailbox^c Performance Indicator^c

Mailbox - Usage of mailbox archiving (performance indicators, quantity structure)^c

IRI: `https://w3id.org/bmontology#Mailbox_PerformanceIndicators_QuantityStructure_MailboxUsageOfMailboxArchiving`

This is a performance indicator of the mailbox service, categorized into performance indicators as well as quantity structure. This indictor captures whether mail archiving is applied.

has super-classes Mailbox^c Performance Indicator^c

Main scope (performance indicators, quantity structure and performance)^c

IRI: `https://w3id.org/bmontology#Servicedesk_PerformanceIndicators_QuantityStructureAndPerformance_MainScope`

This is a performance indicator of the servicedesk service, categorized into performance indicators as well as quantity structure and performance. This indicator captures the geographic areas the provided data is referring to.

has super-classes Performance Indicator^c Servicedesk^c

Maintenance (cost indicators, desktop)^c

IRI: `https://w3id.org/bmontology#Workplace_CostIndicators_Desktop_Maintenance`

This is a cost indicator of the workplace service, categorized into cost indicators as well as desktop. This indicator captures the total operating costs (excl. service desk performance).

has super-classes Cost Indicator^c Software resource indicator^c Workplace^c

Maintenance (cost indicators, laptop)^c

IRI: `https://w3id.org/bmontology#Workplace_CostIndicators_Laptop_Maintenance`

This is a cost indicator of the workplace service, categorized into cost indicators as well as laptop. This indicator captures the total operating costs (excl. service desk performance).

has super-classes Cost Indicator^c Software resource indicator^c Workplace^c

Maintenance costs (cost indicators, BC: basic system)^c

IRI: `https://w3id.org/bmontology#SAPModules_CostIndicators_BCBasicSystem_MaintenanceCosts`

This is a cost indicator of the SAP modules service, categorized into cost indicators as well as BC: basic system. This indicator captures the maintenance costs that are involved in the module and its submodules.

has super-classes Cost Indicator^c Human resource indicator^c SAP modules^c

Maintenance costs (cost indicators, co: controlling)^{c}

IRI: `https://w3id.org/bmontology#SAPModules_CostIndicators_CoControlling_MaintenanceCosts`

This is a cost indicator of the SAP modules service, categorized into cost indicators as well as co: controlling. This indicator captures the maintenance costs that are involved in the module and its submodules.

has super-classes Cost Indicator^{c} Human resource indicator^{c} SAP modules^{c}

Maintenance costs (cost indicators, CS: customer service)^{c}

IRI: `https://w3id.org/bmontology#SAPModules_CostIndicators_CSCustomerService_MaintenanceCosts`

This is a cost indicator of the SAP modules service, categorized into cost indicators as well as CS: customer service. This indicator captures the maintenance costs that are involved in the module and its submodules.

has super-classes Cost Indicator^{c} Human resource indicator^{c} SAP modules^{c}

Maintenance costs (cost indicators, EC: corporate controlling)^{c}

IRI: `https://w3id.org/bmontology#SAPModules_CostIndicators_ECCorporateControlling_MaintenanceCosts`

This is a cost indicator of the SAP modules service, categorized into cost indicators as well as EC: corporate controlling. This indicator captures the maintenance costs that are involved in the module and its submodules.

has super-classes Cost Indicator^{c} Human resource indicator^{c} SAP modules^{c}

Maintenance costs (cost indicators, FI: finance)^{c}

IRI: `https://w3id.org/bmontology#SAPModules_CostIndicators_FIFinance_MaintenanceCosts`

This is a cost indicator of the SAP modules service, categorized into cost indicators as well as FI: finance. This indicator captures the maintenance costs that are involved in the module and its submodules.

has super-classes Cost Indicator^c Human resource indicator^c SAP modules^c

Maintenance costs (cost indicators, MM: materials management)^c

IRI: `https://w3id.org/bmontology#SAPModules_CostIndicators_MMMaterialsManagement_MaintenanceCosts`

This is a cost indicator of the SAP modules service, categorized into cost indicators as well as MM: materials management. This indicator captures the maintenance costs that are involved in the module and its submodules.

has super-classes Cost Indicator^c Human resource indicator^c SAP modules^c

Maintenance costs (cost indicators, PM: plant maintenance)^c

IRI: `https://w3id.org/bmontology#SAPModules_CostIndicators_PMPlantMaintenance_MaintenanceCosts`

This is a cost indicator of the SAP modules service, categorized into cost indicators as well as PM: plant maintenance. This indicator captures the maintenance costs that are involved in the module and its submodules.

has super-classes Cost Indicator^c Human resource indicator^c SAP modules^c

Maintenance costs (cost indicators, PP: production planning and control)^c

IRI: `https://w3id.org/bmontology#SAPModules_CostIndicators_PPProductionPlanningAndControl_MaintenanceCosts`

This is a cost indicator of the SAP modules service, categorized into cost indicators as well as PP: production planning and control. This indicator captures the maintenance costs that are involved in the module and its submodules.

has super-classes Cost Indicator^c Human resource indicator^c SAP modules^c

Maintenance costs (cost indicators, SD: sales and distribution)^c

IRI: https://w3id.org/bmontology#SAPModules_CostIndicators_SDSalesAndDistribution_MaintenanceCosts

This is a cost indicator of the SAP modules service, categorized into cost indicators as well as SD: sales and distribution. This indicator captures the maintenance costs that are involved in the module and its submodules.

has super-classes Cost Indicator^c Human resource indicator^c SAP modules^c

Maintenance costs service desk tool (cost indicators, total costs)^c

IRI: https://w3id.org/bmontology#Servicedesk_CostIndicators_TotalCosts_MaintenanceCostsServiceDeskTool

This is a cost indicator of the servicedesk service, categorized into cost indicators as well as total costs. This indicator captures the costs for the corresponding tool per year.

has super-classes Cost Indicator^c Servicedesk^c Software resource indicator^c

Management of mobile contracts (performance indicators, general indicators)^c

IRI: https://w3id.org/bmontology#MobileDevices_PerformanceIndicators_GeneralIndicators_ManagementOfMobileContracts

This is a performance indicator of the mobile devices service, categorized into performance indicators as well as general indicators. This indicator captures how mobile contracts are managed.

has super-classes Mobile devices^c Performance Indicator^c

Management of mobile devices (performance indicators, general indicators)^c

IRI: https://w3id.org/bmontology#MobileDevices_PerformanceIndicators_GeneralIndicators_ManagementOfMobileDevices

This is a performance indicator of the mobile devices service, categorized into performance indicators as well as general indicators. This indicator captures whether the mobile devices are administrated.

has super-classes Mobile devices^c Performance Indicator^c

Manufacturer of telephony platform (performance indicators, performance information)^c

IRI: `https://w3id.org/bmontology#Telephony_PerformanceIndicators_PerformanceInformation_ManufacturerOfTelephonyPlatform`

This is a performance indicator of the telephony service, categorized into performance indicators as well as performance information. This indicator captures the manufacturer of the used telephone system.

has super-classes Performance Indicator^c Telephony^c

Master data and avoidance of redundancy (performance indicators, quantity structure and performance)^c

IRI: `https://w3id.org/bmontology#SAPBasis_PerformanceIndicators_QuantityStructureAndPerformance_MasterDataAndAvoidanceOfRedundancy`

This is a performance indicator of the SAP basis service, categorized into performance indicators as well as quantity structure and performance. This indicator captures arrangements to avoid redundancy among the master data.

has super-classes Performance Indicator^c SAP basis^c

Master data central or decentral (performance indicators, quantity structure and performance)^c

IRI: `https://w3id.org/bmontology#SAPBasis_PerformanceIndicators_QuantityStructureAndPerformance_MasterDataCentralOrDecentral`

This is a performance indicator of the SAP basis service, categorized into performance indicators as well as quantity structure and performance. This indicator captures whether master data is stored centrally or decentrally.

has super-classes Performance Indicator^c SAP basis^c

Master data management (performance indicators, quantity structure and performance)^c

IRI: `https://w3id.org/bmontology#SAPBasis_PerformanceIndicators_QuantityStructureAndPerformance_MasterDataManagement`

This is a performance indicator of the SAP basis service, categorized into performance indicators as well as quantity structure and performance. This indicator captures whether a master data management (MDM) exists.

has super-classes Performance Indicator^c SAP basis^c

Max. data loss time (performance indicators, quantity structure and performance)^c

IRI: `https://w3id.org/bmontology#Backup_PerformanceIndicators_QuantityStructureAndPerformance_MaxDataLossTime`

This is a performance indicator of the backup service, categorized into performance indicators as well as quantity structure and performance. This indicator captures the maximum data loss time in days.

has super-classes Backup^c Performance Indicator^c

Mobile carrier (performance indicators, general indicators)^c

IRI: `https://w3id.org/bmontology#MobileDevices_PerformanceIndicators_GeneralIndicators_MobileCarrier`

This is a performance indicator of the mobile devices service, categorized into performance indicators as well as general indicators. This indicator captures the mobile service provider.

has super-classes Mobile devices^c Performance Indicator^c

Mobile devices^c

IRI: `https://w3id.org/bmontology#MobileDevicesIndicator`

Classifies mobile device indicators

has super-classes Service template dimension for indicator classification^c

has sub-classes Active solutions in use (performance indicators, general indicators)^c , Bring your own device (performance indicators, general indicators)^c , Contractual regulation regarding the usage of data volume (performance indicators, general indicators)^c , Frequency of changes (years) (performance indicators, general indicators)^c , How are end devices purchased (performance indicators, general indicators)^c , Management of mobile contracts (performance indicators, general indicators)^c , Management of mobile devices (performance indicators, general indicators)^c , Mobile Devices (Blackberry)^c , Mobile Devices (Others)^c , Mobile Devices (Windows Phone)^c , Mobile Devices (iPhone)^c , Mobile carrier (performance indicators, general indicators)^c , Number of active devices in the organization (performance indicators, general indicators)^c , Number of passive devices in the organization (performance indicators, general indicators)^c , On which platforms are the solutions based? (performance indicators, general indicators)^c , Renewal of end devices (performance indicators, general indicators)^c , Support of users having broken devices (performance indicators, general indicators)^c , Usage of iPass (performance indicators, general indicators)^c , Usage of telephone expense (performance indicators, general indicators)^c

is disjoint with Backup^c , Basic data^c , Collaboration^c , Database^c , Dedicated server^c , File Service^c , IMAC^c , LAN^c , Mailbox^c , Remote access service^c , SAP basis^c , SAP modules^c , Servicedesk^c , Storage^c , Telephony^c , Terminal server^c , Virtual server^c , WAN^c , Workplace^c

Mobile Devices (Blackberry)^c

IRI: `https://w3id.org/bmontology#MobileDevices_Blackberry_Indicator`

Classifies mobile devices indicators for Blackberry devices

has super-classes Mobile devices^c

has sub-classes Autonomous installation of apps (performance indicators, security indicators (blackberry))^c , CRM (performance indicators, quantity structure and performance (blackberry))^c , Data encryption (performance indicators, security indicators (blackberry))^c , Depreciation period (performance indicators, quantity structure and performance (blackberry))^c , External services (cost indicators, blackberry)^c , Frequency of password changes (weeks) (performance indicators, security indicators (blackberry))^c , Further usage scenarios (performance indicators, quantity structure and performance (blackberry))^c , Hardware (cost indicators, blackberry)^c , Hardware maintenance (cost indicators, blackberry)^c , Internet access (performance indicators, quantity structure and performance (blackberry))^c , Intranet access (performance indicators, quantity structure and performance (blackberry))^c , Number of end devices (this platform) (performance indicators, quantity structure and performance (blackberry))^c , Number of external personnel per platform (FTE) (performance indicators, quantity structure and performance (blackberry))^c , Number of internal personnel per plantform (FTE) (performance indicators, quantity structure and performance (blackberry))^c , Number of servers (platform-specific) (performance indicators, quantity structure and performance (blackberry))^c , Offsetting Server (cost indicators, blackberry)^c , Others (cost indicators, blackberry)^c , Password changes in fixed periods of time required (performance indicators, security indicators (blackberry))^c , Personal Information Management (PIM) (performance indicators, quantity structure and performance (blackberry))^c , Personnel (cost indicators, blackberry)^c , Platform remote wipe offered (performance indicators, security indicators (blackberry))^c , Private usage allowed (performance indicators, security indicators (blackberry))^c , S/MIME email encryption (performance indicators, security indicators (blackberry))^c , Sandbox (performance indicators, security indicators (blackberry))^c , Security settings based on a central policy (performance indicators, security indicators (blackberry))^c , Software (cost indicators, blackberry)^c , Software maintenance (cost indicators, blackberry)^c , Type of service delivery (performance indicators, quantity structure and performance (blackberry))^c , Way of internet access (performance indicators, security indicators (blackberry))^c

Mobile Devices (iPhone)^c

IRI: `https://w3id.org/bmontology#MobileDevices_iPhone_Indicator`

Classifies mobile devices indicators for iPhones

has super-classes Mobile devices^c

has sub-classes Autonomous installation of apps (performance indicators, security indicators (iPhone))^c , CRM (performance indicators, quantity structure and performance (iPhone))^c , Data encryption (performance indicators, security indicators (iPhone))^c , Depreciation period (performance indicators, quantity structure and performance (iPhone))^c , External services (cost indicators, iPhone)^c , Frequency of password changes (weeks) (performance indicators, security indicators (iPhone))^c , Further usage scenarios (performance indicators, quantity structure and performance (iPhone))^c , Hardware (cost indicators, iPhone)^c , Hardware maintenance (cost indicators, iPhone)^c , Internet access (performance indicators, quantity structure and performance (iPhone))^c , Intranet access (performance indicators, quantity structure and performance (iPhone))^c , Number of end devices (this platform) (performance indicators, quantity structure and performance (iPhone))^c , Number of external personnel per platform (FTE) (performance indicators, quantity structure and performance (iPhone))^c , Number of internal personnel per plantform (FTE) (performance indicators, quantity structure and performance (iPhone))^c , Number of servers (platform-specific) (performance indicators, quantity structure and performance (iPhone))^c , Offsetting Server (cost indicators, iPhone)^c , Others (cost indicators, iPhone)^c , Password changes in fixed periods of time required (performance indicators, security indicators (iPhone))^c , Personal Information Management (PIM) (performance indicators, quantity structure and performance (iPhone))^c , Personnel (cost indicators, iPhone)^c , Platform remote wipe offered (performance indicators, security indicators (iPhone))^c , Private usage allowed (performance indicators, security indicators (iPhone))^c , S/MIME email encryption (performance indicators, security indicators (iPhone))^c , Sandbox (performance indicators, security indicators (iPhone))^c , Security settings based on a central policy (performance indicators, security indicators (iPhone))^c , Software (cost indicators, iPhone)^c , Software maintenance (cost indicators, iPhone)^c , Type of service delivery (performance indicators, quantity structure and performance (iPhone))^c , Way of internet access (performance indicators, security indicators (iPhone))^c

Mobile Devices (Others)^c

IRI: `https://w3id.org/bmontology#MobileDevices_Others_Indicator`

Classifies mobile devices indicators for other devices

has super-classes Mobile devices^c

has sub-classes Autonomous installation of apps (performance indicators, security indicators (other))^c , CRM (performance indicators, quantity structure and performance (other))^c , Data encryption (performance indicators, security indicators (other))^c , Depreciation period (performance indicators, quantity structure and performance (other))^c , External services (cost indicators, others)^c , Frequency of password changes (weeks) (performance indicators, security indicators (other))^c , Further usage scenarios (performance indicators, quantity structure and performance (other))^c , Hardware (cost indicators, others)^c , Hardware maintenance (cost indicators, others)^c , Internet access (performance indicators, quantity structure and performance (other))^c , Intranet access (performance indicators, quantity structure and performance (other))^c , Number of end devices (this platform) (performance indicators, quantity structure and performance (other))^c , Number of external personnel per platform (FTE) (performance indicators, quantity structure and performance (other))^c , Number of internal personnel per plantform (FTE) (performance indicators, quantity structure and performance (other))^c , Number of servers (platform-specific) (performance indicators, quantity structure and performance (other))^c , Offsetting Server (cost indicators, others)^c , Others (cost indicators, others)^c , Password changes in fixed periods of time required (performance indicators, security indicators (other))^c , Personal Information Management (PIM) (performance indicators, quantity structure and performance (other))^c , Personnel (cost indicators, others)^c , Platform (cost indicators, others)^c , Platform (performance indicators, quantity structure and performance (other))^c , Platform (performance indicators, security indicators (other))^c , Platform remote wipe offered (performance indicators, security indicators (other))^c , Private usage allowed (performance indicators, security indicators (other))^c , S/MIME email encryption (performance indicators, security indicators (other))^c , Sandbox (performance indicators, security indicators (other))^c , Security settings based on a central policy (performance indicators, security indicators (other))^c , Software (cost indicators, others)^c , Software maintenance (cost indicators, others)^c , Type of service delivery (performance indicators, quantity structure and performance (other))^c , Way of internet access (performance indicators, security indicators (other))^c

Mobile Devices (Windows Phone)^c

IRI: `https://w3id.org/bmontology#MobileDevices_WindowsPhone_Indicator`

Classifies mobile devices indicators for Windows Phone devices

has super-classes Mobile devices^c

has sub-classes Autonomous installation of apps (performance indicators, security indicators (windows phone))^c , CRM (performance indicators, quantity structure and performance (windows phone))^c , Data encryption (performance indicators, security indicators (windows phone))^c , Depreciation period (performance indicators, quantity structure and performance (windows phone))^c , External services (cost indicators, windows phone)^c , Frequency of password changes (weeks) (performance indicators, security indicators (windows phone))^c , Further usage scenarios (performance indicators, quantity structure and performance (windows phone))^c , Hardware (cost indicators, windows phone)^c , Hardware maintenance (cost indicators, windows phone)^c , Internet access (performance indicators, quantity structure and performance (windows phone))^c , Intranet access (performance indicators, quantity structure and performance (windows phone))^c , Number of end devices (this platform) (performance indicators, quantity structure and performance (windows phone))^c , Number of external personnel per platform (FTE) (performance indicators, quantity structure and performance (windows phone))^c , Number of internal personnel per plantform (FTE) (performance indicators, quantity structure and performance (windows phone))^c , Number of servers (platform-specific) (performance indicators, quantity structure and performance (windows phone))^c , Offsetting Server (cost indicators, windows phone)^c , Others (cost indicators, windows phone)^c , Password changes in fixed periods of time required (performance indicators, security indicators (windows phone))^c , Personal Information Management (PIM) (performance indicators, quantity structure and performance (windows phone))^c , Personnel (cost indicators, windows phone)^c , Platform remote wipe offered (performance indicators, security indicators (windows phone))^c , Private usage allowed (performance indicators, security indicators (windows phone))^c , S/MIME email encryption (performance indicators, security indicators (windows phone))^c , Sandbox (performance indicators, security indicators (windows phone))^c , Security settings based on a central policy (performance indicators, security indicators (windows phone))^c , Software (cost indicators, windows phone)[c] , Software maintenance (cost indicators, windows phone)[c] , Type of service delivery (performance indicators, quantity structure and performance (windows phone))[c] , Way of internet access (performance indicators, security indicators (windows phone))[c]

Module adaption (performance indicators, BC: basic system)[c]

IRI: `https://w3id.org/bmontology#SAPModules_PerformanceIndicators_BCBasicSystem_ModuleAdaption`

This is a performance indicator of the SAP modules service, categorized into performance indicators as well as BC: basic system. This indicator captures whether the module and its submodules has been adapted or whether the process has been adapted in order to fit the default configuration.

has super-classes Performance Indicator[c] SAP modules[c]

Module adaption (performance indicators, co: controlling)[c]

IRI: `https://w3id.org/bmontology#SAPModules_PerformanceIndicators_CoControlling_ModuleAdaption`

This is a performance indicator of the SAP modules service, categorized into performance indicators as well as co: controlling. This indicator captures how far the module and its submodules have been adapted or whether the processes have been adapted so they can be reflected by the default configuration.

has super-classes Performance Indicator[c] SAP modules[c]

Module adaption (performance indicators, CS: customer service)[c]

IRI: `https://w3id.org/bmontology#SAPModules_PerformanceIndicators_CSCustomerService_ModuleAdaption`

This is a performance indicator of the SAP modules service, categorized into performance indicators as well as CS: customer service. This indicator captures how far the module and its submodules have been adapted or whether the processes have been adapted so they can be reflected by the default configuration.

has super-classes Performance Indicator[c] SAP modules[c]

Module adaption (performance indicators, EC: corporate controlling)^c

IRI: `https://w3id.org/bmontology#SAPModules_PerformanceIndicators_ECCorporateControlling_ModuleAdaption`

This is a performance indicator of the SAP modules service, categorized into performance indicators as well as EC: corporate controlling. This indicator captures how far the module and its submodules have been adapted or whether the processes have been adapted so they can be reflected by the default configuration.

has super-classes Performance Indicator^c SAP modules^c

Module adaption (performance indicators, FI: finance)^c

IRI: `https://w3id.org/bmontology#SAPModules_PerformanceIndicators_FIFinance_ModuleAdaption`

This is a performance indicator of the SAP modules service, categorized into performance indicators as well as FI: finance. This indicator captures how far the module and its submodules have been adapted or whether the processes have been adapted so they can be reflected by the default configuration.

has super-classes Performance Indicator^c SAP modules^c

Module adaption (performance indicators, MM: materials management)^c

IRI: `https://w3id.org/bmontology#SAPModules_PerformanceIndicators_MMMaterialsManagement_ModuleAdaption`

This is a performance indicator of the SAP modules service, categorized into performance indicators as well as MM: materials management. This indicator captures how far the module and its submodules have been adapted or whether the processes have been adapted so they can be reflected by the default configuration.

has super-classes Performance Indicator^c SAP modules^c

Module adaption (performance indicators, PM: plant maintenance)^{c}

IRI: `https://w3id.org/bmontology#SAPModules_PerformanceIndicators_PMPlantMaintenance_ModuleAdaption`

This is a performance indicator of the SAP modules service, categorized into performance indicators as well as PM: plant maintenance. This indicator captures how far the module and its submodules have been adapted or whether the processes have been adapted so they can be reflected by the default configuration.

has super-classes Performance Indicator^{c} SAP modules^{c}

Module adaption (performance indicators, PP: production planning and control)^{c}

IRI: `https://w3id.org/bmontology#SAPModules_PerformanceIndicators_PPProductionPlanningAndControl_ModuleAdaption`

This is a performance indicator of the SAP modules service, categorized into performance indicators as well as PP: production planning and control. This indicator captures how far the module and its submodules have been adapted or whether the processes have been adapted so they can be reflected by the default configuration.

has super-classes Performance Indicator^{c} SAP modules^{c}

Module adaption (performance indicators, SD: sales and distribution)^{c}

IRI: `https://w3id.org/bmontology#SAPModules_PerformanceIndicators_SDSalesAndDistribution_ModuleAdaption`

This is a performance indicator of the SAP modules service, categorized into performance indicators as well as SD: sales and distribution. This indicator captures how far the module and its submodules have been adapted or whether the processes have been adapted so they can be reflected by the default configuration.

has super-classes Performance Indicator^{c} SAP modules^{c}

Modules in use (performance indicators, additional information)^{c}

IRI: `https://w3id.org/bmontology#SAPBasis_PerformanceIndicators_AdditionalInformation_ModulesInUse`

This is a performance indicator of the SAP basis service, categorized into performance indicators as well as additional information. This indicator captures the number of used modules of the SAP system.

has super-classes Performance Indicator^{c} SAP basis^{c}

Move - Logical (cost indicators, costs move)^{c}

IRI: `https://w3id.org/bmontology#IMAC_CostIndicators_CostsMove_MoveLogical`

This is a cost indicator of the IMAC service, categorized into cost indicators as well as costs move. This indicator captures the total costs of a logical move.

has super-classes Cost Indicator^{c} Human resource indicator^{c} IMAC^{c}

Move - Physical (cost indicators, costs move)^{c}

IRI: `https://w3id.org/bmontology#IMAC_CostIndicators_CostsMove_MovePhysical`

This is a cost indicator of the IMAC service, categorized into cost indicators as well as costs move. This indicator captures the total costs of a physical move.

has super-classes Cost Indicator^{c} Human resource indicator^{c} IMAC^{c}

Name of the mailsystem (performance indicators, quantity structure)^{c}

IRI: `https://w3id.org/bmontology#Mailbox_PerformanceIndicators_QuantityStructure_NameOfTheMailsystem`

This is a performance indicator of the mailbox service, categorized into performance indicators as well as quantity structure. This indicator captures the name (i.e., determined by the manufacturer) of the mailbox system.

has super-classes Mailbox^c Performance Indicator^c

Number of access point (performance indicators, WLAN)^c

IRI: `https://w3id.org/bmontology#LAN_PerformanceIndicators_WLAN_NumberOfAccessPoint`

This is a performance indicator of the LAN service, categorized into performance indicators as well as WLAN. This indicator captures the number of access points that are available to the WLAN infrastructure within the organization.

has super-classes LAN^c Quantity indicator^c

Number of access ports 1 Gbit with PoE (performance indicators, quantity structure)^c

IRI: `https://w3id.org/bmontology#LAN_PerformanceIndicators_QuantityStructure_NumberOfAccessPorts1GbitWithPoE`

This is a performance indicator of the LAN service, categorized into performance indicators as well as quantity structure. This indicator captures the number of acess ports having 1 Gbit with PoE.

has super-classes Hardware resource indicator^c LAN^c Quantity indicator^c

Number of access ports 1 Gbit without PoE (performance indicators, quantity structure)^c

IRI: `https://w3id.org/bmontology#LAN_PerformanceIndicators_QuantityStructure_NumberOfAccessPorts1GbitWithoutPoE`

This is a performance indicator of the LAN service, categorized into performance indicators as well as quantity structure. This indicator captures the number of acess ports having 1 Gbit without PoE.

has super-classes Hardware resource indicator^c LAN^c Quantity indicator^c

Number of access ports 100Mbit with PoE (performance indicators, quantity structure)[c]

IRI: `https://w3id.org/bmontology#LAN_PerformanceIndicators_QuantityStructure_NumberOfAccessPorts100MbitWithPoE`

This is a performance indicator of the LAN service, categorized into performance indicators as well as quantity structure. This indicator captures the number of acess ports having 100 Mbit with PoE.

has super-classes Hardware resource indicator[c] LAN[c] Quantity indicator[c]

Number of access ports 100Mbit without PoE (performance indicators, quantity structure)[c]

IRI: `https://w3id.org/bmontology#LAN_PerformanceIndicators_QuantityStructure_NumberOfAccessPorts100MbitWithoutPoE`

This is a performance indicator of the LAN service, categorized into performance indicators as well as quantity structure. This indicator captures the number of acess ports having 100 Mbit without PoE.

has super-classes Hardware resource indicator[c] LAN[c] Quantity indicator[c]

Number of active devices in the organization (performance indicators, general indicators)[c]

IRI: `https://w3id.org/bmontology#MobileDevices_PerformanceIndicators_GeneralIndicators_NumberOfActiveDevicesInTheOrganization`

This is a performance indicator of the mobile devices service, categorized into performance indicators as well as general indicators. This indicator captures the number of active devices.

has super-classes Mobile devices[c] Quantity indicator[c]

Number of application server (performance indicators, additional information)^c

IRI: `https://w3id.org/bmontology#SAPBasis_PerformanceIndicators_AdditionalInformation_NumberOfApplicationServer`

This is a performance indicator of the SAP basis service, categorized into performance indicators as well as additional information. This indicator captures how many application servers are used to distribute the load (globally).

has super-classes Quantity indicator^c SAP basis^c

Number of authorized users (performance indicators, SSL VPN access)^c

IRI: `https://w3id.org/bmontology#RemoteAccessService_PerformanceIndicators_SSLVPNAccess_NumberOfAuthorizedUsers`

This is a performance indicator of the remote access service service, categorized into performance indicators as well as SSL VPN access. This indicator captures the number of authorized users for RAS per connection type.

has super-classes Quantity indicator^c Remote access service^c

Number of authorized users (performance indicators, standard mass connection)^c

IRI: `https://w3id.org/bmontology#RemoteAccessService_PerformanceIndicators_StandardMassConnection_NumberOfAuthorizedUsers`

This is a performance indicator of the remote access service service, categorized into performance indicators as well as standard mass connection. This indicator captures the number of authorized users for RAS per connection type.

has super-classes Quantity indicator^c Remote access service^c

Number of authorized users (performance indicators, VPN client)^c

IRI: `https://w3id.org/bmontology#RemoteAccessService_PerformanceIndicators_VPNClient_NumberOfAuthorizedUsers`

This is a performance indicator of the remote access service service, categorized into performance indicators as well as VPN client. This indicator captures the number of authorized users for RAS per connection type.

has super-classes Quantity indicator^c Remote access service^c

Number of backup instances (performance indicators, quantity structure and performance)^c

IRI: `https://w3id.org/bmontology#Backup_PerformanceIndicators_QuantityStructureAndPerformance_NumberOfBackupInstances`

This is a performance indicator of the backup service, categorized into performance indicators as well as quantity structure and performance. This indicator captures the number of backup instances.

has super-classes Backup^c Quantity indicator^c

Number of backup servers (performance indicators, quantity structure and performance)^c

IRI: `https://w3id.org/bmontology#Backup_PerformanceIndicators_QuantityStructureAndPerformance_NumberOfBackupServers`

This is a performance indicator of the backup service, categorized into performance indicators as well as quantity structure and performance. This indicator captures the number of backup servers.

has super-classes Backup^c Quantity indicator^c

Number of clients (performance indicators, quantity structure and performance)^c

IRI: `https://w3id.org/bmontology#SAPBasis_PerformanceIndicators_QuantityStructureAndPerformance_NumberOfClients`

This is a performance indicator of the SAP basis service, categorized into performance indicators as well as quantity structure and performance. This indicator captures the number of clients (w.r.t. multitenancy in SAP) in the captured SAP ERP (+HR) system lines.

has super-classes Quantity indicator^c SAP basis^c

Number of computer centers (computer center levy, basic data)^c

IRI: `https://w3id.org/bmontology#BasicData_ComputerCenterLevy_BasicData_NumberOfComputerCenters`

This is an indicator of the basic data service, categorized into computer center levy as well as basic data. This indicator captures the number of computer centers of the organization (scope: Germany).

has super-classes Basic data^c Quantity indicator^c

Number of connected devices using access ports (performance indicators, quantity structure)^c

IRI: `https://w3id.org/bmontology#LAN_PerformanceIndicators_QuantityStructure_NumberOfConnectedDevicesUsingAccessPorts`

This is a performance indicator of the LAN service, categorized into performance indicators as well as quantity structure. This indicator captures the number of conected devices using access ports.

has super-classes LAN^c Quantity indicator^c

Number of connections to business partners RAS VPN tunnel (performance indicators, VPN tunel to business partners)^c

IRI: `https://w3id.org/bmontology#RemoteAccessService_PerformanceIndicators_VPNTunelToBusinessPartners_NumberOfConnectionsToBusinessPartners RASVPNTunnel`

This is a performance indicator of the remote access service service, categorized into performance indicators as well as VPN tunel to business partners. This indicator catures the number of granted connections for RAS VPN tunnels to business partners.

has super-classes Quantity indicator^c Remote access service^c

Number of cores (performance indicators, host systems)^c

IRI: `https://w3id.org/bmontology#VirtualServer_PerformanceIndicators_HostSystems_NumberOfCores`

This is a performance indicator of the virtual server service, categorized into performance indicators as well as host systems. This indicator captures the total number of cores of the physical ystems (host systems) (not sockets).

has super-classes Quantity indicator^c Virtual server^c

Number of countries managed by the IT (performance indicators, basic data)^c

IRI: `https://w3id.org/bmontology#BasicData_PerformanceIndicators_BasicData_NumberOfCountriesManagedByTheIT`

This is a performance indicator of the basic data service, categorized into performance indicators as well as basic data. This indicator captures the number of countries supported by the IT.

has super-classes Basic data^c Quantity indicator^c

Number of database version (performance indicators, variant 1 (high availability))^c

IRI: `https://w3id.org/bmontology#Database_PerformanceIndicators_Variant1HighAvailability_NumberOfDatabaseVersion`

This is a performance indicator of the database service, categorized into performance indicators as well as variant 1 (high availability). This indicator capture both the quantity as well as the type of the used database versions.

has super-classes Database (Variant 1)^c Quantity indicator^c Software resource indicator^c

Number of database version (performance indicators, variant 2)^c

IRI: `https://w3id.org/bmontology#Database_PerformanceIndicators_Variant2_NumberOfDatabaseVersion`

This is a performance indicator of the database service, categorized into performance indicators as well as variant 2. This indicator capture both the quantity as well as the type of the used database versions.

has super-classes Datenbanken (Variante 2)^c Quantity indicator^c Software resource indicator^c

Number of databases (performance indicators, variant 1 (high availability))^c

IRI: `https://w3id.org/bmontology#Database_PerformanceIndicators_Variant1HighAvailability_NumberOfDatabases`

This is a performance indicator of the database service, categorized into performance indicators as well as variant 1 (high availability). This indicator captures the number of used databases.

has super-classes Database (Variant 1)^c Quantity indicator^c Software resource indicator^c

Number of databases (performance indicators, variant 2)[c]

IRI: `https://w3id.org/bmontology#Database_PerformanceIndicators_Variant2_NumberOfDatabases`

This is a performance indicator of the database service, categorized into performance indicators as well as variant 2. This indicator captures the number of used databases.

has super-classes Datenbanken (Variante 2)[c] Quantity indicator[c] Software resource indicator[c]

Number of dedicated servers (performance indicators, quantity structure and performance)[c]

IRI: `https://w3id.org/bmontology#TerminalServer_PerformanceIndicators_QuantityStructureAndPerformance_NumberOfDedicatedServers`

This is a performance indicator of the terminal server service, categorized into performance indicators as well as quantity structure and performance. This indicator captures the number of dedicated servers that are used within this module.

has super-classes Quantity indicator[c] Terminal server[c]

Number of devices (performance indicators, performance indicators)[c]

IRI: `https://w3id.org/bmontology#IMAC_PerformanceIndicators_PerformanceIndicators_NumberOfDevices`

This is a performance indicator of the IMAC service, categorized into performance indicators as well as performance indicators. All used devices (desktop, laptop), which are involved in the IMAC module.

has super-classes IMAC[c] Quantity indicator[c]

Number of distributed packages per year (performance indicators, quantity structure and performance)[c]

IRI: `https://w3id.org/bmontology#Workplace_PerformanceIndicators_QuantityStructureAndPerformance_NumberOfDistributedPackagesPerYear`

This is a performance indicator of the workplace service, categorized into performance indicators as well as quantity structure and performance. This indicator captures the number of distributed packages per year.

has super-classes Quantity indicator^c Workplace^c

Number of distributed packages per year (performance indicators, service level of IMAC processes)^c

IRI: `https://w3id.org/bmontology#IMAC_PerformanceIndicators_ServiceLevelOfIMACProcesses_NumberOfDistributedPackagesPerYear`

This is a performance indicator of the IMAC service, categorized into performance indicators as well as service level of IMAC processes. This indicator captures the number of ditributed software packages per year.

has super-classes IMAC^c Quantity indicator^c

Number of employees (general organization data, basic data)^c

IRI: `https://w3id.org/bmontology#BasicData_GeneralOrganizationData_BasicData_NumberOfEmployees`

This is an indicator of the basic data service, categorized into general organization data as well as basic data. This indicator captures the number of employees of the organizational units supported by the IT.

has super-classes Basic data^c Quantity indicator^c

Number of employees in service desk management (FTE) (performance indicators, quantity structure and performance)^c

IRI: `https://w3id.org/bmontology#Servicedesk_PerformanceIndicators_QuantityStructureAndPerformance_NumberOfEmployeesInServiceDeskManagementFTE`

This is a performance indicator of the servicedesk service, categorized into performance indicators as well as quantity structure and performance. This indicator captures the number of employees in the service desk management.

has super-classes Quantity indicator^c Servicedesk^c

Number of end devices (this platform) (performance indicators, quantity structure and performance (blackberry))^c

IRI: `https://w3id.org/bmontology#MobileDevices_PerformanceIndicators_QuantityStructureAndPerformanceBlackberry_NumberOfEndDevicesThisPlatform`

This is a performance indicator of the mobile devices service, categorized into performance indicators as well as quantity structure and performance (blackberry). This indicator captures the number of devices using the corresponding platform.

has super-classes Mobile Devices (Blackberry)^c Quantity indicator^c

Number of end devices (this platform) (performance indicators, quantity structure and performance (iPhone))^c

IRI: `https://w3id.org/bmontology#MobileDevices_PerformanceIndicators_QuantityStructureAndPerformanceIPhone_NumberOfEndDevicesThisPlatform`

This is a performance indicator of the mobile devices service, categorized into performance indicators as well as quantity structure and performance (iPhone). This indicator captures the number of devices using the corresponding platform.

has super-classes Mobile Devices (iPhone)^c Quantity indicator^c

Number of end devices (this platform) (performance indicators, quantity structure and performance (other))^c

IRI: `https://w3id.org/bmontology#MobileDevices_PerformanceIndicators_QuantityStructureAndPerformanceOther_NumberOfEndDevicesThisPlatform`

This is a performance indicator of the mobile devices service, categorized into performance indicators as well as quantity structure and performance (other). This indicator captures the number of devices using the corresponding platform.

has super-classes Mobile Devices (Others)^c Quantity indicator^c

Number of end devices (this platform) (performance indicators, quantity structure and performance (windows phone))^c

IRI: `https://w3id.org/bmontology#MobileDevices_PerformanceIndicators_QuantityStructureAndPerformanceWindowsPhone_NumberOfEndDevicesThisPlatform`

This is a performance indicator of the mobile devices service, categorized into performance indicators as well as quantity structure and performance (windows phone). This indicator captures the number of devices using the corresponding platform.

has super-classes Mobile Devices (Windows Phone)^c Quantity indicator^c

Number of external IT employees (FTE) (performance indicators, basic data)^c

IRI: `https://w3id.org/bmontology#BasicData_PerformanceIndicators_BasicData_NumberOfExternalITEmployeesFTE`

This is a performance indicator of the basic data service, categorized into performance indicators as well as basic data. This indicator captures the number of external employees in the IT.

has super-classes Basic data^c Quantity indicator^c

Number of external personnel (FTE) (performance indicators, conferencing (incl. video conferencing tools))^c

IRI: `https://w3id.org/bmontology#Collaboration_PerformanceIndicators_ConferencingInclVideoConferencingTools_NumberOfExternalPersonnelFTE`

This is a performance indicator of the collaboration service, categorized into performance indicators as well as conferencing (incl. video conferencing tools). This indicator captures the number of external employees for this module in FTE.

has super-classes Collaboration^c Quantity indicator^c

Number of external personnel (FTE) (performance indicators, cross-system)^c

IRI: `https://w3id.org/bmontology#VirtualServer_PerformanceIndicators_CrossSystem_NumberOfExternalPersonnelFTE`

This is a performance indicator of the virtual server service, categorized into performance indicators as well as cross-system. This indicator captures the number of external employees for this module in FTE.

has super-classes Quantity indicator^c Virtual server^c

Number of external personnel (FTE) (performance indicators, lync and other applications (without telephony))^c

IRI: `https://w3id.org/bmontology#Collaboration_PerformanceIndicators_LyncAndOtherApplicationsWithoutTelephony_NumberOfExternalPersonnelFTE`

This is a performance indicator of the collaboration service, categorized into performance indicators as well as lync and other applications (without telephony). This indicator captures the number of external employees for this module in FTE.

has super-classes Collaboration^c Quantity indicator^c

Number of external personnel (FTE) (performance indicators, performance indicators)^c

IRI: `https://w3id.org/bmontology#IMAC_PerformanceIndicators_PerformanceIndicators_NumberOfExternalPersonnelFTE`

This is a performance indicator of the IMAC service, categorized into performance indicators as well as performance indicators. This indicator captures the number of external employees for this module in FTE.

has super-classes IMAC^c Quantity indicator^c

Number of external personnel (FTE) (performance indicators, quantity structure (large))^c

IRI: `https://w3id.org/bmontology#DedicatedServer_PerformanceIndicators_QuantityStructureLarge_NumberOfExternalPersonnelFTE`

This is a performance indicator of the dedicated server service, categorized into performance indicators as well as quantity structure (large). This indicator captures the number of external employees for this module in FTE.

has super-classes Dedicated server (large)^c Quantity indicator^c

Number of external personnel (FTE) (performance indicators, quantity structure (medium))^c

IRI: `https://w3id.org/bmontology#DedicatedServer_PerformanceIndicators_QuantityStructureMedium_NumberOfExternalPersonnelFTE`

This is a performance indicator of the dedicated server service, categorized into performance indicators as well as quantity structure (medium). This indicator captures the number of external employees for this module in FTE.

has super-classes Dedicated server (medium)^c Quantity indicator^c

Number of external personnel (FTE) (performance indicators, quantity structure (small))^c

IRI: `https://w3id.org/bmontology#DedicatedServer_PerformanceIndicators_QuantityStructureSmall_NumberOfExternalPersonnelFTE`

This is a performance indicator of the dedicated server service, categorized into performance indicators as well as quantity structure (small). This indicator captures the number of external employees for this module in FTE.

has super-classes Dedicated server (small)^c Quantity indicator^c

Number of external personnel (FTE) (performance indicators, quantity structure and performance)[c]

IRI: `https://w3id.org/bmontology#Backup_PerformanceIndicators_QuantityStructureAndPerformance_NumberOfExternalPersonnelFTE`

This is a performance indicator of the backup service, categorized into performance indicators as well as quantity structure and performance. This indicator captures the number of external employees for this module in FTE.

has super-classes Backup[c] Quantity indicator[c]

Number of external personnel (FTE) (performance indicators, quantity structure and performance)[c]

IRI: `https://w3id.org/bmontology#SAPBasis_PerformanceIndicators_QuantityStructureAndPerformance_NumberOfExternalPersonnelFTE`

This is a performance indicator of the SAP basis service, categorized into performance indicators as well as quantity structure and performance. This indicator captures the number of external employees for this module in FTE.

has super-classes Quantity indicator[c] SAP basis[c]

Number of external personnel (FTE) (performance indicators, quantity structure and performance)[c]

IRI: `https://w3id.org/bmontology#Storage_PerformanceIndicators_QuantityStructureAndPerformance_NumberOfExternalPersonnelFTE`

This is a performance indicator of the storage service, categorized into performance indicators as well as quantity structure and performance. This indicator captures the number of external employees for this module in FTE.

has super-classes Quantity indicator[c] Storage[c]

Number of external personnel (FTE) (performance indicators, quantity structure and performance)^c

IRI: `https://w3id.org/bmontology#TerminalServer_PerformanceIndicators_QuantityStructureAndPerformance_NumberOfExternalPersonnelFTE`

This is a performance indicator of the terminal server service, categorized into performance indicators as well as quantity structure and performance. This indicator captures the number of external employees for this module in FTE.

has super-classes Quantity indicator^c Terminal server^c

Number of external personnel (FTE) (performance indicators, quantity structure and performance)^c

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureAndPerformance_NumberOfExternalPersonnelFTE`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure and performance. This indicator captures the number of external employees for this module in FTE.

has super-classes Quantity indicator^c WAN^c

Number of external personnel (FTE) (performance indicators, quantity structure and performance)^c

IRI: `https://w3id.org/bmontology#Workplace_PerformanceIndicators_QuantityStructureAndPerformance_NumberOfExternalPersonnelFTE`

This is a performance indicator of the workplace service, categorized into performance indicators as well as quantity structure and performance. This indicator captures the number of external employees for this module in FTE.

has super-classes Quantity indicator^c Workplace^c

Number of external personnel (FTE) (performance indicators, quantity structure)^c

IRI: `https://w3id.org/bmontology#FileService_PerformanceIndicators_QuantityStructure_NumberOfExternalPersonnelFTE`

This is a performance indicator of the file service service, categorized into performance indicators as well as quantity structure. This indicator captures the number of external employees for this module in FTE.

has super-classes File Service^c Quantity indicator^c

Number of external personnel (FTE) (performance indicators, quantity structure)^c

IRI: `https://w3id.org/bmontology#LAN_PerformanceIndicators_QuantityStructure_NumberOfExternalPersonnelFTE`

This is a performance indicator of the LAN service, categorized into performance indicators as well as quantity structure. This indicator captures the number of external employees for this module in FTE.

has super-classes LAN^c Quantity indicator^c

Number of external personnel (FTE) (performance indicators, quantity structure)^c

IRI: `https://w3id.org/bmontology#Mailbox_PerformanceIndicators_QuantityStructure_NumberOfExternalPersonnelFTE`

This is a performance indicator of the mailbox service, categorized into performance indicators as well as quantity structure. This indicator captures the number of external employees for this module in FTE.

has super-classes Mailbox^c Quantity indicator^c

Number of external personnel (FTE) (performance indicators, sharePoint and other applications)^c

IRI: `https://w3id.org/bmontology#Collaboration_PerformanceIndicators_SharePointAndOtherApplications_NumberOfExternalPersonnelFTE`

This is a performance indicator of the collaboration service, categorized into performance indicators as well as sharePoint and other applications. This indicator captures the number of external employees for this module in FTE.

has super-classes Collaboration^c Quantity indicator^c

Number of external personnel (FTE) (performance indicators, SSL VPN access)^c

IRI: `https://w3id.org/bmontology#RemoteAccessService_PerformanceIndicators_SSLVPNAccess_NumberOfExternalPersonnelFTE`

This is a performance indicator of the remote access service service, categorized into performance indicators as well as SSL VPN access. This indicator captures the number of external employees for this module in FTE.

has super-classes Quantity indicator^c Remote access service^c

Number of external personnel (FTE) (performance indicators, standard mass connection)^c

IRI: `https://w3id.org/bmontology#RemoteAccessService_PerformanceIndicators_StandardMassConnection_NumberOfExternalPersonnelFTE`

This is a performance indicator of the remote access service service, categorized into performance indicators as well as standard mass connection. This indicator captures the number of external employees for this module in FTE.

has super-classes Quantity indicator^c Remote access service^c

Number of external personnel (FTE) (performance indicators, variant 1 (high availability))^c

IRI: `https://w3id.org/bmontology#Database_PerformanceIndicators_Variant1HighAvailability_NumberOfExternalPersonnelFTE`

This is a performance indicator of the database service, categorized into performance indicators as well as variant 1 (high availability). This indicator captures the number of external employees for this module in FTE.

has super-classes Database (Variant 1)^c Human resource indicator^c Quantity indicator^c

Number of external personnel (FTE) (performance indicators, variant 2)^c

IRI: `https://w3id.org/bmontology#Database_PerformanceIndicators_Variant2_NumberOfExternalPersonnelFTE`

This is a performance indicator of the database service, categorized into performance indicators as well as variant 2. This indicator captures the number of external employees for this module in FTE.

has super-classes Datenbanken (Variante 2)^c Human resource indicator^c Quantity indicator^c

Number of external personnel (FTE) (performance indicators, VPN client)^c

IRI: `https://w3id.org/bmontology#RemoteAccessService_PerformanceIndicators_VPNClient_NumberOfExternalPersonnelFTE`

This is a performance indicator of the remote access service service, categorized into performance indicators as well as VPN client. This indicator captures the number of external employees for this module in FTE.

has super-classes Quantity indicator^c Remote access service^c

Number of external personnel (FTE) (performance indicators, VPN tunel to business partners)^c

IRI: `https://w3id.org/bmontology#RemoteAccessService_PerformanceIndicators_VPNTunelToBusinessPartners_NumberOfExternalPersonnelFTE`

This is a performance indicator of the remote access service service, categorized into performance indicators as well as VPN tunel to business partners. This indicator captures the number of external employees for this module in FTE.

has super-classes Quantity indicator^c Remote access service^c

Number of external personnel per platform (FTE) (performance indicators, performance information)^c

IRI: `https://w3id.org/bmontology#Telephony_PerformanceIndicators_PerformanceInformation_NumberOfExternalPersonnelPerPlatformFTE`

This is a performance indicator of the telephony service, categorized into performance indicators as well as performance information. This indicator captures the number of external employees for this module in FTE.

has super-classes Quantity indicator^c Telephony^c

Number of external personnel per platform (FTE) (performance indicators, quantity structure and performance (blackberry))^c

IRI: `https://w3id.org/bmontology#MobileDevices_PerformanceIndicators_QuantityStructureAndPerformanceBlackberry_NumberOfExternalPersonnelPerPlatformFTE`

This is a performance indicator of the mobile devices service, categorized into performance indicators as well as quantity structure and performance (blackberry). This indicator captures the number of external employees for this module in FTE.

has super-classes Mobile Devices (Blackberry)^c Quantity indicator^c

Number of external personnel per platform (FTE) (performance indicators, quantity structure and performance (iPhone))^c

IRI: `https://w3id.org/bmontology#MobileDevices_PerformanceIndicators_QuantityStructureAndPerformanceIPhone_NumberOfExternalPersonnelPerPlatformFTE`

This is a performance indicator of the mobile devices service, categorized into performance indicators as well as quantity structure and performance (iPhone). This indicator captures the number of external employees for this module in FTE.

has super-classes Mobile Devices (iPhone)^c Quantity indicator^c

Number of external personnel per platform (FTE) (performance indicators, quantity structure and performance (other))^c

IRI: `https://w3id.org/bmontology#MobileDevices_PerformanceIndicators_QuantityStructureAndPerformanceOther_NumberOfExternalPersonnelPerPlatformFTE`

This is a performance indicator of the mobile devices service, categorized into performance indicators as well as quantity structure and performance (other). This indicator captures the number of external employees for this module in FTE.

has super-classes Mobile Devices (Others)^c Quantity indicator^c

Number of external personnel per platform (FTE) (performance indicators, quantity structure and performance (windows phone))^c

IRI: `https://w3id.org/bmontology#MobileDevices_PerformanceIndicators_QuantityStructureAndPerformanceWindowsPhone_NumberOfExternalPersonnelPerPlatformFTE`

This is a performance indicator of the mobile devices service, categorized into performance indicators as well as quantity structure and performance (windows phone). This indicator captures the number of external employees for this module in FTE.

has super-classes Mobile Devices (Windows Phone)^c Quantity indicator^c

Number of external personnel WLAN (FTE) (performance indicators, WLAN)^c

IRI: `https://w3id.org/bmontology#LAN_PerformanceIndicators_WLAN_NumberOfExternalPersonnelWLANFTE`

This is a performance indicator of the LAN service, categorized into performance indicators as well as WLAN. This indicator captures the number of external employees that are involved in WLAN tasks.

has super-classes LAN^c Quantity indicator^c

Number of full users (performance indicators, quantity structure and performance)^c

IRI: `https://w3id.org/bmontology#SAPBasis_PerformanceIndicators_QuantityStructureAndPerformance_NumberOfFullUsers`

This is a performance indicator of the SAP basis service, categorized into performance indicators as well as quantity structure and performance. This indicator captures the number of 'full users' of the SAP ERP (+HR) system lines.

has super-classes Quantity indicator^c SAP basis^c

Number of guest systems (performance indicators, guest system)^c

IRI: `https://w3id.org/bmontology#VirtualServer_PerformanceIndicators_GuestSystem_NumberOfGuestSystems`

This is a performance indicator of the virtual server service, categorized into performance indicators as well as guest system. This indicator captures the number of guest systems.

has super-classes Quantity indicator^c Virtual server^c

Number of guest systems (performance indicators, quantity structure and performance)^c

IRI: `https://w3id.org/bmontology#TerminalServer_PerformanceIndicators_QuantityStructureAndPerformance_NumberOfGuestSystems`

This is a performance indicator of the terminal server service, categorized into performance indicators as well as quantity structure and performance. This indicator captures the number of guest systems using virtual servers.

has super-classes Quantity indicator^c Terminal server^c

Number of incident tickets per year (performance indicators, quantity structure and performance)^c

IRI: `https://w3id.org/bmontology#Servicedesk_PerformanceIndicators_QuantityStructureAndPerformance_NumberOfIncidentTicketsPerYear`

This is a performance indicator of the servicedesk service, categorized into performance indicators as well as quantity structure and performance. This indicator captures the average number of incident tickets per year, processed by the service desk.

has super-classes Quantity indicator^c Servicedesk^c

Number of incidents (performance indicators, additional information)^c

IRI: `https://w3id.org/bmontology#RemoteAccessService_PerformanceIndicators_AdditionalInformation_NumberOfIncidents`

This is a performance indicator of the remote access service service, categorized into performance indicators as well as additional information. This indicator captures the number of incidents for RAS per year.

has super-classes Quantity indicator^c Remote access service^c

Number of internal IT employees (FTE) (performance indicators, basic data)^c

IRI: `https://w3id.org/bmontology#BasicData_PerformanceIndicators_BasicData_NumberOfInternalITEmployeesFTE`

This is a performance indicator of the basic data service, categorized into performance indicators as well as basic data. This indicator captures the number of internal employees in the IT.

has super-classes Basic data^c Quantity indicator^c

Number of internal personnel (FTE) (performance indicators, conferencing (incl. video conferencing tools))^c

IRI: `https://w3id.org/bmontology#Collaboration_PerformanceIndicators_ConferencingInclVideoConferencingTools_NumberOfInternalPersonnelFTE`

This is a performance indicator of the collaboration service, categorized into performance indicators as well as conferencing (incl. video conferencing tools). This indicator captures the number of internal employees for this module in FTE.

has super-classes Collaboration^c Quantity indicator^c

Number of internal personnel (FTE) (performance indicators, cross-system)^c

IRI: `https://w3id.org/bmontology#VirtualServer_PerformanceIndicators_CrossSystem_NumberOfInternalPersonnelFTE`

This is a performance indicator of the virtual server service, categorized into performance indicators as well as cross-system. This indicator captures the number of internal employees for this module in FTE.

has super-classes Quantity indicator^c Virtual server^c

Number of internal personnel (FTE) (performance indicators, lync and other applications (without telephony))^c

IRI: `https://w3id.org/bmontology#Collaboration_PerformanceIndicators_LyncAndOtherApplicationsWithoutTelephony_NumberOfInternalPersonnelFTE`

This is a performance indicator of the collaboration service, categorized into performance indicators as well as lync and other applications (without telephony). This indicator captures the number of internal employees for this module in FTE.

has super-classes Collaboration^c Quantity indicator^c

Number of internal personnel (FTE) (performance indicators, performance indicators)^c

IRI: `https://w3id.org/bmontology#IMAC_PerformanceIndicators_PerformanceIndicators_NumberOfInternalPersonnelFTE`

This is a performance indicator of the IMAC service, categorized into performance indicators as well as performance indicators. This indicator captures the number of employees for this module in FTE.

has super-classes IMAC^c Quantity indicator^c

Number of internal personnel (FTE) (performance indicators, quantity structure (large))^c

IRI: `https://w3id.org/bmontology#DedicatedServer_PerformanceIndicators_QuantityStructureLarge_NumberOfInternalPersonnelFTE`

This is a performance indicator of the dedicated server service, categorized into performance indicators as well as quantity structure (large). This indicator captures the number of internal employees for this module in FTE.

has super-classes Dedicated server (large)^c Quantity indicator^c

Number of internal personnel (FTE) (performance indicators, quantity structure (medium))^c

IRI: `https://w3id.org/bmontology#DedicatedServer_PerformanceIndicators_QuantityStructureMedium_NumberOfInternalPersonnelFTE`

This is a performance indicator of the dedicated server service, categorized into performance indicators as well as quantity structure (medium). This indicator captures the number of internal employees for this module in FTE.

has super-classes Dedicated server (medium)^c Quantity indicator^c

Number of internal personnel (FTE) (performance indicators, quantity structure (small))^c

IRI: `https://w3id.org/bmontology#DedicatedServer_PerformanceIndicators_QuantityStructureSmall_NumberOfInternalPersonnelFTE`

This is a performance indicator of the dedicated server service, categorized into performance indicators as well as quantity structure (small). This indicator captures the number of internal employees for this module in FTE.

has super-classes Dedicated server (small)^c Quantity indicator^c

Number of internal personnel (FTE) (performance indicators, quantity structure and performance)^c

IRI: `https://w3id.org/bmontology#Backup_PerformanceIndicators_QuantityStructureAndPerformance_NumberOfInternalPersonnelFTE`

This is a performance indicator of the backup service, categorized into performance indicators as well as quantity structure and performance. This indicator captures the number of internal employees for this module in FTE.

has super-classes Backup^c Quantity indicator^c

Number of internal personnel (FTE) (performance indicators, quantity structure and performance)^c

IRI: `https://w3id.org/bmontology#SAPBasis_PerformanceIndicators_QuantityStructureAndPerformance_NumberOfInternalPersonnelFTE`

This is a performance indicator of the SAP basis service, categorized into performance indicators as well as quantity structure and performance. This indicator captures the number of internal employees for this module in FTE.

has super-classes Quantity indicator^c SAP basis^c

Number of internal personnel (FTE) (performance indicators, quantity structure and performance)^c

IRI: `https://w3id.org/bmontology#Storage_PerformanceIndicators_QuantityStructureAndPerformance_NumberOfInternalPersonnelFTE`

This is a performance indicator of the storage service, categorized into performance indicators as well as quantity structure and performance. This indicator captures the number of internal employees for this module in FTE.

has super-classes Quantity indicator^c Storage^c

Number of internal personnel (FTE) (performance indicators, quantity structure and performance)^c

IRI: `https://w3id.org/bmontology#TerminalServer_PerformanceIndicators_QuantityStructureAndPerformance_NumberOfInternalPersonnelFTE`

This is a performance indicator of the terminal server service, categorized into performance indicators as well as quantity structure and performance. This indicator captures the number of employees for this module in FTE.

has super-classes Quantity indicator^c Terminal server^c

Number of internal personnel (FTE) (performance indicators, quantity structure and performance)^c

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureAndPerformance_NumberOfInternalPersonnelFTE`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure and performance. This indicator captures the number of employees involved in WAN tasks.

has super-classes Quantity indicator^c WAN^c

Number of internal personnel (FTE) (performance indicators, quantity structure and performance)^c

IRI: `https://w3id.org/bmontology#Workplace_PerformanceIndicators_QuantityStructureAndPerformance_NumberOfInternalPersonnelFTE`

This is a performance indicator of the workplace service, categorized into performance indicators as well as quantity structure and performance. This indicator captures the number of internal employees for this module in FTE.

has super-classes Quantity indicator^c Workplace^c

Number of internal personnel (FTE) (performance indicators, quantity structure)^c

IRI: `https://w3id.org/bmontology#FileService_PerformanceIndicators_QuantityStructure_NumberOfInternalPersonnelFTE`

This is a performance indicator of the file service service, categorized into performance indicators as well as quantity structure. This indicator captures the number of internal employees for this module in FTE.

has super-classes File Service^c Quantity indicator^c

Number of internal personnel (FTE) (performance indicators, quantity structure)^c

IRI: `https://w3id.org/bmontology#LAN_PerformanceIndicators_QuantityStructure_NumberOfInternalPersonnelFTE`

This is a performance indicator of the LAN service, categorized into performance indicators as well as quantity structure. This indicator captures the number of internal employees for this module in FTE.

has super-classes LAN^c Quantity indicator^c

Number of internal personnel (FTE) (performance indicators, quantity structure)[c]

IRI: https://w3id.org/bmontology#Mailbox_PerformanceIndicators_QuantityStructure_NumberOfInternalPersonnelFTE

This is a performance indicator of the mailbox service, categorized into performance indicators as well as quantity structure. This indicator captures the number of employees for this module in FTE.

has super-classes Mailbox[c] Quantity indicator[c]

Number of internal personnel (FTE) (performance indicators, sharePoint and other applications)[c]

IRI: https://w3id.org/bmontology#Collaboration_PerformanceIndicators_SharePointAndOtherApplications_NumberOfInternalPersonnelFTE

This is a performance indicator of the collaboration service, categorized into performance indicators as well as sharePoint and other applications. This indicator captures the number of internal employees for this module in FTE.

has super-classes Collaboration[c] Quantity indicator[c]

Number of internal personnel (FTE) (performance indicators, SSL VPN access)[c]

IRI: https://w3id.org/bmontology#RemoteAccessService_PerformanceIndicators_SSLVPNAccess_NumberOfInternalPersonnelFTE

This is a performance indicator of the remote access service service, categorized into performance indicators as well as SSL VPN access. This indicator captures the number of internal employees for this module in FTE.

has super-classes Quantity indicator[c] Remote access service[c]

Number of internal personnel (FTE) (performance indicators, standard mass connection)^c

IRI: `https://w3id.org/bmontology#RemoteAccessService_PerformanceIndicators_StandardMassConnection_NumberOfInternalPersonnelFTE`

This is a performance indicator of the remote access service service, categorized into performance indicators as well as standard mass connection. This indicator captures the number of internal employees for this module in FTE.

has super-classes Quantity indicator^c Remote access service^c

Number of internal personnel (FTE) (performance indicators, variant 1 (high availability))^c

IRI: `https://w3id.org/bmontology#Database_PerformanceIndicators_Variant1HighAvailability_NumberOfInternalPersonnelFTE`

This is a performance indicator of the database service, categorized into performance indicators as well as variant 1 (high availability). This indicator captures the number of internal employees for this module in FTE.

has super-classes Database (Variant 1)^c Human resource indicator^c Quantity indicator^c

Number of internal personnel (FTE) (performance indicators, variant 2)^c

IRI: `https://w3id.org/bmontology#Database_PerformanceIndicators_Variant2_NumberOfInternalPersonnelFTE`

This is a performance indicator of the database service, categorized into performance indicators as well as variant 2. This indicator captures the number of internal employees for this module in FTE.

has super-classes Datenbanken (Variante 2)^c Human resource indicator^c Quantity indicator^c

Number of internal personnel (FTE) (performance indicators, VPN client)^c

IRI: `https://w3id.org/bmontology#RemoteAccessService_PerformanceIndicators_VPNClient_NumberOfInternalPersonnelFTE`

This is a performance indicator of the remote access service service, categorized into performance indicators as well as VPN client. This indicator captures the number of internal employees for this module in FTE.

has super-classes Quantity indicator^c Remote access service^c

Number of internal personnel (FTE) (performance indicators, VPN tunel to business partners)^c

IRI: `https://w3id.org/bmontology#RemoteAccessService_PerformanceIndicators_VPNTunelToBusinessPartners_NumberOfInternalPersonnelFTE`

This is a performance indicator of the remote access service service, categorized into performance indicators as well as VPN tunel to business partners. This indicator captures the number of internal employees for this module in FTE.

has super-classes Quantity indicator^c Remote access service^c

Number of internal personnel per plantform (FTE) (performance indicators, performance information)^c

IRI: `https://w3id.org/bmontology#Telephony_PerformanceIndicators_PerformanceInformation_NumberOfInternalPersonnelPerPlantformFTE`

This is a performance indicator of the telephony service, categorized into performance indicators as well as performance information. This indicator captures the number of employees for this module in FTE.

has super-classes Quantity indicator^c Telephony^c

Number of internal personnel per plantform (FTE) (performance indicators, quantity structure and performance (blackberry))^c

IRI: `https://w3id.org/bmontology#MobileDevices_PerformanceIndicators_QuantityStructureAndPerformanceBlackberry_NumberOfInternalPersonnelPerPlantformFTE`

This is a performance indicator of the mobile devices service, categorized into performance indicators as well as quantity structure and performance (blackberry). This indicator captures the number of employees for this module in FTE.

has super-classes Mobile Devices (Blackberry)^c Quantity indicator^c

Number of internal personnel per plantform (FTE) (performance indicators, quantity structure and performance (iPhone))^c

IRI: `https://w3id.org/bmontology#MobileDevices_PerformanceIndicators_QuantityStructureAndPerformanceIPhone_NumberOfInternalPersonnelPerPlantformFTE`

This is a performance indicator of the mobile devices service, categorized into performance indicators as well as quantity structure and performance (iPhone). This indicator captures the number of employees for this module in FTE.

has super-classes Mobile Devices (iPhone)^c Quantity indicator^c

Number of internal personnel per plantform (FTE) (performance indicators, quantity structure and performance (other))^c

IRI: `https://w3id.org/bmontology#MobileDevices_PerformanceIndicators_QuantityStructureAndPerformanceOther_NumberOfInternalPersonnelPerPlantformFTE`

This is a performance indicator of the mobile devices service, categorized into performance indicators as well as quantity structure and performance (other). This indicator captures the number of employees for this module in FTE.

has super-classes Mobile Devices (Others)^c Quantity indicator^c

Number of internal personnel per plantform (FTE) (performance indicators, quantity structure and performance (windows phone))[c]

IRI: `https://w3id.org/bmontology#MobileDevices_PerformanceIndicators_QuantityStructureAndPerformanceWindowsPhone_NumberOfInternalPersonnelPerPlantformFTE`

This is a performance indicator of the mobile devices service, categorized into performance indicators as well as quantity structure and performance (windows phone). This indicator captures the number of employees for this module in FTE.

has super-classes Mobile Devices (Windows Phone)[c] Quantity indicator[c]

Number of internal personnel WLAN (FTE) (performance indicators, WLAN)[c]

IRI: `https://w3id.org/bmontology#LAN_PerformanceIndicators_WLAN_NumberOfInternalPersonnelWLANFTE`

This is a performance indicator of the LAN service, categorized into performance indicators as well as WLAN. This indicator captures the number of internal employees involved in WLAN tasks.

has super-classes LAN[c] Quantity indicator[c]

Number of IT developers (FTE) (performance indicators, basic data)[c]

IRI: `https://w3id.org/bmontology#BasicData_PerformanceIndicators_BasicData_NumberOfITDevelopersFTE`

This is a performance indicator of the basic data service, categorized into performance indicators as well as basic data. This indicator captures the number of developers within the IT.

has super-classes Basic data[c] Quantity indicator[c]

Number of IT users (performance indicators, basic data)^c

IRI: `https://w3id.org/bmontology#BasicData_PerformanceIndicators_BasicData_NumberOfITUsers`

This is a performance indicator of the basic data service, categorized into performance indicators as well as basic data. This indicator captures the number of IT users in the organization.

has super-classes Basic data^c Quantity indicator^c

Number of languages (performance indicators, quantity structure and performance)^c

IRI: `https://w3id.org/bmontology#Servicedesk_PerformanceIndicators_QuantityStructureAndPerformance_NumberOfLanguages`

This is a performance indicator of the servicedesk service, categorized into performance indicators as well as quantity structure and performance. This indicator captures the number of support languages.

has super-classes Quantity indicator^c Servicedesk^c

Number of libraries (disk & tapes) (performance indicators, quantity structure and performance)^c

IRI: `https://w3id.org/bmontology#Backup_PerformanceIndicators_QuantityStructureAndPerformance_NumberOfLibrariesDiskTapes`

This is a performance indicator of the backup service, categorized into performance indicators as well as quantity structure and performance. This indicator captures the number of libraries used within the organization.

has super-classes Backup^c Quantity indicator^c

Number of light users (performance indicators, quantity structure and performance)^c

IRI: `https://w3id.org/bmontology#SAPBasis_PerformanceIndicators_QuantityStructureAndPerformance_NumberOfLightUsers`

This is a performance indicator of the SAP basis service, categorized into performance indicators as well as quantity structure and performance. This indicator captures the number of 'light users' of the SAP ERP (+HR) system lines.

has super-classes Quantity indicator^c SAP basis^c

Number of location video WAN APA (performance indicators, quantity structure (APA))^c

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureAPA_NumberOfLocationVideoWANAPA`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (APA). This indicator captures the number of locations video per country/region.

has super-classes Quantity indicator^c WAN^c

Number of locations (performance indicators, general)^c

IRI: `https://w3id.org/bmontology#SAPModules_PerformanceIndicators_General_NumberOfLocations`

This is a performance indicator of the SAP modules service, categorized into performance indicators as well as general. This indicator captures the number of locations using SAP.

has super-classes Quantity indicator^c SAP modules^c

Number of locations (performance indicators, quantity structure (other countries))^c

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureOtherCountries_NumberOfLocations`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (other countries). This indicator captures the number of WAN locations per country/region.

has super-classes Quantity indicator^c WAN^c

Number of locations APA (performance indicators, quantity structure (APA))^c

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureAPA_NumberOfLocationsAPA`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (APA). This indicator captures the number of WAN locations per country/region.

has super-classes Quantity indicator^c WAN^c

Number of locations Brazil (performance indicators, quantity structure (SA))^c

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureSA_NumberOfLocationsBrazil`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (SA). This indicator captures the number of WAN locations per country/region.

has super-classes Quantity indicator^c WAN^c

Number of locations China (performance indicators, quantity structure (APA))^c

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureAPA_NumberOfLocationsChina`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (APA). This indicator captures the number of WAN locations per country/region.

has super-classes Quantity indicator^c WAN^c

Number of locations EMEA (performance indicators, quantity structure (EMEA))^c

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureEMEA_NumberOfLocationsEMEA`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (EMEA). This indicator captures the number of WAN locations per country/region.

has super-classes Quantity indicator^c WAN^c

Number of locations Germany (performance indicators, quantity structure (EMEA))^c

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureEMEA_NumberOfLocationsGermany`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (EMEA). This indicator captures the number of WAN locations per country/region.

has super-classes Quantity indicator^c WAN^c

Number of locations India (performance indicators, quantity structure (APA))^c

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureAPA_NumberOfLocationsIndia`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (APA). This indicator captures the number of WAN locations per country/region.

has super-classes Quantity indicator^c WAN^c

Number of locations Mexico (performance indicators, quantity structure (NA))^{c}

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureNA_NumberOfLocationsMexico`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (NA). This indicator captures the number of WAN locations per country/region.

has super-classes Quantity indicator^{c} WAN^{c}

Number of locations NA (performance indicators, quantity structure (NA))^{c}

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureNA_NumberOfLocationsNA`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (NA). This indicator captures the number of WAN locations per country/region.

has super-classes Quantity indicator^{c} WAN^{c}

Number of locations other APA (performance indicators, quantity structure (APA))^{c}

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureAPA_NumberOfLocationsOtherAPA`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (APA). This indicator captures the number of WAN locations per country/region.

has super-classes Quantity indicator^{c} WAN^{c}

Number of locations other EMEA (performance indicators, quantity structure (EMEA))[c]

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureEMEA_NumberOfLocationsOtherEMEA`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (EMEA). This indicator captures the number of WAN locations per country/region.

has super-classes Quantity indicator[c] WAN[c]

Number of locations other NA (performance indicators, quantity structure (NA))[c]

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureNA_NumberOfLocationsOtherNA`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (NA). This indicator captures the number of WAN locations per country/region.

has super-classes Quantity indicator[c] WAN[c]

Number of locations other SA (performance indicators, quantity structure (SA))[c]

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureSA_NumberOfLocationsOtherSA`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (SA). This indicator captures the number of WAN locations per country/region.

has super-classes Quantity indicator[c] WAN[c]

Number of locations prioritization WAN (performance indicators, quantity structure (other countries))^c

IRI: https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureOtherCountries_NumberOfLocationsPrioritizationWAN

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (other countries). This indicator captures the number of locations data prioritization per country/region.

has super-classes Quantity indicator^c WAN^c

Number of locations prioritization WAN APA (performance indicators, quantity structure (APA))^c

IRI: https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureAPA_NumberOfLocationsPrioritizationWANAPA

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (APA). This indicator captures the number of locations data prioritization per country/region.

has super-classes Quantity indicator^c WAN^c

Number of locations prioritization WAN Brazil (performance indicators, quantity structure (SA))^c

IRI: https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureSA_NumberOfLocationsPrioritizationWANBrazil

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (SA). This indicator captures the number of locations data prioritization per country/region.

has super-classes Quantity indicator^c WAN^c

Number of locations prioritization WAN China (performance indicators, quantity structure (APA))^c

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureAPA_NumberOfLocationsPrioritizationWANChina`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (APA). This indicator captures the number of locations data prioritization per country/region.

has super-classes Quantity indicator^c WAN^c

Number of locations prioritization WAN EMEA (performance indicators, quantity structure (EMEA))^c

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureEMEA_NumberOfLocationsPrioritizationWANEMEA`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (EMEA). This indicator captures the number of locations data prioritization per country/region.

has super-classes Quantity indicator^c WAN^c

Number of locations prioritization WAN Germany (performance indicators, quantity structure (EMEA))^c

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureEMEA_NumberOfLocationsPrioritizationWANGermany`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (EMEA). This indicator captures the number of locations data prioritization per country/region.

has super-classes Quantity indicator^c WAN^c

Number of locations prioritization WAN India (performance indicators, quantity structure (APA))^c

IRI: https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureAPA_NumberOfLocationsPrioritizationWANIndia

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (APA). This indicator captures the number of locations data prioritization per country/region.

has super-classes Quantity indicator^c WAN^c

Number of locations prioritization WAN Mexico (performance indicators, quantity structure (NA))^c

IRI: https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureNA_NumberOfLocationsPrioritizationWANMexico

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (NA). This indicator captures the number of locations data prioritization per country/region.

has super-classes Quantity indicator^c WAN^c

Number of locations prioritization WAN NA (performance indicators, quantity structure (NA))^c

IRI: https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureNA_NumberOfLocationsPrioritizationWANNA

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (NA). This indicator captures the number of locations data prioritization per country/region.

has super-classes Quantity indicator^c WAN^c

Number of locations prioritization WAN other APA (performance indicators, quantity structure (APA))^c

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureAPA_NumberOfLocationsPrioritizationWANOtherAPA`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (APA). This indicator captures the number of locations data prioritization per country/region.

has super-classes Quantity indicator^c WAN^c

Number of locations prioritization WAN other EMEA (performance indicators, quantity structure (EMEA))^c

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureEMEA_NumberOfLocationsPrioritizationWANOtherEMEA`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (EMEA). This indicator captures the number of locations data prioritization per country/region.

has super-classes Quantity indicator^c WAN^c

Number of locations prioritization WAN other NA (performance indicators, quantity structure (NA))^c

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureNA_NumberOfLocationsPrioritizationWANOtherNA`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (NA). This indicator captures the number of locations data prioritization per country/region.

has super-classes Quantity indicator^c WAN^c

Number of locations prioritization WAN other SA (performance indicators, quantity structure (SA))^c

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureSA_NumberOfLocationsPrioritizationWANOtherSA`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (SA). This indicator captures the number of locations data prioritization per country/region.

has super-classes Quantity indicator^c WAN^c

Number of locations prioritization WAN Russia (performance indicators, quantity structure (EMEA))^c

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureEMEA_NumberOfLocationsPrioritizationWANRussia`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (EMEA). This indicator captures the number of locations data prioritization per country/region.

has super-classes Quantity indicator^c WAN^c

Number of locations prioritization WAN SA (performance indicators, quantity structure (SA))^c

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureSA_NumberOfLocationsPrioritizationWANSA`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (SA). This indicator captures the number of locations data prioritization per country/region.

has super-classes Quantity indicator^c WAN^c

Number of locations prioritization WAN South Africa (performance indicators, quantity structure (EMEA))^c

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureEMEA_NumberOfLocationsPrioritizationWANSouthAfrica`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (EMEA). This indicator captures the number of locations data prioritization per country/region.

has super-classes Quantity indicator^c WAN^c

Number of locations prioritization WAN Turkey (performance indicators, quantity structure (EMEA))^c

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureEMEA_NumberOfLocationsPrioritizationWANTurkey`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (EMEA). This indicator captures the number of locations data prioritization per country/region.

has super-classes Quantity indicator^c WAN^c

Number of locations prioritization WAN USA (performance indicators, quantity structure (NA))^c

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureNA_NumberOfLocationsPrioritizationWANUSA`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (NA). This indicator captures the number of locations data prioritization per country/region.

has super-classes Quantity indicator^c WAN^c

Number of locations Russia (performance indicators, quantity structure (EMEA))^c

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureEMEA_NumberOfLocationsRussia`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (EMEA). This indicator captures the number of WAN locations per country/region.

has super-classes Quantity indicator^c WAN^c

Number of locations SA (performance indicators, quantity structure (SA))^c

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureSA_NumberOfLocationsSA`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (SA). This indicator captures the number of WAN locations per country/region.

has super-classes Quantity indicator^c WAN^c

Number of locations South Africa (performance indicators, quantity structure (EMEA))^c

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureEMEA_NumberOfLocationsSouthAfrica`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (EMEA). This indicator captures the number of WAN locations per country/region.

has super-classes Quantity indicator^c WAN^c

Number of locations Turkey (performance indicators, quantity structure (EMEA))^c

IRI: https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureEMEA_NumberOfLocationsTurkey

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (EMEA). This indicator captures the number of WAN locations per country/region.

has super-classes Quantity indicator^c WAN^c

Number of locations USA (performance indicators, quantity structure (NA))^c

IRI: https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureNA_NumberOfLocationsUSA

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (NA). This indicator captures the number of WAN locations per country/region.

has super-classes Quantity indicator^c WAN^c

Number of locations video WAN (performance indicators, quantity structure (other countries))^c

IRI: https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureOtherCountries_NumberOfLocationsVideoWAN

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (other countries). This indicator captures the number of locations video per country/region.

has super-classes Quantity indicator^c WAN^c

Number of locations video WAN Brazil (performance indicators, quantity structure (SA))^c

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureSA_NumberOfLocationsVideoWANBrazil`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (SA). This indicator captures the number of locations video per country/region.

has super-classes Quantity indicator^c WAN^c

Number of locations video WAN China (performance indicators, quantity structure (APA))^c

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureAPA_NumberOfLocationsVideoWANChina`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (APA). This indicator captures the number of locations video per country/region.

has super-classes Quantity indicator^c WAN^c

Number of locations video WAN EMEA (performance indicators, quantity structure (EMEA))^c

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureEMEA_NumberOfLocationsVideoWANEMEA`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (EMEA). This indicator captures the number of locations video per country/region.

has super-classes Quantity indicator^c WAN^c

Number of locations video WAN Germany (performance indicators, quantity structure (EMEA))^c

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureEMEA_NumberOfLocationsVideoWANGermany`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (EMEA). This indicator captures the number of locations video per country/region.

has super-classes Quantity indicator^c WAN^c

Number of locations video WAN India (performance indicators, quantity structure (APA))^c

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureAPA_NumberOfLocationsVideoWANIndia`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (APA). This indicator captures the number of locations video per country/region.

has super-classes Quantity indicator^c WAN^c

Number of locations video WAN Mexico (performance indicators, quantity structure (NA))^c

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureNA_NumberOfLocationsVideoWANMexico`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (NA). This indicator captures the number of locations video per country/region.

has super-classes Quantity indicator^c WAN^c

Number of locations video WAN NA (performance indicators, quantity structure (NA))^c

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureNA_NumberOfLocationsVideoWANNA`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (NA). This indicator captures the number of locations video per country/region.

has super-classes Quantity indicator^c WAN^c

Number of locations video WAN other APA (performance indicators, quantity structure (APA))^c

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureAPA_NumberOfLocationsVideoWANOtherAPA`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (APA). This indicator captures the number of locations video per country/region.

has super-classes Quantity indicator^c WAN^c

Number of locations video WAN other EMEA (performance indicators, quantity structure (EMEA))^c

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureEMEA_NumberOfLocationsVideoWANOtherEMEA`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (EMEA). This indicator captures the number of locations video per country/region.

has super-classes Quantity indicator^c WAN^c

Number of locations video WAN other NA (performance indicators, quantity structure (NA))^c

IRI: https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureNA_NumberOfLocationsVideoWANOtherNA

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (NA). This indicator captures the number of locations video per country/region.

has super-classes Quantity indicator^c WAN^c

Number of locations video WAN other SA (performance indicators, quantity structure (SA))^c

IRI: https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureSA_NumberOfLocationsVideoWANOtherSA

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (SA). This indicator captures the number of locations video per country/region.

has super-classes Quantity indicator^c WAN^c

Number of locations video WAN Russia (performance indicators, quantity structure (EMEA))^c

IRI: https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureEMEA_NumberOfLocationsVideoWANRussia

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (EMEA). This indicator captures the number of locations video per country/region.

has super-classes Quantity indicator^c WAN^c

Number of locations video WAN SA (performance indicators, quantity structure (SA))^c

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureSA_NumberOfLocationsVideoWANSA`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (SA). This indicator captures the number of locations video per country/region.

has super-classes Quantity indicator^c WAN^c

Number of locations video WAN South Africa (performance indicators, quantity structure (EMEA))^c

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureEMEA_NumberOfLocationsVideoWANSouthAfrica`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (EMEA). This indicator captures the number of locations video per country/region.

has super-classes Quantity indicator^c WAN^c

Number of locations video WAN Turkey (performance indicators, quantity structure (EMEA))^c

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureEMEA_NumberOfLocationsVideoWANTurkey`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (EMEA). This indicator captures the number of locations video per country/region.

has super-classes Quantity indicator^c WAN^c

Number of locations video WAN UA (performance indicators, quantity structure (NA))^c

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureNA_NumberOfLocationsVideoWANUA`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (NA). This indicator captures the number of locations video per country/region.

has super-classes Quantity indicator^c WAN^c

Number of locations VoIP WAN (performance indicators, quantity structure (other countries))^c

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureOtherCountries_NumberOfLocationsVoIPWAN`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (other countries). This indicator captures the number of locations VoIP per country/region.

has super-classes Quantity indicator^c WAN^c

Number of locations VoIP WAN APA (performance indicators, quantity structure (APA))^c

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureAPA_NumberOfLocationsVoIPWANAPA`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (APA). This indicator captures the number of locations VoIP per country/region.

has super-classes Quantity indicator^c WAN^c

Number of locations VoIP WAN Brazil (performance indicators, quantity structure (SA))[c]

IRI: https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureSA_NumberOfLocationsVoIPWANBrazil

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (SA). This indicator captures the number of locations VoIP per country/region.

has super-classes Quantity indicator[c] WAN[c]

Number of locations VoIP WAN China (performance indicators, quantity structure (APA))[c]

IRI: https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureAPA_NumberOfLocationsVoIPWANChina

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (APA). This indicator captures the number of locations VoIP per country/region.

has super-classes Quantity indicator[c] WAN[c]

Number of locations VoIP WAN EMEA (performance indicators, quantity structure (EMEA))[c]

IRI: https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureEMEA_NumberOfLocationsVoIPWANEMEA

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (EMEA). This indicator captures the number of locations VoIP per country/region.

has super-classes Quantity indicator[c] WAN[c]

Number of locations VoIP WAN Germany (performance indicators, quantity structure (EMEA))^c

IRI: https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureEMEA_NumberOfLocationsVoIPWANGermany

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (EMEA). This indicator captures the number of locations VoIP per country/region.

has super-classes Quantity indicator^c WAN^c

Number of locations VoIP WAN India (performance indicators, quantity structure (APA))^c

IRI: https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureAPA_NumberOfLocationsVoIPWANIndia

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (APA). This indicator captures the number of locations VoIP per country/region.

has super-classes Quantity indicator^c WAN^c

Number of locations VoIP WAN Mexico (performance indicators, quantity structure (NA))^c

IRI: https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureNA_NumberOfLocationsVoIPWANMexico

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (NA). This indicator captures the number of locations VoIP per country/region.

has super-classes Quantity indicator^c WAN^c

Number of locations VoIP WAN NA (performance indicators, quantity structure (NA))^c

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureNA_NumberOfLocationsVoIPWANNA`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (NA). This indicator captures the number of locations VoIP per country/region.

has super-classes Quantity indicator^c WAN^c

Number of locations VoIP WAN other APA (performance indicators, quantity structure (APA))^c

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureAPA_NumberOfLocationsVoIPWANOtherAPA`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (APA). This indicator captures the number of locations VoIP per country/region.

has super-classes Quantity indicator^c WAN^c

Number of locations VoIP WAN other EMEA (performance indicators, quantity structure (EMEA))^c

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureEMEA_NumberOfLocationsVoIPWANOtherEMEA`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (EMEA). This indicator captures the number of locations VoIP per country/region.

has super-classes Quantity indicator^c WAN^c

Number of locations VoIP WAN other NA (performance indicators, quantity structure (NA))^c

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureNA_NumberOfLocationsVoIPWANOtherNA`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (NA). This indicator captures the number of locations VoIP per country/region.

has super-classes Quantity indicator^c WAN^c

Number of locations VoIP WAN other SA (performance indicators, quantity structure (SA))^c

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureSA_NumberOfLocationsVoIPWANOtherSA`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (SA). This indicator captures the number of locations VoIP per country/region.

has super-classes Quantity indicator^c WAN^c

Number of locations VoIP WAN Russia (performance indicators, quantity structure (EMEA))^c

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureEMEA_NumberOfLocationsVoIPWANRussia`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (EMEA). This indicator captures the number of locations VoIP per country/region.

has super-classes Quantity indicator^c WAN^c

Number of locations VoIP WAN SA (performance indicators, quantity structure (SA))^c

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureSA_NumberOfLocationsVoIPWANSA`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (SA). This indicator captures the number of locations VoIP per country/region.

has super-classes Quantity indicator^c WAN^c

Number of locations VoIP WAN South Africa (performance indicators, quantity structure (EMEA))^c

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureEMEA_NumberOfLocationsVoIPWANSouthAfrica`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (EMEA). This indicator captures the number of locations VoIP per country/region.

has super-classes Quantity indicator^c WAN^c

Number of locations VoIP WAN Turkey (performance indicators, quantity structure (EMEA))^c

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureEMEA_NumberOfLocationsVoIPWANTurkey`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (EMEA). This indicator captures the number of locations VoIP per country/region.

has super-classes Quantity indicator^c WAN^c

Number of locations VoIP WAN USA (performance indicators, quantity structure (NA))^{c}

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureNA_NumberOfLocationsVoIPWANUSA`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (NA). This indicator captures the number of locations VoIP per country/region.

has super-classes Quantity indicator^{c} WAN^{c}

Number of locations without prioritization WAN (performance indicators, quantity structure (other countries))^{c}

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureOtherCountries_NumberOfLocationsWithoutPrioritizationWAN`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (other countries). This indicator captures the locations without prioritization WAN per country/region.

has super-classes Quantity indicator^{c} WAN^{c}

Number of locations without prioritization WAN APA (performance indicators, quantity structure (APA))^{c}

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureAPA_NumberOfLocationsWithoutPrioritizationWANAPA`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (APA). This indicator captures the locations without prioritization WAN per country/region.

has super-classes Quantity indicator^{c} WAN^{c}

Number of locations without prioritization WAN Brazil (performance indicators, quantity structure (SA))^c

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureSA_NumberOfLocationsWithoutPrioritizationWANBrazil`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (SA). This indicator captures the locations without prioritization WAN per country/region.

has super-classes Quantity indicator^c WAN^c

Number of locations without prioritization WAN China (performance indicators, quantity structure (APA))^c

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureAPA_NumberOfLocationsWithoutPrioritizationWANChina`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (APA). This indicator captures the locations without prioritization WAN per country/region.

has super-classes Quantity indicator^c WAN^c

Number of locations without prioritization WAN EMEA (performance indicators, quantity structure (EMEA))^c

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureEMEA_NumberOfLocationsWithoutPrioritizationWANEMEA`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (EMEA). This indicator captures the locations without prioritization WAN per country/region.

has super-classes Quantity indicator^c WAN^c

Number of locations without prioritization WAN Germany (performance indicators, quantity structure (EMEA))^c

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureEMEA_NumberOfLocationsWithoutPrioritizationWANGermany`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (EMEA). This indicator captures the locations without prioritization WAN per country/region.

has super-classes Quantity indicator^c WAN^c

Number of locations without prioritization WAN India (performance indicators, quantity structure (APA))^c

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureAPA_NumberOfLocationsWithoutPrioritizationWANIndia`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (APA). This indicator captures the locations without prioritization WAN per country/region.

has super-classes Quantity indicator^c WAN^c

Number of locations without prioritization WAN Mexico (performance indicators, quantity structure (NA))^c

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureNA_NumberOfLocationsWithoutPrioritizationWANMexico`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (NA). This indicator captures the locations without prioritization WAN per country/region.

has super-classes Quantity indicator^c WAN^c

Number of locations without prioritization WAN NA (performance indicators, quantity structure (NA))^c

IRI: https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureNA_NumberOfLocationsWithoutPrioritizationWANNA

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (NA). This indicator captures the locations without prioritization WAN per country/region.

has super-classes Quantity indicator^c WAN^c

Number of locations without prioritization WAN other APA (performance indicators, quantity structure (APA))^c

IRI: https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureAPA_NumberOfLocationsWithoutPrioritizationWANOtherAPA

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (APA). This indicator captures the locations without prioritization WAN per country/region.

has super-classes Quantity indicator^c WAN^c

Number of locations without prioritization WAN other EMEA (performance indicators, quantity structure (EMEA))^c

IRI: https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureEMEA_NumberOfLocationsWithoutPrioritizationWANOtherEMEA

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (EMEA). This indicator captures the locations without prioritization WAN per country/region.

has super-classes Quantity indicator^c WAN^c

Number of locations without prioritization WAN other NA (performance indicators, quantity structure (NA))^c

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureNA_NumberOfLocationsWithoutPrioritizationWANOtherNA`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (NA). This indicator captures the locations without prioritization WAN per country/region.

has super-classes Quantity indicator^c WAN^c

Number of locations without prioritization WAN other SA (performance indicators, quantity structure (SA))^c

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureSA_NumberOfLocationsWithoutPrioritizationWANOtherSA`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (SA). This indicator captures the locations without prioritization WAN per country/region.

has super-classes Quantity indicator^c WAN^c

Number of locations without prioritization WAN Russia (performance indicators, quantity structure (EMEA))^c

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureEMEA_NumberOfLocationsWithoutPrioritizationWANRussia`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (EMEA). This indicator captures the locations without prioritization WAN per country/region.

has super-classes Quantity indicator^c WAN^c

Number of locations without prioritization WAN SA (performance indicators, quantity structure (SA))^c

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureSA_NumberOfLocationsWithoutPrioritizationWANSA`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (SA). This indicator captures the locations without prioritization WAN per country/region.

has super-classes Quantity indicator^c WAN^c

Number of locations without prioritization WAN South Africa (performance indicators, quantity structure (EMEA))^c

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureEMEA_NumberOfLocationsWithoutPrioritizationWANSouthAfrica`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (EMEA). This indicator captures the locations without prioritization WAN per country/region.

has super-classes Quantity indicator^c WAN^c

Number of locations without prioritization WAN Turkey (performance indicators, quantity structure (EMEA))^c

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureEMEA_NumberOfLocationsWithoutPrioritizationWANTurkey`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (EMEA). This indicator captures the locations without prioritization WAN per country/region.

has super-classes Quantity indicator^c WAN^c

Number of locations without prioritization WAN USA (performance indicators, quantity structure (NA))^c

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureNA_NumberOfLocationsWithoutPrioritizationWANUSA`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (NA). This indicator captures the locations without prioritization WAN per country/region.

has super-classes Quantity indicator^c WAN^c

Number of long running batch processes (performance indicators, quantity structure and performance)^c

IRI: `https://w3id.org/bmontology#SAPBasis_PerformanceIndicators_QuantityStructureAndPerformance_NumberOfLongRunningBatchProcesses`

This is a performance indicator of the SAP basis service, categorized into performance indicators as well as quantity structure and performance. This indicator captures the number of available batches per month (representative load) without any additional load (e.g., load caused by the turn of the year.

has super-classes Quantity indicator^c SAP basis^c

Number of mailboxes (performance indicators, quantity structure)^c

IRI: `https://w3id.org/bmontology#Mailbox_PerformanceIndicators_QuantityStructure_NumberOfMailboxes`

This is a performance indicator of the mailbox service, categorized into performance indicators as well as quantity structure. This indicator captures the number of mailboxes.

has super-classes Mailbox^c Quantity indicator^c

Number of mailservers (performance indicators, quantity structure)^c

IRI: `https://w3id.org/bmontology#Mailbox_PerformanceIndicators_QuantityStructure_NumberOfMailservers`

This is a performance indicator of the mailbox service, categorized into performance indicators as well as quantity structure. This indicator captures the number of mail servers.

has super-classes Mailbox^c Quantity indicator^c

Number of maintaned phone numbers (performance indicators, quantity structure (classical telephony))^c

IRI: `https://w3id.org/bmontology#Telephony_PerformanceIndicators_QuantityStructureClassicalTelephony_NumberOfMaintanedPhoneNumbers`

This is a performance indicator of the telephony service, categorized into performance indicators as well as quantity structure (classical telephony). This indicator captures the number of supported phone numbers.

has super-classes Quantity indicator^c Telephony^c

Number of managed locations (performance indicators, performance information)^c

IRI: `https://w3id.org/bmontology#Telephony_PerformanceIndicators_PerformanceInformation_NumberOfManagedLocations`

This is a performance indicator of the telephony service, categorized into performance indicators as well as performance information. This indicator captures the number of supported locations.

has super-classes Quantity indicator^c Telephony^c

Number of managed phone numbers (performance indicators, quantity structure (voIP))^c

IRI: `https://w3id.org/bmontology#Telephony_PerformanceIndicators_QuantityStructureVoIP_NumberOfManagedPhoneNumbers`

This is a performance indicator of the telephony service, categorized into performance indicators as well as quantity structure (voIP). This indicator captures the number of supported phone numbers.

has super-classes Quantity indicator^c Telephony^c

Number of module users (performance indicators, BC: basic system)^c

IRI: `https://w3id.org/bmontology#SAPModules_PerformanceIndicators_BCBasicSystem_NumberOfModuleUsers`

This is a performance indicator of the SAP modules service, categorized into performance indicators as well as BC: basic system. This indicator captures the number of users of this module (incl. submodules).

has super-classes Quantity indicator^c SAP modules^c

Number of module users (performance indicators, co: controlling)^c

IRI: `https://w3id.org/bmontology#SAPModules_PerformanceIndicators_CoControlling_NumberOfModuleUsers`

This is a performance indicator of the SAP modules service, categorized into performance indicators as well as co: controlling. This indicator captures the number of users of this module (incl. submodules).

has super-classes Quantity indicator^c SAP modules^c

Number of module users (performance indicators, CS: customer service)^c

IRI: `https://w3id.org/bmontology#SAPModules_PerformanceIndicators_CSCustomerService_NumberOfModuleUsers`

This is a performance indicator of the SAP modules service, categorized into performance indicators as well as CS: customer service. This indicator captures the number of users of this module (incl. submodules).

has super-classes Quantity indicator^c SAP modules^c

Number of module users (performance indicators, EC: corporate controlling)^c

IRI: `https://w3id.org/bmontology#SAPModules_PerformanceIndicators_ECCorporateControlling_NumberOfModuleUsers`

This is a performance indicator of the SAP modules service, categorized into performance indicators as well as EC: corporate controlling. This indicator captures the number of users of this module (incl. submodules).

has super-classes Quantity indicator^c SAP modules^c

Number of module users (performance indicators, FI: finance)^c

IRI: `https://w3id.org/bmontology#SAPModules_PerformanceIndicators_FIFinance_NumberOfModuleUsers`

This is a performance indicator of the SAP modules service, categorized into performance indicators as well as FI: finance. This indicator captures the number of users of this module (incl. submodules).

has super-classes Quantity indicator^c SAP modules^c

Number of module users (performance indicators, MM: materials management)^c

IRI: `https://w3id.org/bmontology#SAPModules_PerformanceIndicators_MMMaterialsManagement_NumberOfModuleUsers`

This is a performance indicator of the SAP modules service, categorized into performance indicators as well as MM: materials management. This indicator captures the number of users of this module (incl. submodules).

has super-classes Quantity indicator^c SAP modules^c

Number of module users (performance indicators, PM: plant maintenance)^c

IRI: `https://w3id.org/bmontology#SAPModules_PerformanceIndicators_PMPlantMaintenance_NumberOfModuleUsers`

This is a performance indicator of the SAP modules service, categorized into performance indicators as well as PM: plant maintenance. This indicator captures the number of users of this module (incl. submodules).

has super-classes Quantity indicator^c SAP modules^c

Number of module users (performance indicators, PP: production planning and control)^c

IRI: `https://w3id.org/bmontology#SAPModules_PerformanceIndicators_PPProductionPlanningAndControl_NumberOfModuleUsers`

This is a performance indicator of the SAP modules service, categorized into performance indicators as well as PP: production planning and control. This indicator captures the number of users of this module (incl. submodules).

has super-classes Quantity indicator^c SAP modules^c

Number of module users (performance indicators, SD: sales and distribution)^c

IRI: `https://w3id.org/bmontology#SAPModules_PerformanceIndicators_SDSalesAndDistribution_NumberOfModuleUsers`

This is a performance indicator of the SAP modules service, categorized into performance indicators as well as SD: sales and distribution. This indicator captures the number of users of this module (incl. submodules).

has super-classes Quantity indicator[c] SAP modules[c]

Number of other access ports (performance indicators, quantity structure)[c]

IRI: `https://w3id.org/bmontology#LAN_PerformanceIndicators_QuantityStructure_NumberOfOtherAccessPorts`

This is a performance indicator of the LAN service, categorized into performance indicators as well as quantity structure. This indicator captures the number of other access ports.

has super-classes LAN[c] Quantity indicator[c]

Number of passive devices in the organization (performance indicators, general indicators)[c]

IRI: `https://w3id.org/bmontology#MobileDevices_PerformanceIndicators_GeneralIndicators_NumberOfPassiveDevicesInTheOrganization`

This is a performance indicator of the mobile devices service, categorized into performance indicators as well as general indicators. This indicator captures the number of passive devices.

has super-classes Mobile devices[c] Quantity indicator[c]

Number of patch cycles per year (performance indicators, quantity structure and performance)[c]

IRI: `https://w3id.org/bmontology#TerminalServer_PerformanceIndicators_QuantityStructureAndPerformance_NumberOfPatchCyclesPerYear`

This is a performance indicator of the terminal server service, categorized into performance indicators as well as quantity structure and performance. This indicator captures the number of patch cycles per year.

has super-classes Quantity indicator[c] Terminal server[c]

Number of physical hosts (performance indicators, quantity structure and performance)^c

IRI: `https://w3id.org/bmontology#TerminalServer_PerformanceIndicators_QuantityStructureAndPerformance_NumberOfPhysicalHosts`

This is a performance indicator of the terminal server service, categorized into performance indicators as well as quantity structure and performance. This indicator captures the number of physical servers used within this module.

has super-classes Quantity indicator^c Terminal server^c

Number of physical hosts in the server farm (performance indicators, host systems)^c

IRI: `https://w3id.org/bmontology#VirtualServer_PerformanceIndicators_HostSystems_NumberOfPhysicalHostsInTheServerFarm`

This is a performance indicator of the virtual server service, categorized into performance indicators as well as host systems. This indicator captures the number of physical hosts in the farm.

has super-classes Quantity indicator^c Virtual server^c

Number of providers WLAN (performance indicators, quantity structure and performance)^c

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureAndPerformance_NumberOfProvidersWLAN`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure and performance. This indicator captures the number of WAN providers.

has super-classes Quantity indicator^c WAN^c

Number of Runtime errors (performance indicators, quantity structure and performance)[c]

IRI: `https://w3id.org/bmontology#SAPBasis_PerformanceIndicators_QuantityStructureAndPerformance_NumberOfRuntimeErrors`

This is a performance indicator of the SAP basis service, categorized into performance indicators as well as quantity structure and performance. This indicator captures the number of runtime errors over all batches per month.

has super-classes Quantity indicator[c] SAP basis[c]

Number of servers (performance indicators, quantity structure (large))[c]

IRI: `https://w3id.org/bmontology#DedicatedServer_PerformanceIndicators_QuantityStructureLarge_NumberOfServers`

This is a performance indicator of the dedicated server service, categorized into performance indicators as well as quantity structure (large). This indicator captures the number of dedicated servers.

has super-classes Dedicated server (large)[c] Quantity indicator[c]

Number of servers (performance indicators, quantity structure (small))[c]

IRI: `https://w3id.org/bmontology#DedicatedServer_PerformanceIndicators_QuantityStructureSmall_NumberOfServers`

This is a performance indicator of the dedicated server service, categorized into performance indicators as well as quantity structure (small). This indicator captures the number of dedicated servers.

has super-classes Dedicated server (small)[c] Quantity indicator[c]

Number of servers (platform-specific) (performance indicators, quantity structure (medium))^c

IRI: `https://w3id.org/bmontology#DedicatedServer_PerformanceIndicators_QuantityStructureMedium_NumberOfServersPlatformSpecific`

This is a performance indicator of the dedicated server service, categorized into performance indicators as well as quantity structure (medium). This indicator captures the number of dedicated servers.

has super-classes Dedicated server (medium)^c Quantity indicator^c

Number of servers (platform-specific) (performance indicators, quantity structure and performance (blackberry))^c

IRI: `https://w3id.org/bmontology#MobileDevices_PerformanceIndicators_QuantityStructureAndPerformanceBlackberry_NumberOfServersPlatformSpecific`

This is a performance indicator of the mobile devices service, categorized into performance indicators as well as quantity structure and performance (blackberry). This indicator captures the number of servers required for service provision on the respective platform.

has super-classes Mobile Devices (Blackberry)^c Quantity indicator^c

Number of servers (platform-specific) (performance indicators, quantity structure and performance (iPhone))^c

IRI: `https://w3id.org/bmontology#MobileDevices_PerformanceIndicators_QuantityStructureAndPerformanceIPhone_NumberOfServersPlatformSpecific`

This is a performance indicator of the mobile devices service, categorized into performance indicators as well as quantity structure and performance (iPhone). This indicator captures the number of servers required for service provision on the respective platform.

has super-classes Mobile Devices (iPhone)^c Quantity indicator^c

Number of servers (platform-specific) (performance indicators, quantity structure and performance (other))^c

IRI: `https://w3id.org/bmontology#MobileDevices_PerformanceIndicators _QuantityStructureAndPerformanceOther_NumberOfServersPlatformSpecific`

This is a performance indicator of the mobile devices service, categorized into performance indicators as well as quantity structure and performance (other). This indicator captures the number of servers required for service provision on the respective platform.

has super-classes Mobile Devices (Others)^c Quantity indicator^c

Number of servers (platform-specific) (performance indicators, quantity structure and performance (windows phone))^c

IRI: `https://w3id.org/bmontology#MobileDevices_PerformanceIndicators _QuantityStructureAndPerformanceWindowsPhone_NumberOfServersPlatform Specific`

This is a performance indicator of the mobile devices service, categorized into performance indicators as well as quantity structure and performance (windows phone). This indicator captures the number of servers required for service provision on the respective platform.

has super-classes Mobile Devices (Windows Phone)^c Quantity indicator^c

Number of service desk agents, first level (FTE) (performance indicators, quantity structure and performance)^c

IRI: `https://w3id.org/bmontology#Servicedesk_PerformanceIndicators _QuantityStructureAndPerformance_NumberOfServiceDeskAgentsFirstLevelFTE`

This is a performance indicator of the servicedesk service, categorized into performance indicators as well as quantity structure and performance. This indicator captures the number of service desk agent in the first level support.

has super-classes Quantity indicator^c Servicedesk^c

Number of service requests per year (performance indicators, quantity structure and performance)[c]

IRI: `https://w3id.org/bmontology#Servicedesk_PerformanceIndicators_QuantityStructureAndPerformance_NumberOfServiceRequestsPerYear`

This is a performance indicator of the servicedesk service, categorized into performance indicators as well as quantity structure and performance. This indicator captures the average number of service requests arriving at the service desk (per year).

has super-classes Quantity indicator[c] Servicedesk[c]

Number of snapshots in primary storage per day (performance indicators, quantity structure and performance)[c]

IRI: `https://w3id.org/bmontology#Backup_PerformanceIndicators_QuantityStructureAndPerformance_NumberOfSnapshotsInPrimaryStoragePerDay`

This is a performance indicator of the backup service, categorized into performance indicators as well as quantity structure and performance. This indicator captures the number of snapshots within the primary storage for restore.

has super-classes Backup[c] Quantity indicator[c]

Number of supported users (performance indicators, quantity structure and performance)[c]

IRI: `https://w3id.org/bmontology#Servicedesk_PerformanceIndicators_QuantityStructureAndPerformance_NumberOfSupportedUsers`

This is a performance indicator of the servicedesk service, categorized into performance indicators as well as quantity structure and performance. This indicator captures the number of users supported by the service desk.

has super-classes Quantity indicator[c] Servicedesk[c]

Number of system lines (Landscape) (performance indicators, quantity structure and performance)^c

IRI: `https://w3id.org/bmontology#SAPBasis_PerformanceIndicators_QuantityStructureAndPerformance_NumberOfSystemLinesLandscape`

This is a performance indicator of the SAP basis service, categorized into performance indicators as well as quantity structure and performance. This indicator captures the number (sum) of SAP system lines (including quality assurance of all technical systems except for project systems).

has super-classes Quantity indicator^c SAP basis^c

Number of systems (ERP + HR) (performance indicators, quantity structure and performance)^c

IRI: `https://w3id.org/bmontology#SAPBasis_PerformanceIndicators_QuantityStructureAndPerformance_NumberOfSystemsERPHR`

This is a performance indicator of the SAP basis service, categorized into performance indicators as well as quantity structure and performance. This indicator captures the number (sum) of used SAP ERP systems (+HR).

has super-classes Quantity indicator^c SAP basis^c

Number of systems (Landscape) (performance indicators, quantity structure and performance)^c

IRI: `https://w3id.org/bmontology#SAPBasis_PerformanceIndicators_QuantityStructureAndPerformance_NumberOfSystemsLandscape`

This is a performance indicator of the SAP basis service, categorized into performance indicators as well as quantity structure and performance. This indicator captures the number (sum) of SAP systems used within the organization (including quality assurance of all technical systems except for project systems).

has super-classes Quantity indicator^c SAP basis^c

Number of systems to be secured (performance indicators, quantity structure and performance)^c

IRI: https://w3id.org/bmontology#Backup_PerformanceIndicators_QuantityStructureAndPerformance_NumberOfSystemsToBeSecured

This is a performance indicator of the backup service, categorized into performance indicators as well as quantity structure and performance. This indicator captures the number of systems that have to be backed up.

has super-classes Backup^c Quantity indicator^c

Number of sytem lines (ERP + HR) (performance indicators, quantity structure and performance)^c

IRI: https://w3id.org/bmontology#SAPBasis_PerformanceIndicators_QuantityStructureAndPerformance_NumberOfSytemLinesERPHR

This is a performance indicator of the SAP basis service, categorized into performance indicators as well as quantity structure and performance. This indicator captures the number (sum) of used SAP ERP system lines (+HR).

has super-classes Quantity indicator^c SAP basis^c

Number of tape drives (performance indicators, quantity structure and performance)^c

IRI: https://w3id.org/bmontology#Backup_PerformanceIndicators_QuantityStructureAndPerformance_NumberOfTapeDrives

This is a performance indicator of the backup service, categorized into performance indicators as well as quantity structure and performance. This indicator captures the sum of used tape drive types.

has super-classes Backup^c Quantity indicator^c

Number of telephony end devices (performance indicators, quantity structure (classical telephony))^c

IRI: `https://w3id.org/bmontology#Telephony_PerformanceIndicators_QuantityStructureClassicalTelephony_NumberOfTelephonyEndDevices`

This is a performance indicator of the telephony service, categorized into performance indicators as well as quantity structure (classical telephony). This indicator captures the number of used classical telephone devices and VoIP devices.

has super-classes Quantity indicator^c Telephony^c

Number of telephony end devices (performance indicators, quantity structure (voIP))^c

IRI: `https://w3id.org/bmontology#Telephony_PerformanceIndicators_QuantityStructureVoIP_NumberOfTelephonyEndDevices`

This is a performance indicator of the telephony service, categorized into performance indicators as well as quantity structure (voIP). This indicator captures the number of used classical telephone devices and VoIP devices.

has super-classes Quantity indicator^c Telephony^c

Number of used operation systems (performance indicators, cross-system)^c

IRI: `https://w3id.org/bmontology#VirtualServer_PerformanceIndicators_CrossSystem_NumberOfUsedOperationSystems`

This is a performance indicator of the virtual server service, categorized into performance indicators as well as cross-system. This indicator captures the number of used operating system variants.

has super-classes Quantity indicator^c Virtual server^c

Number of used operation systems (performance indicators, quantity structure and performance)^c

IRI: `https://w3id.org/bmontology#Workplace_PerformanceIndicators_QuantityStructureAndPerformance_NumberOfUsedOperationSystems`

This is a performance indicator of the workplace service, categorized into performance indicators as well as quantity structure and performance. This indicator captures the number of distributed packages per year.

has super-classes Quantity indicator^c Workplace^c

Number of users China (performance indicators, quantity structure (APA))^c

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureAPA_NumberOfUsersChina`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (APA). This indicator captures the number of users of the WAN infrastruture per country/region.

has super-classes Quantity indicator^c WAN^c

Number of users (performance indicators, conferencing (incl. video conferencing tools))^c

IRI: `https://w3id.org/bmontology#Collaboration_PerformanceIndicators_ConferencingInclVideoConferencingTools_NumberOfUsers`

This is a performance indicator of the collaboration service, categorized into performance indicators as well as conferencing (incl. video conferencing tools). This indicator captures how many employees are using tools of the given category.

has super-classes Collaboration^c Quantity indicator^c

Number of users (performance indicators, lync and other applications (without telephony))^c

IRI: `https://w3id.org/bmontology#Collaboration_PerformanceIndicators_LyncAndOtherApplicationsWithoutTelephony_NumberOfUsers`

This is a performance indicator of the collaboration service, categorized into performance indicators as well as lync and other applications (without telephony). This indicator captures how many employees are using tools of the given category.

has super-classes Collaboration^c Quantity indicator^c

Number of users (performance indicators, quantity structure (other countries))^c

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureOtherCountries_NumberOfUsers`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (other countries). This indicator captures the number of users of the WAN infrastruture per country/region.

has super-classes Quantity indicator^c WAN^c

Number of users (performance indicators, sharePoint and other applications)^c

IRI: `https://w3id.org/bmontology#Collaboration_PerformanceIndicators_SharePointAndOtherApplications_NumberOfUsers`

This is a performance indicator of the collaboration service, categorized into performance indicators as well as sharePoint and other applications. This indicator captures how many employees are using tools of the given category.

has super-classes Collaboration^c Quantity indicator^c

Number of users APA (performance indicators, quantity structure (APA))^c

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureAPA_NumberOfUsersAPA`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (APA). This indicator captures the number of users of the WAN infrastruture per country/region.

has super-classes Quantity indicator^c WAN^c

Number of users Brazil (performance indicators, quantity structure (SA))^c

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureSA_NumberOfUsersBrazil`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (SA). This indicator captures the number of users of the WAN infrastruture per country/region.

has super-classes Quantity indicator^c WAN^c

Number of users concurrent (performance indicators, quantity structure and performance)^c

IRI: `https://w3id.org/bmontology#TerminalServer_PerformanceIndicators_QuantityStructureAndPerformance_NumberOfUsersConcurrent`

This is a performance indicator of the terminal server service, categorized into performance indicators as well as quantity structure and performance. This indicator captures the number of concurrent users.

has super-classes Quantity indicator^c Terminal server^c

Number of users EMEA (performance indicators, quantity structure (EMEA))^c

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureEMEA_NumberOfUsersEMEA`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (EMEA). This indicator captures the number of users of the WAN infrastruture per country/region.

has super-classes Quantity indicator^c WAN^c

Number of users Germany (performance indicators, quantity structure (EMEA))^c

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureEMEA_NumberOfUsersGermany`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (EMEA). This indicator captures the number of users of the WAN infrastruture per country/region.

has super-classes Quantity indicator^c WAN^c

Number of users India (performance indicators, quantity structure (APA))^c

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureAPA_NumberOfUsersIndia`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (APA). This indicator captures the number of users of the WAN infrastruture per country/region.

has super-classes Quantity indicator^c WAN^c

Number of users Mail (performance indicators, quantity structure)^c

IRI: https://w3id.org/bmontology#Mailbox_PerformanceIndicators_QuantityStructure_NumberOfUsersMail

This is a performance indicator of the mailbox service, categorized into performance indicators as well as quantity structure. This indicator captures the number of users having a personal mailbox.

has super-classes Mailbox^c Quantity indicator^c

Number of users Mexico (performance indicators, quantity structure (NA))^c

IRI: https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureNA_NumberOfUsersMexico

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (NA). This indicator captures the number of users of the WAN infrastruture per country/region.

has super-classes Quantity indicator^c WAN^c

Number of users NA (performance indicators, quantity structure (NA))^c

IRI: https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureNA_NumberOfUsersNA

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (NA). This indicator captures the number of users of the WAN infrastruture per country/region.

has super-classes Quantity indicator^c WAN^c

Number of users other APA (performance indicators, quantity structure (APA))[c]

IRI: https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureAPA_NumberOfUsersOtherAPA

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (APA). This indicator captures the number of users of the WAN infrastruture per country/region.

has super-classes Quantity indicator[c] WAN[c]

Number of users other EMEA (performance indicators, quantity structure (EMEA))[c]

IRI: https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureEMEA_NumberOfUsersOtherEMEA

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (EMEA). This indicator captures the number of users of the WAN infrastruture per country/region.

has super-classes Quantity indicator[c] WAN[c]

Number of users other NA (performance indicators, quantity structure (NA))[c]

IRI: https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureNA_NumberOfUsersOtherNA

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (NA). This indicator captures the number of users of the WAN infrastruture per country/region.

has super-classes Quantity indicator[c] WAN[c]

Number of users other SA (performance indicators, quantity structure (SA))[c]

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureSA_NumberOfUsersOtherSA`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (SA). This indicator captures the number of users of the WAN infrastruture per country/region.

has super-classes Quantity indicator[c] WAN[c]

Number of users Russia (performance indicators, quantity structure (EMEA))[c]

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureEMEA_NumberOfUsersRussia`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (EMEA). This indicator captures the number of users of the WAN infrastruture per country/region.

has super-classes Quantity indicator[c] WAN[c]

Number of users SA (performance indicators, quantity structure (SA))[c]

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureSA_NumberOfUsersSA`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (SA). This indicator captures the number of users of the WAN infrastruture per country/region.

has super-classes Quantity indicator[c] WAN[c]

Number of users South Africa (performance indicators, quantity structure (EMEA))^c

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureEMEA_NumberOfUsersSouthAfrica`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (EMEA). This indicator captures the number of users of the WAN infrastruture per country/region.

has super-classes Quantity indicator^c WAN^c

Number of users supported from the cental location (performance indicators, quantity structure (classical telephony))^c

IRI: `https://w3id.org/bmontology#Telephony_PerformanceIndicators_QuantityStructureClassicalTelephony_NumberOfUsersSupportedFromTheCentalLocation`

This is a performance indicator of the telephony service, categorized into performance indicators as well as quantity structure (classical telephony). This indicator captures the number of users supported from a centralized location.

has super-classes Quantity indicator^c Telephony^c

Number of users supported from the cental location (performance indicators, quantity structure (voIP))^c

IRI: `https://w3id.org/bmontology#Telephony_PerformanceIndicators_QuantityStructureVoIP_NumberOfUsersSupportedFromTheCentalLocation`

This is a performance indicator of the telephony service, categorized into performance indicators as well as quantity structure (voIP). This indicator captures the number of users supported from a centralized location.

has super-classes Quantity indicator^c Telephony^c

Number of users total (performance indicators, quantity structure and performance)^c

IRI: `https://w3id.org/bmontology#TerminalServer_PerformanceIndicators_QuantityStructureAndPerformance_NumberOfUsersTotal`

This is a performance indicator of the terminal server service, categorized into performance indicators as well as quantity structure and performance. This indicator captures the total number of users for terminal server.

has super-classes Quantity indicator^c Terminal server^c

Number of users Turkey (performance indicators, quantity structure (EMEA))^c

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureEMEA_NumberOfUsersTurkey`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (EMEA). This indicator captures the number of users of the WAN infrastruture per country/region.

has super-classes Quantity indicator^c WAN^c

Number of users USA (performance indicators, quantity structure (NA))^c

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureNA_NumberOfUsersUSA`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (NA). This indicator captures the number of users of the WAN infrastruture per country/region.

has super-classes Quantity indicator^c WAN^c

Number of WLAN controller (performance indicators, WLAN)^c

IRI: `https://w3id.org/bmontology#LAN_PerformanceIndicators_WLAN_NumberOfWLANController`

This is a performance indicator of the LAN service, categorized into performance indicators as well as WLAN. This indicator capture the number of WLAN controllers available for the WLAN infrastructure.

has super-classes LAN^c Quantity indicator^c

Number of working students / intern (performance indicators, basic data)^c

IRI: `https://w3id.org/bmontology#BasicData_PerformanceIndicators_BasicData_NumberOfWorkingStudentsIntern`

This is a performance indicator of the basic data service, categorized into performance indicators as well as basic data. This indicator captures the number of working students and interns working in the IT.

has super-classes Basic data^c Quantity indicator^c

Number of workplaces (desktop) (performance indicators, quantity structure and performance)^c

IRI: `https://w3id.org/bmontology#Workplace_PerformanceIndicators_QuantityStructureAndPerformance_NumberOfWorkplacesDesktop`

This is a performance indicator of the workplace service, categorized into performance indicators as well as quantity structure and performance. This indicator captures the number of desktop workplaces in this organization.

has super-classes Quantity indicator^c Workplace^c

Number of workplaces (laptop) (performance indicators, quantity structure and performance)^c

IRI: `https://w3id.org/bmontology#Workplace_PerformanceIndicators_QuantityStructureAndPerformance_NumberOfWorkplacesLaptop`

This is a performance indicator of the workplace service, categorized into performance indicators as well as quantity structure and performance. This indicator captures the number of laptops within an organization.

has super-classes Quantity indicator^c Workplace^c

Offered services (performance indicators, quantity structure and performance)^c

IRI: `https://w3id.org/bmontology#TerminalServer_PerformanceIndicators_QuantityStructureAndPerformance_OfferedServices`

This is a performance indicator of the terminal server service, categorized into performance indicators as well as quantity structure and performance. This indicator captures which services are offered.

has super-classes Performance Indicator^c Terminal server^c

Offetting backup (cost indicators, classical telephony)^c

IRI: `https://w3id.org/bmontology#Telephony_CostIndicators_ClassicalTelephony_OffettingBackup`

This is a cost indicator of the telephony service, categorized into cost indicators as well as classical telephony. This indicator captures the costs of the backup for the telephony module.

has super-classes Cost Indicator^c Hardware resource indicator^c Telephony^c

Offetting backup (cost indicators, conferencing (incl. video conferencing tools))^c

IRI: `https://w3id.org/bmontology#Collaboration_CostIndicators_ConferencingInclVideoConferencingTools_OffettingBackup`

This is a cost indicator of the collaboration service, categorized into cost indicators as well as conferencing (incl. video conferencing tools). This indicator captures the costs of the backup for the collaboration module.

has super-classes Collaboration^c Cost Indicator^c Hardware resource indicator^c

Offetting backup (cost indicators, lync and other applications (without telephony))^c

IRI: `https://w3id.org/bmontology#Collaboration_CostIndicators_LyncAndOtherApplicationsWithoutTelephony_OffettingBackup`

This is a cost indicator of the collaboration service, categorized into cost indicators as well as lync and other applications (without telephony). This indicator captures the costs of the backup for the collaboration module.

has super-classes Collaboration^c Cost Indicator^c Hardware resource indicator^c

Offetting backup (cost indicators, sharePoint and other applications)^c

IRI: `https://w3id.org/bmontology#Collaboration_CostIndicators_SharePointAndOtherApplications_OffettingBackup`

This is a cost indicator of the collaboration service, categorized into cost indicators as well as sharePoint and other applications. This indicator captures the costs of the backup for the collaboration module.

has super-classes Collaboration^c Cost Indicator^c Hardware resource indicator^c

Offetting backup (cost indicators, total costs)^c

IRI: `https://w3id.org/bmontology#FileService_CostIndicators_TotalCosts_OffettingBackup`

This is a cost indicator of the file service service, categorized into cost indicators as well as total costs. This indicator captures the costs of the backup for the file service module.

has super-classes Cost Indicator^c File Service^c Hardware resource indicator^c

Offetting backup (cost indicators, total costs)^c

IRI: `https://w3id.org/bmontology#Mailbox_CostIndicators_TotalCosts_OffettingBackup`

This is a cost indicator of the mailbox service, categorized into cost indicators as well as total costs. This indicator captures the costs of the backup for the mailbox module.

has super-classes Cost Indicator^c Hardware resource indicator^c Mailbox^c

Offetting backup (cost indicators, total costs)^c

IRI: https://w3id.org/bmontology#SAPBasis_CostIndicators_TotalCosts_OffettingBackup

This is a cost indicator of the SAP basis service, categorized into cost indicators as well as total costs. This indicator captures the costs of the backup for the SAP basis module.

has super-classes Cost Indicator^c Hardware resource indicator^c SAP basis^c

Offetting backup (cost indicators, variant 1 (high availability))^c

IRI: https://w3id.org/bmontology#Database_CostIndicators_Variant1HighAvailability_OffettingBackup

This is a cost indicator of the database service, categorized into cost indicators as well as variant 1 (high availability). This indicator captures the costs of the backup for the database module.

has super-classes Cost Indicator^c Database (Variant 1)^c Hardware resource indicator^c

Offetting backup (cost indicators, variant 2)^c

IRI: https://w3id.org/bmontology#Database_CostIndicators_Variant2_OffettingBackup

This is a cost indicator of the database service, categorized into cost indicators as well as variant 2. This indicator captures the costs of the backup for the database module.

has super-classes Cost Indicator^c Datenbanken (Variante 2)^c Hardware resource indicator^c

Offetting backup (cost indicators, voIP)^c

IRI: `https://w3id.org/bmontology#Telephony_CostIndicators_VoIP_OffettingBackup`

This is a cost indicator of the telephony service, categorized into cost indicators as well as voIP. This indicator captures the costs of the backup for the telephony module.

has super-classes Cost Indicator^c Hardware resource indicator^c Telephony^c

Offsetting Install (cost indicators, desktop)^c

IRI: `https://w3id.org/bmontology#Workplace_CostIndicators_Desktop_OffsettingInstall`

This is a cost indicator of the workplace service, categorized into cost indicators as well as desktop. This indicator captures the costs for Install for the workplace module.

has super-classes Cost Indicator^c Human resource indicator^c Workplace^c

Offsetting Install (cost indicators, laptop)^c

IRI: `https://w3id.org/bmontology#Workplace_CostIndicators_Laptop_OffsettingInstall`

This is a cost indicator of the workplace service, categorized into cost indicators as well as laptop. This indicator captures the costs for Install for the workplace module.

has super-classes Cost Indicator^c Human resource indicator^c Workplace^c

Offsetting Server (cost indicators, blackberry)^c

IRI: `https://w3id.org/bmontology#MobileDevices_CostIndicators_Blackberry_OffsettingServer`

This is a cost indicator of the mobile devices service, categorized into cost indicators as well as blackberry. This indicator captures the costs for servers of the mobile devices module.

has super-classes Cost Indicator^c Hardware resource indicator^c Mobile Devices (Blackberry)^c

Offsetting Server (cost indicators, classical telephony)^c

IRI: `https://w3id.org/bmontology#Telephony_CostIndicators_ClassicalTelephony_OffsettingServer`

This is a cost indicator of the telephony service, categorized into cost indicators as well as classical telephony. This indicator captures the costs for servers of the telephony module.

has super-classes Cost Indicator^c Hardware resource indicator^c Telephony^c

Offsetting Server (cost indicators, conferencing (incl. video conferencing tools))^c

IRI: `https://w3id.org/bmontology#Collaboration_CostIndicators_ConferencingInclVideoConferencingTools_OffsettingServer`

This is a cost indicator of the collaboration service, categorized into cost indicators as well as conferencing (incl. video conferencing tools). This indicator captures the costs for servers of the collaboration module.

has super-classes Collaboration^c Cost Indicator^c Hardware resource indicator^c

Offsetting Server (cost indicators, cost indicators)^c

IRI: `https://w3id.org/bmontology#Backup_CostIndicators_CostIndicators_OffsettingServer`

This is a cost indicator of the backup service, categorized into cost indicators as well as cost indicators. This indicator captures the costs for servers of the backup module.

has super-classes Backup^c Cost Indicator^c Human resource indicator^c

Offsetting Server (cost indicators, high)^c

IRI: `https://w3id.org/bmontology#Storage_CostIndicators_High_OffsettingServer`

This is a cost indicator of the storage service, categorized into cost indicators as well as high. This indicator captures the costs for servers of the storage module.

has super-classes Cost Indicator^c Hardware resource indicator^c Storage (High)^c

Offsetting Server (cost indicators, iPhone)^c

IRI: `https://w3id.org/bmontology#MobileDevices_CostIndicators_IPhone_OffsettingServer`

This is a cost indicator of the mobile devices service, categorized into cost indicators as well as iPhone. This indicator captures the costs for servers of the mobile devices module.

has super-classes Cost Indicator^c Hardware resource indicator^c Mobile Devices (iPhone)^c

Offsetting Server (cost indicators, low)^c

IRI: `https://w3id.org/bmontology#Storage_CostIndicators_Low_OffsettingServer`

This is a cost indicator of the storage service, categorized into cost indicators as well as low. This indicator captures the costs for servers of the storage module.

has super-classes Cost Indicator^c Hardware resource indicator^c Storage (Low)^c

Offsetting Server (cost indicators, lync and other applications (without telephony))^c

IRI: `https://w3id.org/bmontology#Collaboration_CostIndicators_LyncAndOtherApplicationsWithoutTelephony_OffsettingServer`

This is a cost indicator of the collaboration service, categorized into cost indicators as well as lync and other applications (without telephony). This indicator captures the costs for servers of the collaboration module.

has super-classes Collaboration^c Cost Indicator^c Hardware resource indicator^c

Offsetting Server (cost indicators, medium)^c

IRI: `https://w3id.org/bmontology#Storage_CostIndicators_Medium_OffsettingServer`

This is a cost indicator of the storage service, categorized into cost indicators as well as medium. This indicator captures the costs for servers of the storage module.

has super-classes Cost Indicator^c Hardware resource indicator^c Storage (Medium)^c

Offsetting Server (cost indicators, others)^c

IRI: `https://w3id.org/bmontology#MobileDevices_CostIndicators_Others_OffsettingServer`

This is a cost indicator of the mobile devices service, categorized into cost indicators as well as others. This indicator captures the costs for servers of the mobile devices module.

has super-classes Cost Indicator^c Hardware resource indicator^c Mobile Devices (Others)^c

Offsetting Server (cost indicators, sharePoint and other applications)^c

IRI: `https://w3id.org/bmontology#Collaboration_CostIndicators_SharePointAndOtherApplications_OffsettingServer`

This is a cost indicator of the collaboration service, categorized into cost indicators as well as sharePoint and other applications. This indicator captures the costs for servers of the collaboration module.

has super-classes Collaboration^c Cost Indicator^c Hardware resource indicator^c

Offsetting Server (cost indicators, total costs)^c

IRI: `https://w3id.org/bmontology#FileService_CostIndicators_TotalCosts_OffsettingServer`

This is a cost indicator of the file service service, categorized into cost indicators as well as total costs. This indicator captures the costs for servers of the file service module.

has super-classes Cost Indicator^c File Service^c Hardware resource indicator^c

Offsetting Server (cost indicators, total costs)^c

IRI: `https://w3id.org/bmontology#Mailbox_CostIndicators_TotalCosts_OffsettingServer`

This is a cost indicator of the mailbox service, categorized into cost indicators as well as total costs. This indicator captures the costs for servers of the mailbox module.

has super-classes Cost Indicator^c Hardware resource indicator^c Mailbox^c

Offsetting Server (cost indicators, total costs)^c

IRI: `https://w3id.org/bmontology#SAPBasis_CostIndicators_TotalCosts_OffsettingServer`

This is a cost indicator of the SAP basis service, categorized into cost indicators as well as total costs. This indicator captures the costs for servers of the SAP basis module.

has super-classes Cost Indicator^c Hardware resource indicator^c SAP basis^c

Offsetting Server (cost indicators, total costs)^c

IRI: `https://w3id.org/bmontology#TerminalServer_CostIndicators_TotalCosts_OffsettingServer`

This is a cost indicator of the terminal server service, categorized into cost indicators as well as total costs. This indicator captures the costs for servers of the terminal server module.

has super-classes Cost Indicator^c Hardware resource indicator^c Terminal server^c

Offsetting Server (cost indicators, variant 1 (high availability))^c

IRI: `https://w3id.org/bmontology#Database_CostIndicators_Variant1HighAvailability_OffsettingServer`

This is a cost indicator of the database service, categorized into cost indicators as well as variant 1 (high availability). This indicator captures the costs for servers of the database module.

has super-classes Cost Indicator^c Database (Variant 1)^c Hardware resource indicator^c

Offsetting Server (cost indicators, variant 2)^c

IRI: `https://w3id.org/bmontology#Database_CostIndicators_Variant2_OffsettingServer`

This is a cost indicator of the database service, categorized into cost indicators as well as variant 2. This indicator captures the costs for servers of the database module.

has super-classes Cost Indicator^c Datenbanken (Variante 2)^c Hardware resource indicator^c

Offsetting Server (cost indicators, voIP)^c

IRI: `https://w3id.org/bmontology#Telephony_CostIndicators_VoIP_OffsettingServer`

This is a cost indicator of the telephony service, categorized into cost indicators as well as voIP. This indicator captures the costs for servers of the telephony module.

has super-classes Cost Indicator^c Hardware resource indicator^c Telephony^c

Offsetting Server (cost indicators, windows phone)^c

IRI: `https://w3id.org/bmontology#MobileDevices_CostIndicators_WindowsPhone_OffsettingServer`

This is a cost indicator of the mobile devices service, categorized into cost indicators as well as windows phone. This indicator captures the costs for servers of the mobile devices module.

has super-classes Cost Indicator^c Hardware resource indicator^c Mobile Devices (Windows Phone)^c

Offsetting Storage (cost indicators, classical telephony)^c

IRI: `https://w3id.org/bmontology#Telephony_CostIndicators_ClassicalTelephony_OffsettingStorage`

This is a cost indicator of the telephony service, categorized into cost indicators as well as classical telephony. This indicator captures the costs for storage of the telephony module.

has super-classes Cost Indicator^c Hardware resource indicator^c Telephony^c

Offsetting Storage (cost indicators, conferencing (incl. video conferencing tools))^c

IRI: `https://w3id.org/bmontology#Collaboration_CostIndicators_ConferencingInclVideoConferencingTools_OffsettingStorage`

This is a cost indicator of the collaboration service, categorized into cost indicators as well as conferencing (incl. video conferencing tools). This indicator captures the costs for storage of the collaboration module.

has super-classes Collaboration^c Cost Indicator^c Hardware resource indicator^c

Offsetting Storage (cost indicators, cost indicators)^c

IRI: `https://w3id.org/bmontology#Backup_CostIndicators_CostIndicators_OffsettingStorage`

This is a cost indicator of the backup service, categorized into cost indicators as well as cost indicators. This indicator captures the costs for storage of this module.

has super-classes Backup^c Cost Indicator^c Human resource indicator^c

Offsetting Storage (cost indicators, lync and other applications (without telephony))^c

IRI: `https://w3id.org/bmontology#Collaboration_CostIndicators_LyncAndOtherApplicationsWithoutTelephony_OffsettingStorage`

This is a cost indicator of the collaboration service, categorized into cost indicators as well as lync and other applications (without telephony). This indicator captures the costs for storage of the collaboration module.

has super-classes Collaboration^c Cost Indicator^c Hardware resource indicator^c

Offsetting Storage (cost indicators, sharePoint and other applications)^c

IRI: `https://w3id.org/bmontology#Collaboration_CostIndicators_SharePointAndOtherApplications_OffsettingStorage`

This is a cost indicator of the collaboration service, categorized into cost indicators as well as sharePoint and other applications. This indicator captures the costs for storage of the collaboration module.

has super-classes Collaboration^c Cost Indicator^c Hardware resource indicator^c

Offsetting Storage (cost indicators, total costs)^c

IRI: `https://w3id.org/bmontology#FileService_CostIndicators_TotalCosts_OffsettingStorage`

This is a cost indicator of the file service service, categorized into cost indicators as well as total costs. This indicator captures the costs for storage of the file service module.

has super-classes Cost Indicator^c File Service^c Hardware resource indicator^c

Offsetting Storage (cost indicators, total costs)^c

IRI: `https://w3id.org/bmontology#Mailbox_CostIndicators_TotalCosts_OffsettingStorage`

This is a cost indicator of the mailbox service, categorized into cost indicators as well as total costs. This indicator captures the costs for storage of the mailbox module.

has super-classes Cost Indicator^c Hardware resource indicator^c Mailbox^c

Offsetting Storage (cost indicators, total costs)^c

IRI: https://w3id.org/bmontology#SAPBasis_CostIndicators_TotalCosts_OffsettingStorage

This is a cost indicator of the SAP basis service, categorized into cost indicators as well as total costs. This indicator captures the costs for storage of the SAP basis module.

has super-classes Cost Indicator^c Hardware resource indicator^c SAP basis^c

Offsetting Storage (cost indicators, total costs)^c

IRI: https://w3id.org/bmontology#TerminalServer_CostIndicators_TotalCosts_OffsettingStorage

This is a cost indicator of the terminal server service, categorized into cost indicators as well as total costs. This indicator captures the costs for storage of the terminal server module.

has super-classes Cost Indicator^c Hardware resource indicator^c Terminal server^c

Offsetting Storage (cost indicators, variant 1 (high availability))^c

IRI: https://w3id.org/bmontology#Database_CostIndicators_Variant1HighAvailability_OffsettingStorage

This is a cost indicator of the database service, categorized into cost indicators as well as variant 1 (high availability). This indicator captures the costs for storage of the database module.

has super-classes Cost Indicator^c Database (Variant 1)^c Hardware resource indicator^c

Offsetting Storage (cost indicators, variant 2)^c

IRI: https://w3id.org/bmontology#Database_CostIndicators_Variant2_OffsettingStorage

This is a cost indicator of the database service, categorized into cost indicators as well as variant 2. This indicator captures the costs for storage of the database module.

has super-classes Cost Indicator^c Datenbanken (Variante 2)^c Hardware resource indicator^c

Offsetting Storage (cost indicators, voIP)^c

IRI: `https://w3id.org/bmontology#Telephony_CostIndicators_VoIP_OffsettingStorage`

This is a cost indicator of the telephony service, categorized into cost indicators as well as voIP. This indicator captures the costs for storage of the telephony module.

has super-classes Cost Indicator^c Hardware resource indicator^c Telephony^c

On which platforms are the solutions based? (performance indicators, general indicators)^c

IRI: `https://w3id.org/bmontology#MobileDevices_PerformanceIndicators_GeneralIndicators_OnWhichPlatformsAreTheSolutionsBased`

This is a performance indicator of the mobile devices service, categorized into performance indicators as well as general indicators. This indicator captures the platforms the solutions are based on.

has super-classes Mobile devices^c Performance Indicator^c Software resource indicator^c

Operating system in use (performance indicators, variant 1 (high availability))^c

IRI: `https://w3id.org/bmontology#Database_PerformanceIndicators_Variant1HighAvailability_OperatingSystemInUse`

This is a performance indicator of the database service, categorized into performance indicators as well as variant 1 (high availability). This indicator captures which operating system is mainly used.

has super-classes Database (Variant 1)^c Performance Indicator^c Software resource indicator^c

Operating system in use (performance indicators, variant 2)[c]

IRI: `https://w3id.org/bmontology#Database_PerformanceIndicators_Variant2_OperatingSystemInUse`

This is a performance indicator of the database service, categorized into performance indicators as well as variant 2. This indicator captures which operating system is mainly used.

has super-classes Datenbanken (Variante 2)[c] Performance Indicator[c] Software resource indicator[c]

Operationally used storage volume (performance indicators, quantity structure (high))[c]

IRI: `https://w3id.org/bmontology#Storage_PerformanceIndicators_QuantityStructureHigh_OperationallyUsedStorageVolume`

This is a performance indicator of the storage service, categorized into performance indicators as well as quantity structure (high). This indicator capture the storage volume which is used operationally per indicator group.

has super-classes Quantity indicator[c] Storage (High)[c]

Operationally used storage volume (performance indicators, quantity structure (low))[c]

IRI: `https://w3id.org/bmontology#Storage_PerformanceIndicators_QuantityStructureLow_OperationallyUsedStorageVolume`

This is a performance indicator of the storage service, categorized into performance indicators as well as quantity structure (low). This indicator capture the storage volume which is used operationally per indicator group.

has super-classes Quantity indicator[c] Storage (Low)[c]

Operationally used storage volume (performance indicators, quantity structure (medium))^c

IRI: `https://w3id.org/bmontology#Storage_PerformanceIndicators_QuantityStructureMedium_OperationallyUsedStorageVolume`

This is a performance indicator of the storage service, categorized into performance indicators as well as quantity structure (medium). This indicator capture the storage volume which is used operationally per indicator group.

has super-classes Hardware resource indicator^c Quantity indicator^c Storage (Medium)^c

Organizational form of IT (performance indicators, basic data)^c

IRI: `https://w3id.org/bmontology#BasicData_PerformanceIndicators_BasicData_OrganizationalFormOfIT`

This is a performance indicator of the basic data service, categorized into performance indicators as well as basic data. This indicator captures the organizational form of the IT.

has super-classes Basic data^c Performance Indicator^c

Other end devices (performance indicators, others (classical telephony))^c

IRI: `https://w3id.org/bmontology#Telephony_PerformanceIndicators_OthersClassicalTelephony_OtherEndDevices`

This is a performance indicator of the telephony service, categorized into performance indicators as well as others (classical telephony). This indicator captures whether processes (e.g., provision, installation, configuration, operation, maintenance) are implemented internally or (partly) outsourced.

has super-classes Hardware resource indicator^c Performance Indicator^c Telephony^c

Other end devices (performance indicators, sourcing (voIP))^c

IRI: `https://w3id.org/bmontology#Telephony_PerformanceIndicators_SourcingVoIP_OtherEndDevices`

This is a performance indicator of the telephony service, categorized into performance indicators as well as sourcing (voIP). This indicator captures whether processes (e.g., provision, installation, configuration, operation, maintenance) are implemented internally or (partly) outsourced.

has super-classes Hardware resource indicator^c Performance Indicator^c Telephony^c

Other technologie (performance indicators, technology)^c

IRI: `https://w3id.org/bmontology#Servicedesk_PerformanceIndicators_Technology_OtherTechnologie`

This is a performance indicator of the servicedesk service, categorized into performance indicators as well as technology. This indicator captures other technologies used at the service desk.

has super-classes Performance Indicator^c Servicedesk^c Software resource indicator^c

Others (cost indicators, active components)^c

IRI: `https://w3id.org/bmontology#LAN_CostIndicators_ActiveComponents_Others`

This is a cost indicator of the LAN service, categorized into cost indicators as well as active components. This indicator captures other costs per year (EUR).

has super-classes Cost Indicator^c LAN^c

Others (cost indicators, blackberry)^c

IRI: `https://w3id.org/bmontology#MobileDevices_CostIndicators_Blackberry_Others`

This is a cost indicator of the mobile devices service, categorized into cost indicators as well as blackberry. This indicator captures other costs per year (EUR).

has super-classes Cost Indicator^c Mobile Devices (Blackberry)^c

Others (cost indicators, classical telephony)^c

IRI: `https://w3id.org/bmontology#Telephony_CostIndicators_ClassicalTelephony_Others`

This is a cost indicator of the telephony service, categorized into cost indicators as well as classical telephony. This indicator captures other costs per year (EUR).

has super-classes Cost Indicator^c Telephony^c

Others (cost indicators, conferencing (incl. video conferencing tools))^c

IRI: `https://w3id.org/bmontology#Collaboration_CostIndicators_ConferencingInclVideoConferencingTools_Others`

This is a cost indicator of the collaboration service, categorized into cost indicators as well as conferencing (incl. video conferencing tools). This indicator captures other costs per year (EUR).

has super-classes Collaboration^c Cost Indicator^c

Others (cost indicators, cost indicator (medium))^c

IRI: `https://w3id.org/bmontology#DedicatedServer_CostIndicators_CostIndicatorMedium_Others`

This is a cost indicator of the dedicated server service, categorized into cost indicators as well as cost indicator (medium). This indicator captures other costs involved in the dedicated server module (yearly).

has super-classes Cost Indicator^c Dedicated server (medium)^c

Others (cost indicators, cost indicators (large))^c

IRI: `https://w3id.org/bmontology#DedicatedServer_CostIndicators_CostIndicatorsLarge_Others`

This is a cost indicator of the dedicated server service, categorized into cost indicators as well as cost indicators (large). This indicator captures other costs involved in the dedicated server module (yearly).

has super-classes Cost Indicator^c Dedicated server (large)^c

Others (cost indicators, cost indicators (small))^c

IRI: `https://w3id.org/bmontology#DedicatedServer_CostIndicators_CostIndicatorsSmall_Others`

This is a cost indicator of the dedicated server service, categorized into cost indicators as well as cost indicators (small). This indicator captures other costs involved in the dedicated server module (yearly).

has super-classes Cost Indicator^c Dedicated server (small)^c

Others (cost indicators, cost indicators)^c

IRI: `https://w3id.org/bmontology#Backup_CostIndicators_CostIndicators_Others`

This is a cost indicator of the backup service, categorized into cost indicators as well as cost indicators. This indicator captures other costs involved in the backup module (yearly).

has super-classes Backup^c Cost Indicator^c

Others (cost indicators, desktop)^c

IRI: `https://w3id.org/bmontology#Workplace_CostIndicators_Desktop_Others`

This is a cost indicator of the workplace service, categorized into cost indicators as well as desktop. This indicator captures other costs per year (EUR).

has super-classes Cost Indicator^c Workplace^c

Others (cost indicators, high)^c

IRI: `https://w3id.org/bmontology#Storage_CostIndicators_High_Others`

This is a cost indicator of the storage service, categorized into cost indicators as well as high. This indicator captures other costs involved in the storage module (yearly).

has super-classes Cost Indicator^c Storage (High)^c

Others (cost indicators, iPhone)^c

IRI: `https://w3id.org/bmontology#MobileDevices_CostIndicators_IPhone_Others`

This is a cost indicator of the mobile devices service, categorized into cost indicators as well as iPhone. This indicator captures other costs per year (EUR).

has super-classes Cost Indicator^c Mobile Devices (iPhone)^c

Others (cost indicators, laptop)^c

IRI: `https://w3id.org/bmontology#Workplace_CostIndicators_Laptop_Others`

This is a cost indicator of the workplace service, categorized into cost indicators as well as laptop. This indicator captures other costs per year (EUR).

has super-classes Cost Indicator^c Workplace^c

Others (cost indicators, low)^c

IRI: `https://w3id.org/bmontology#Storage_CostIndicators_Low_Others`

This is a cost indicator of the storage service, categorized into cost indicators as well as low. This indicator captures other costs involved in the storage module (yearly).

has super-classes Cost Indicator^c Storage (Low)^c

Others (cost indicators, lync and other applications (without telephony))^c

IRI: `https://w3id.org/bmontology#Collaboration_CostIndicators_LyncAndOtherApplicationsWithoutTelephony_Others`

This is a cost indicator of the collaboration service, categorized into cost indicators as well as lync and other applications (without telephony). This indicator captures other costs per year (EUR).

has super-classes Collaboration^c Cost Indicator^c

Others (cost indicators, medium)^c

IRI: `https://w3id.org/bmontology#Storage_CostIndicators_Medium_Others`

This is a cost indicator of the storage service, categorized into cost indicators as well as medium. This indicator captures other costs involved in the storage module (yearly).

has super-classes Cost Indicator^c Storage (Medium)^c

Others (cost indicators, monitoring and administration environment)^c

IRI: `https://w3id.org/bmontology#LAN_CostIndicators_MonitoringAndAdministrationEnvironment_Others`

This is a cost indicator of the LAN service, categorized into cost indicators as well as monitoring and administration environment. This indicator captures other costs per year (EUR).

has super-classes Cost Indicator^c LAN^c

Others (cost indicators, others)^c

IRI: `https://w3id.org/bmontology#MobileDevices_CostIndicators_Others_Others`

This is a cost indicator of the mobile devices service, categorized into cost indicators as well as others. This indicator captures other costs per year (EUR).

has super-classes Cost Indicator^c Mobile Devices (Others)^c

Others (cost indicators, security environment)^c

IRI: `https://w3id.org/bmontology#LAN_CostIndicators_SecurityEnvironment_Others`

This is a cost indicator of the LAN service, categorized into cost indicators as well as security environment. This indicator captures other costs per year (EUR).

has super-classes Cost Indicator^c LAN^c

Others (cost indicators, sharePoint and other applications)^c

IRI: `https://w3id.org/bmontology#Collaboration_CostIndicators_SharePointAndOtherApplications_Others`

This is a cost indicator of the collaboration service, categorized into cost indicators as well as sharePoint and other applications. This indicator captures other costs per year (EUR).

has super-classes Collaboration^c Cost Indicator^c

Others (cost indicators, SSL VPN access)^c

IRI: `https://w3id.org/bmontology#RemoteAccessService_CostIndicators_SSLVPNAccess_Others`

This is a cost indicator of the remote access service service, categorized into cost indicators as well as SSL VPN access. This indicator captures other costs per year (EUR).

has super-classes Cost Indicator^c Remote access service^c

Others (cost indicators, standard mass connection)^c

IRI: `https://w3id.org/bmontology#RemoteAccessService_CostIndicators_StandardMassConnection_Others`

This is a cost indicator of the remote access service service, categorized into cost indicators as well as standard mass connection. This indicator captures other costs per year (EUR).

has super-classes Cost Indicator^c Remote access service^c

Others (cost indicators, total costs of guest systems)^c

IRI: `https://w3id.org/bmontology#VirtualServer_CostIndicators_TotalCostsOfGuestSystems_Others`

This is a cost indicator of the virtual server service, categorized into cost indicators as well as total costs of guest systems. This indicator captures other costs involved in guest systems (yearly).

has super-classes Cost Indicator^c Virtual server^c

Others (cost indicators, total costs of host systems)^c

IRI: `https://w3id.org/bmontology#VirtualServer_CostIndicators_TotalCostsOfHostSystems_Others`

This is a cost indicator of the virtual server service, categorized into cost indicators as well as total costs of host systems. This indicator captures other costs involved in host systems (yearly).

has super-classes Cost Indicator^c Virtual server^c

Others (cost indicators, total costs)^c

IRI: `https://w3id.org/bmontology#FileService_CostIndicators_TotalCosts_Others`

This is a cost indicator of the file service service, categorized into cost indicators as well as total costs. This indicator captures other costs per year (EUR).

has super-classes Cost Indicator^c File Service^c

Others (cost indicators, total costs)[c]

IRI: `https://w3id.org/bmontology#Mailbox_CostIndicators_TotalCosts_Others`

This is a cost indicator of the mailbox service, categorized into cost indicators as well as total costs. This indicator captures remaining costs of the mailbox module.

has super-classes Cost Indicator[c] Mailbox[c]

Others (cost indicators, total costs)[c]

IRI: `https://w3id.org/bmontology#SAPBasis_CostIndicators_TotalCosts_Others`

This is a cost indicator of the SAP basis service, categorized into cost indicators as well as total costs. This indicator captures other costs (yearly).

has super-classes Cost Indicator[c] SAP basis[c]

Others (cost indicators, total costs)[c]

IRI: `https://w3id.org/bmontology#Servicedesk_CostIndicators_TotalCosts_Others`

This is a cost indicator of the servicedesk service, categorized into cost indicators as well as total costs. This indicator captures remaining costs of the service desk.

has super-classes Cost Indicator[c] Servicedesk[c]

Others (cost indicators, total costs)[c]

IRI: `https://w3id.org/bmontology#TerminalServer_CostIndicators_TotalCosts_Others`

This is a cost indicator of the terminal server service, categorized into cost indicators as well as total costs. This indicator captures other costs involved in the terminal server module (yearly).

has super-classes Cost Indicator[c] Terminal server[c]

Others (cost indicators, variant 1 (high availability))[c]

IRI: `https://w3id.org/bmontology#Database_CostIndicators_Variant1HighAvailability_Others`

This is a cost indicator of the database service, categorized into cost indicators as well as variant 1 (high availability). This indicator captures other costs per database system (yearly).

has super-classes Cost Indicator[c] Database (Variant 1)[c]

Others (cost indicators, variant 2)[c]

IRI: `https://w3id.org/bmontology#Database_CostIndicators_Variant2_Others`

This is a cost indicator of the database service, categorized into cost indicators as well as variant 2. This indicator captures other costs per database system (yearly).

has super-classes Cost Indicator[c] Datenbanken (Variante 2)[c]

Others (cost indicators, voIP)[c]

IRI: `https://w3id.org/bmontology#Telephony_CostIndicators_VoIP_Others`

This is a cost indicator of the telephony service, categorized into cost indicators as well as voIP. This indicator captures other costs per year (EUR).

has super-classes Cost Indicator[c] Telephony[c]

Others (cost indicators, VPN client)[c]

IRI: `https://w3id.org/bmontology#RemoteAccessService_CostIndicators_VPNClient_Others`

This is a cost indicator of the remote access service service, categorized into cost indicators as well as VPN client. This indicator captures other costs per year (EUR).

has super-classes Cost Indicator[c] Remote access service[c]

Others (cost indicators, VPN tunel to business partners)[c]

IRI: `https://w3id.org/bmontology#RemoteAccessService_CostIndicators_VPNTunelToBusinessPartners_Others`

This is a cost indicator of the remote access service service, categorized into cost indicators as well as VPN tunel to business partners. This indicator captures other costs per year (EUR).

has super-classes Cost Indicator[c] Remote access service[c]

Others (cost indicators, windows phone)[c]

IRI: `https://w3id.org/bmontology#MobileDevices_CostIndicators_WindowsPhone_Others`

This is a cost indicator of the mobile devices service, categorized into cost indicators as well as windows phone. This indicator captures other costs per year (EUR).

has super-classes Cost Indicator[c] Mobile Devices (Windows Phone)[c]

Others (cost indicators, WLAN)[c]

IRI: `https://w3id.org/bmontology#LAN_CostIndicators_WLAN_Others`

This is a cost indicator of the LAN service, categorized into cost indicators as well as WLAN. This indicator captures other costs per year (EUR).

has super-classes Cost Indicator[c] LAN[c]

Own computers allowed for external employees (performance indicators, additional information)[c]

IRI: `https://w3id.org/bmontology#RemoteAccessService_PerformanceIndicators_AdditionalInformation_OwnComputersAllowedForExternalEmployees`

This is a performance indicator of the remote access service service, categorized into performance indicators as well as additional information. This indicator captures whether external employees are allowed to use own devices for RAS.

has super-classes Performance Indicator^c Remote access service^c

Participation^c

IRI: `https://w3id.org/bmontology#Participation`

Represents the participation of an organization at a benchmark

has super-classes situationparticipation includes^{op} exactly 1 organizationparticipation includes^{op} exactly 1 Benchmark^c

is in domain of has benchmark^{op} , has indicator declaration^{op} , has organization^{op} , participation includes^{op}

is in range of is benchmark of^{op} , is included in the participation^{op} , is indicator declaration of^{op} , is organization of^{op}

Password changes in fixed periods of time required (performance indicators, security indicators (blackberry))^c

IRI: `https://w3id.org/bmontology#MobileDevices_PerformanceIndicators_SecurityIndicatorsBlackberry_PasswordChangesInFixedPeriodsOfTimeRequired`

This is a performance indicator of the mobile devices service, categorized into performance indicators as well as security indicators (blackberry). This indicator captures whether the password must be changed regularly in fixed periods of time.

has super-classes Mobile Devices (Blackberry)^c Performance Indicator^c

Password changes in fixed periods of time required (performance indicators, security indicators (iPhone))^c

IRI: `https://w3id.org/bmontology#MobileDevices_PerformanceIndicators_SecurityIndicatorsIPhone_PasswordChangesInFixedPeriodsOfTimeRequired`

This is a performance indicator of the mobile devices service, categorized into performance indicators as well as security indicators (iPhone). This indicator captures whether the password must be changed regularly in fixed periods of time.

has super-classes Mobile Devices (iPhone)^c Performance Indicator^c

Password changes in fixed periods of time required (performance indicators, security indicators (other))[c]

IRI: https://w3id.org/bmontology#MobileDevices_PerformanceIndicators_SecurityIndicatorsOther_PasswordChangesInFixedPeriodsOfTimeRequired

This is a performance indicator of the mobile devices service, categorized into performance indicators as well as security indicators (other). This indicator captures whether the password must be changed regularly in fixed periods of time.

has super-classes Mobile Devices (Others)[c] Performance Indicator[c]

Password changes in fixed periods of time required (performance indicators, security indicators (windows phone))[c]

IRI: https://w3id.org/bmontology#MobileDevices_PerformanceIndicators_SecurityIndicatorsWindowsPhone_PasswordChangesInFixedPeriodsOfTimeRequired

This is a performance indicator of the mobile devices service, categorized into performance indicators as well as security indicators (windows phone). This indicator captures whether the password must be changed regularly in fixed periods of time.

has super-classes Mobile Devices (Windows Phone)[c] Performance Indicator[c]

Patch cycles (performance indicators, quantity structure (large))[c]

IRI: https://w3id.org/bmontology#DedicatedServer_PerformanceIndicators_QuantityStructureLarge_PatchCycles

This is a performance indicator of the dedicated server service, categorized into performance indicators as well as quantity structure (large). This indicator captures the patch cycles per server and year (e.g., on demand or on a regular basis).

has super-classes Dedicated server (large)[c] Quantity indicator[c]

Patch cycles (performance indicators, quantity structure (medium))^c

IRI: `https://w3id.org/bmontology#DedicatedServer_PerformanceIndicators_QuantityStructureMedium_PatchCycles`

This is a performance indicator of the dedicated server service, categorized into performance indicators as well as quantity structure (medium). This indicator captures the patch cycles per server and year.

has super-classes Dedicated server (medium)^c Quantity indicator^c

Patch cycles (performance indicators, quantity structure (small))^c

IRI: `https://w3id.org/bmontology#DedicatedServer_PerformanceIndicators_QuantityStructureSmall_PatchCycles`

This is a performance indicator of the dedicated server service, categorized into performance indicators as well as quantity structure (small). This indicator captures the patch cycles per server and year.

has super-classes Dedicated server (small)^c Quantity indicator^c

Patch cycles (performance indicators, variant 1 (high availability))^c

IRI: `https://w3id.org/bmontology#Database_PerformanceIndicators_Variant1HighAvailability_PatchCycles`

This is a performance indicator of the database service, categorized into performance indicators as well as variant 1 (high availability). This indicator captures the number of patch cycles.

has super-classes Database (Variant 1)^c Quantity indicator^c

Patch cycles (performance indicators, variant 2)^c

IRI: `https://w3id.org/bmontology#Database_PerformanceIndicators_Variant2_PatchCycles`

This is a performance indicator of the database service, categorized into performance indicators as well as variant 2. This indicator captures the number of patch cycles.

has super-classes Datenbanken (Variante 2)^c Quantity indicator^c

Performance Indicator^c

IRI: `https://w3id.org/bmontology#PerformanceIndicator`

Classifies performance indicators

has super-classes Type dimension for indicator classification^c

has sub-classes 24/7 service / regular office hours (performance indicators, quantity structure and performance)^c , ACD system (performance indicators, technology)^c , Access points (performance indicators, SSL VPN access)^c , Access points (performance indicators, VPN client)^c , Access points (performance indicators, VPN tunel to business partners)^c , Access points (performance indicators, standard mass connection)^c , Active solutions in use (performance indicators, general indicators)^c , Added value of VoIP (performance indicators, performance information)^c , Additional backup technologies (performance indicators, quantity structure and performance)^c , Additional information (performance indicators, variant 1 (high availability))^c , Additional information (performance indicators, variant 2)^c , Autonomous installation of apps (performance indicators, security indicators (blackberry))^c , Autonomous installation of apps (performance indicators, security indicators (iPhone))^c , Autonomous installation of apps (performance indicators, security indicators (other))^c , Autonomous installation of apps (performance indicators, security indicators (windows phone))^c , Average frequency of change of a client (performance indicators, performance indicators)^c , Backend and client systems (performance indicators, SSL VPN access)^c , Backend and client systems (performance indicators, VPN client)^c , Backend and client systems (performance indicators, VPN tunel to business partners)^c , Backend and client systems (performance indicators, standard mass connection)^c , Backup software (performance indicators, quantity structure and performance)^c , Backup strategy (performance indicators, cross-system)^c , Backup strategy (performance indicators, quantity structure (large))^c , Backup strategy (performance indicators, quantity structure (medium))^c , Backup strategy (performance indicators, quantity structure (small))^c , Backup strategy (performance indicators, quantity structure and performance)^c , Backup strategy (performance indicators, quantity structure and performance)^c , Backup strategy (performance indicators, quantity structure)^c , Backup strategy (performance indicators, quantity structure)^c , Backup strategy (performance indicators, variant 1 (high availability))^c , Backup strategy (performance indicators, variant 2)^c , Backup technology over WAN (performance indicators, quantity structure and performance)^c , Bandwidth management (performance indicators, quantity structure and performance)^c , Batch processing (performance indicators, additional information)^c , Bring your own device (performance indicators, general indicators)^c , CRM (performance indicators, quantity structure and performance (blackberry))^c , CRM (performance indicators, quantity structure and performance (iPhone))^c , CRM (performance indicators, quantity structure and performance (other))^c , CRM (performance indicators, quantity structure and performance (windows phone))^c , Cabling Gbit over copper (performance indicators, additional information)^c , Category performance (performance indicators, quantity structure and performance)^c , Characteristics of LAN (performance indicators, additional information)^c , Characteristics of persistence (performance indicators, quantity structure and performance)^c , Contract term WAN (performance indicators, quantity structure and performance)^c , Contractual regulation regarding the usage of data volume (performance indicators, general indicators)^c , Copy of backup inventory (performance indicators, quantity structure and performance)^c , Cost rate FTE (performance indicators, SSL VPN access)^c , Cost rate FTE (performance indicators, VPN client)^c , Cost rate FTE (performance indicators, VPN tunel to business partners)^c , Cost rate FTE (performance indicators, standard mass connection)^c , Data encryption (performance indicators, security indicators (blackberry))^c , Data encryption (performance indicators, security indicators (iPhone))^c , Data encryption (performance indicators, security indicators (other))^c , Data encryption (performance indicators, security indicators (windows phone))^c , Database in use (performance indicators, variant 1 (high availability))^c , Database in use (performance indicators, variant 2)^c , Database systems (performance indicators, variant 1 (high availability))^c , Database systems (performance indicators, variant 2)^c , Dedicated or shared service desk (performance indicators, quantity structure and performance)^c , Degree of coverage (performance indicators, general)^c , Degree of maturity SAP ERP (performance indicators, general)^c , Degree of maturity of the module (performance indicators, BC: basic system)^c , Degree of maturity of the module (performance indicators, CS: customer service)^c , Degree of maturity of the module (performance indicators, EC: corporate controlling)^c , Degree of maturity of the module (performance indicators, FI: finance)^c , Degree of maturity of the module (performance indicators, MM: materials management)^c , Degree of maturity of the module (performance indicators, PM: plant maintenance)^c , Degree of maturity of the module (performance indicators, PP: production planning and control)^c , Degree of maturity of the module (performance indicators, SD: sales and distribution)^c , Degree of maturity of the module (performance indicators, co: controlling)^c , Degree of virtualization (performance indicators, cross-system)^c , Depreciation period (performance indicators, basic data)^c , Depreciation period (performance indicators, quantity structure and performance (blackberry))^c , Depreciation period (performance indicators, quantity structure and performance (iPhone))^c , Depreciation period (performance indicators, quantity structure and performance (other))^c , Depreciation period (performance indicators, quantity structure and performance (windows phone))^c , Depth authorization concept (performance indicators, quantity structure)^c , Dialog processing (performance indicators, additional information)^c , Dialog response time (performance indicators, additional information)^c , Distribution of tertiary cabling (performance indicators, additional information)^c , Distribution of tickets (performance indicators, quantity structure and performance)^c , Document collaboration (performance indicators, tools)^c , Dynamics of changes (performance indicators, general)^c , Effort of external administration (FTE) (performance indicators, BC: basic system)^c , Effort of external administration (FTE) (performance indicators, CS: customer service)^c , Effort of external administration (FTE) (performance indicators, EC: corporate controlling)^c , Effort of external administration (FTE) (performance indicators, FI: finance)^c , Effort of external administration (FTE) (performance indicators, MM: materials management)^c , Effort of external administration (FTE) (performance indicators, PM: plant maintenance)^c , Effort of external administration (FTE) (performance indicators, PP: production planning and control)^c , Effort of external administration (FTE) (performance indicators, SD: sales and distribution)^c , Effort of external administration (FTE) (performance indicators, co: controlling)^c , Effort of external maintenance (FTE) (performance indicators, BC: basic system)^c , Effort of external maintenance (FTE) (performance indicators, CS: customer service)^c , Effort of external maintenance (FTE) (performance indicators, EC: corporate controlling)^c , Effort of external maintenance (FTE) (performance indicators, FI: finance)^c , Effort of external maintenance (FTE) (performance indicators, MM: materials management)^c , Effort of external maintenance (FTE) (performance indicators, PM: plant maintenance)^c , Effort of external maintenance (FTE) (performance indicators, PP: production planning and control)^c , Effort of external maintenance (FTE) (performance indicators, SD: sales and distribution)^c , Effort of external maintenance (FTE) (performance indicators, co: controlling)^c , Effort of in-house development (performance indicators, BC: basic system)^c , Effort of in-house development (performance indicators, CS: customer service)^c , Effort of in-house development (performance indicators, EC: corporate controlling)^c , Effort of in-house development (performance indicators, FI: finance)^c , Effort of in-house development (performance indicators, MM: materials management)^c , Effort of in-house development (performance indicators, PM: plant maintenance)^c , Effort of in-house development (performance indicators, PP: production planning and control)^c , Effort of in-house development (performance indicators, SD: sales and distribution)^c , Effort of in-house development (performance indicators, co: controlling)^c , Effort of internal administration (FTE) (performance indicators, BC: basic system)^c , Effort of internal administration (FTE) (performance indicators, CS: customer service)^c , Effort of internal administration (FTE) (performance indicators, EC: corporate controlling)^c , Effort of internal administration (FTE) (performance indicators, FI: finance)^c , Effort of internal administration (FTE) (performance indicators, MM: materials management)^c , Effort of internal administration (FTE) (performance indicators, PM: plant maintenance)^c , Effort of internal administration (FTE) (performance indicators, PP: production planning and control)^c , Effort of internal administration (FTE) (performance indicators, SD: sales and distribution)^c , Effort of internal administration (FTE) (performance indicators, co: controlling)^c , Effort of internal maintenance (FTE) (performance indicators, BC: basic system)^c , Effort of internal maintenance (FTE) (performance indicators, CS: customer service)^c , Effort of internal maintenance (FTE) (performance indicators, EC: corporate controlling)^c , Effort of internal maintenance (FTE) (performance indicators, FI: finance)^c , Effort of internal maintenance (FTE) (performance indicators, MM: materials management)^c , Effort of internal maintenance (FTE) (performance indicators, PM: plant maintenance)^c , Effort of internal maintenance (FTE) (performance indicators, PP: production planning and control)^c , Effort of internal maintenance (FTE) (performance indicators, SD: sales and distribution)^c , Effort of internal maintenance (FTE) (performance indicators, co: controlling)^c , Equipment of a default workingplace computer (desktop/laptop) (performance indicators, quantity structure and performance)^c , Estimated distribution storage architecture DASD (performance indicators, quantity structure and performance)^c , Estimated distribution storage architecture NAS (performance indicators, quantity structure and performance)^c , Estimated distribution storage architecture SAN (performance indicators, quantity structure and performance)^c , Factor of redundancy (performance indicators, host systems)^c , First level support (performance indicators, included)^c , Frequency Add SW automatically (performance indicators, performance indicators)^c , Frequency Add SW manually (performance indicators, performance indicators)^c , Frequency Add additional HW components (performance indicators, performance indicators)^c , Frequency of Change/Delete (performance indicators, performance indicators)^c , Frequency of a desktop installation (performance indicators, performance indicators)^c , Frequency of a laptop installation (performance indicators, performance indicators)^c , Frequency of a thin client installation (performance indicators, performance indicators)^c , Frequency of changes (years) (performance indicators, general indicators)^c , Frequency of logical move (performance indicators, performance indicators)^c , Frequency of password changes (weeks) (performance indicators, security indicators (blackberry))^c , Frequency of password changes (weeks) (performance indicators, security indicators (iPhone))^c , Frequency of password changes (weeks) (performance indicators, security indicators (other))^c , Frequency of password changes (weeks) (performance indicators, security indicators (windows phone))^c , Frequency of physical move (performance indicators, performance indicators)^c , Further submodules (performance indicators, BC: basic system)^c , Further submodules (performance indicators, CS: customer service)^c , Further submodules (performance indicators, EC: corporate controlling)^c , Further submodules (performance indicators, FI: finance)^c , Further submodules (performance indicators, MM: materials management)^c , Further submodules (performance indicators, PM: plant maintenance)^c , Further submodules (performance indicators, PP: production planning and control)^c , Further submodules (performance indicators, SD: sales and distribution)^c , Further submodules (performance indicators, co: controlling)^c , Further usage scenarios (performance indicators, quantity structure and performance (blackberry))^c , Further usage scenarios (performance indicators, quantity structure and performance (iPhone))^c , Further usage scenarios (performance indicators, quantity structure and performance (other))^c , Further usage scenarios (performance indicators, quantity structure and performance (windows phone))^c , Governance (performance indicators, general)^c , How are end devices purchased (performance indicators, general indicators)^c , How is the infrastructure integration regulated (performance indicators, conferencing (incl. video conferencing tools))^c , How is the infrastructure integration regulated (performance indicators, lync and other applications (without telephony))^c , How is the infrastructure integration regulated (performance indicators, sharePoint and other applications)^c , Information about admin environment (performance indicators, performance and architecture)^c , Installation supported by automation (performance indicators, cross-system)^c , Instant messaging (performance indicators, tools)^c , Interface self service (performance indicators, technology)^c , Interfaces (performance indicators, general)^c , Internationality (performance indicators, general)^c , Internet access (performance indicators, quantity structure and performance (blackberry))^c , Internet access (performance indicators, quantity structure and performance (iPhone))^c , Internet access (performance indicators, quantity structure and performance (other))^c , Internet access (performance indicators, quantity structure and performance (windows phone))^c , Intranet access (performance indicators, quantity structure and performance (blackberry))^c , Intranet access (performance indicators, quantity structure and performance (iPhone))^c , Intranet access (performance indicators, quantity structure and performance (other))^c , Intranet access (performance indicators, quantity structure and performance (windows phone))^c , Introsion detection systems (performance indicators, additional information)^c , Is the module used in production (performance indicators, BC: basic system)^c , Is the module used in production (performance indicators, CS: customer service)^c , Is the module used in production (performance indicators, EC: corporate controlling)^c , Is the module used in production (performance indicators, FI: finance)^c , Is the module used in production (performance indicators, MM: materials management)^c , Is the module used in production (performance indicators, PM: plant maintenance)^c , Is the module used in production (performance indicators, PP: production planning and control)^c , Is the module used in production (performance indicators, SD: sales and distribution)^c , Is the module used in production (performance indicators, co: controlling)^c , Knowledge management (performance indicators, technology)^c , Legal form of the organization (performance indicators, basic data)^c , Location of first level support (performance indicators, quantity structure and performance)^c , Mailbox - Usage of mailbox archiving (performance indicators, quantity structure)^c , Mailbox - operating mode (performance indicators, quantity structure)^c , Main scope (performance indicators, quantity structure and performance)^c , Management of mobile contracts (performance indicators, general indicators)^c , Management of mobile devices (performance indicators, general indicators)^c , Manufacturer of telephony platform (performance indicators, performance information)^c , Master data and avoidance of redundancy (performance indicators, quantity structure and performance)^c , Master data central or decentral (performance indicators, quantity structure and performance)^c , Master data management (performance indicators, quantity structure and performance)^c , Max. data loss time (performance indicators, quantity structure and performance)^c , Mobile carrier (performance indicators, general indicators)^c , Module adaption (performance indicators, BC: basic system)^c , Module adaption (performance indicators, CS: customer service)^c , Module adaption (performance indicators, EC: corporate controlling)^c , Module adaption (performance indicators, FI: finance)^c , Module adaption (performance indicators, MM: materials management)^c , Module adaption (performance indicators, PM: plant maintenance)^c , Module adaption (performance indicators, PP: production planning and control)^c , Module adaption (performance indicators, SD: sales and distribution)^c , Module adaption (performance indicators, co: controlling)^c , Modules in use (performance indicators, additional information)^c , Name of the mailsystem (performance indicators, quantity structure)^c , Offered services (performance indicators, quantity structure and performance)^c , On which platforms are the solutions based? (performance indicators, general indicators)^c , Operating system in use (performance indicators, variant 1 (high availability))^c , Operating system in use (performance indicators, variant 2)^c , Organizational form of IT (performance indicators, basic data)^c , Other end devices (performance indicators, others (classical telephony))^c , Other end devices (performance indicators, sourcing (voIP))^c , Other technologie (performance indicators, technology)^c , Own computers allowed for external employees (performance indicators, additional information)^c , Password changes in fixed periods of time required (performance indicators, security indicators (blackberry))^c , Password changes in fixed periods of time required (performance indicators, security indicators (iPhone))^c , Password changes in fixed periods of time required (performance indicators, security indicators (other))^c , Password changes in fixed periods of time required (performance indicators, security indicators (windows phone))^c , Personal Information Management (PIM) (performance indicators, quantity structure and performance (blackberry))^c , Personal Information Management (PIM) (performance indicators, quantity structure and performance (iPhone))^c , Personal Information Management (PIM) (performance indicators, quantity structure and performance (other))^c , Personal Information Management (PIM) (performance indicators, quantity structure and performance (windows phone))^c , Platform (performance indicators, quantity structure and performance (other))^c , Platform (performance indicators, security indicators (other))^c , Platform remote wipe offered (performance indicators, security indicators (blackberry))^c , Platform remote wipe offered (performance indicators, security indicators (iPhone))^c , Platform remote wipe offered (performance indicators, security indicators (other))^c , Platform remote wipe offered (performance indicators, security indicators (windows phone))^c , Portion LX port (performance indicators, port information)^c , Portion QoS for VoIP (Portion of ports) (performance indicators, port information)^c , Portion QoS for video (Portion of ports) (performance indicators, port information)^c , Portion of access ports with NAC (performance indicators, port information)^c , Primary used backup technology (cost recording) (performance indicators, quantity structure and performance)^c , Private usage allowed (performance indicators, security indicators (blackberry))^c , Private usage allowed (performance indicators, security indicators (iPhone))^c , Private usage allowed (performance indicators, security indicators (other))^c , Private usage allowed (performance indicators, security indicators (windows phone))^c , Processing of Non-IT services (performance indicators, quantity structure and performance)^c , Proportion of backup (Agents) (performance indicators, quantity structure and performance)^c , Proportion of backup (Files) (performance indicators, quantity structure and performance)^c , Proportion of backup (NDMP) (performance indicators, quantity structure and performance)^c , Quality indicator^c , Quantity indicator^c , RFC processing (performance indicators, additional information)^c , Range of service 'telephony' in other countries (performance indicators, performance information)^c , Recovery time in category low (performance indicators, quantity structure and performance)^c , Redundant uplinks of access and distribution switches (performance indicators, performance and architecture)^c , Renewal of end devices (performance indicators, general indicators)^c , Reporting (performance indicators, technology)^c , S/MIME email encryption (performance indicators, security indicators (blackberry))^c , S/MIME email encryption (performance indicators, security indicators (iPhone))^c , S/MIME email encryption (performance indicators, security indicators (other))^c , S/MIME email encryption (performance indicators, security indicators (windows phone))^c , SAPS value (performance indicators, quantity structure and performance)^c , Sandbox (performance indicators, security indicators (blackberry))^c , Sandbox (performance indicators, security indicators (iPhone))^c , Sandbox (performance indicators, security indicators (other))^c , Sandbox (performance indicators, security indicators (windows phone))^c , Security checks for foreign computers of external employees (performance indicators, additional information)^c , Security settings based on a central policy (performance indicators, security indicators (blackberry))^c , Security settings based on a central policy (performance indicators, security indicators (iPhone))^c , Security settings based on a central policy (performance indicators, security indicators (other))^c , Security settings based on a central policy (performance indicators, security indicators (windows phone))^c , Self services (performance indicators, included)^c , Service desk communication (performance indicators, quantity structure and performance)^c , Service requests (performance indicators, included)^c , Social Enterprise Collaboration (performance indicators, tools)^c , Social Media Collaboration (performance indicators, tools)^c , Sourcing Platform - Maintenance (performance indicators, others (classical telephony))^c , Sourcing Platform - Maintenance (performance indicators, sourcing (voIP))^c , Sourcing Platform - Provision (performance indicators, others (classical telephony))^c , Sourcing Platform - Provision (performance indicators, sourcing (voIP))^c , Storage internal/external (performance indicators, quantity structure and performance)^c , Storage period (default) (performance indicators, quantity structure and performance)^c , Structure of IT in the organization (performance indicators, basic data)^c , Sum of backup bandwidth (performance indicators, quantity structure (other countries))^c , Sum of backup bandwidth APA (performance indicators, quantity structure (APA))^c , Sum of backup bandwidth Brazil (performance indicators, quantity structure (SA))^c , Sum of backup bandwidth China (performance indicators, quantity structure (APA))^c , Sum of backup bandwidth EMEA (performance indicators, quantity structure (EMEA))^c , Sum of backup bandwidth Germany (performance indicators, quantity structure (EMEA))^c , Sum of backup bandwidth India (performance indicators, quantity structure (APA))^c , Sum of backup bandwidth Mexico (performance indicators, quantity structure (NA))^c , Sum of backup bandwidth NA (performance indicators, quantity structure (NA))^c , Sum of backup bandwidth Russia (performance indicators, quantity structure (EMEA))^c , Sum of backup bandwidth SA (performance indicators, quantity structure (SA))^c , Sum of backup bandwidth South Africa (performance indicators, quantity structure (EMEA))^c , Sum of backup bandwidth Turkey (performance indicators, quantity structure (EMEA))^c , Sum of backup bandwidth USA (performance indicators, quantity structure (NA))^c , Sum of backup bandwidth other APA (performance indicators, quantity structure (APA))^c , Sum of backup bandwidth other EMEA (performance indicators, quantity structure (EMEA))^c , Sum of backup bandwidth other NA (performance indicators, quantity structure (NA))^c , Sum of backup bandwidth other SA (performance indicators, quantity structure (SA))^c , Sum primary bandwidth (performance indicators, quantity structure (other countries))^c , Sum primary bandwidth APA (performance indicators, quantity structure (APA))^c , Sum primary bandwidth Brazil (performance indicators, quantity structure (SA))^c , Sum primary bandwidth China (performance indicators, quantity structure (APA))^c , Sum primary bandwidth EMEA (performance indicators, quantity structure (EMEA))^c , Sum primary bandwidth Germany (performance indicators, quantity structure (EMEA))^c , Sum primary bandwidth India (performance indicators, quantity structure (APA))^c , Sum primary bandwidth Mexico (performance indicators, quantity structure (NA))^c , Sum primary bandwidth NA (performance indicators, quantity structure (NA))^c , Sum primary bandwidth Russia (performance indicators, quantity structure (EMEA))^c , Sum primary bandwidth SA (performance indicators, quantity structure (SA))^c , Sum primary bandwidth South Africa (performance indicators, quantity structure (EMEA))^c , Sum primary bandwidth Turkey (performance indicators, quantity structure (EMEA))^c , Sum primary bandwidth USA (performance indicators, quantity structure (NA))^c , Sum primary bandwidth other APA (performance indicators, quantity structure (APA))^c , Sum primary bandwidth other EMEA (performance indicators, quantity structure (EMEA))^c , Sum primary bandwidth other NA (performance indicators, quantity structure (NA))^c , Sum primary bandwidth other SA (performance indicators, quantity structure (SA))^c , Support of users having broken devices (performance indicators, general indicators)^c , Ticket system (performance indicators, technology)^c , Type of service delivery (performance indicators, quantity structure and performance (blackberry))^c , Type of service delivery (performance indicators, quantity structure and performance (iPhone))^c , Type of service delivery (performance indicators, quantity structure and performance (other))^c , Type of service delivery (performance indicators, quantity structure and performance (windows phone))^c , Type of sourcing (performance indicators, additional information)^c , Type of sourcing (performance indicators, additional information)^c , Type of sourcing (performance indicators, cross-system)^c , Type of sourcing (performance indicators, performance indicators)^c , Type of sourcing (performance indicators, quantity structure (large))^c , Type of sourcing (performance indicators, quantity structure (medium))^c , Type of sourcing (performance indicators, quantity structure (small))^c , Type of sourcing (performance indicators, quantity structure and performance)^c , Type of sourcing (performance indicators, quantity structure and performance)^c , Type of sourcing (performance indicators, quantity structure and performance)^c , Type of sourcing (performance indicators, quantity structure and performance)^c , Type of sourcing (performance indicators, quantity structure and performance)^c , Type of sourcing (performance indicators, quantity structure and performance)^c , Type of sourcing (performance indicators, quantity structure)^c , Type of sourcing (performance indicators, quantity structure)^c , Type of sourcing (performance indicators, variant 1 (high availability))^c , Type of sourcing (performance indicators, variant 2)^c , Types of tape drives (performance indicators, quantity structure and performance)^c , Usage WAN (performance indicators, quantity structure and performance)^c , Usage of BLOB files (performance indicators, variant 1 (high availability))^c , Usage of BLOB files (performance indicators, variant 2)^c , Usage of iPass (performance indicators, general indicators)^c , Usage of snapshot technologies (performance indicators, quantity structure and performance)^c , Usage of snapshots of primary storage for restore (performance indicators, quantity structure and performance)^c , Usage of telephone expense (performance indicators, general indicators)^c , Usage scenarios (performance indicators, conferencing (incl. video conferencing tools))^c , Usage scenarios (performance indicators, lync and other applications (without telephony))^c , Usage scenarios (performance indicators, sharePoint and other applications)^c , User management (performance indicators, included)^c , Video conferencing (performance indicators, tools)^c , Virtualization technology in use (performance indicators, guest system)^c , Voice over W-LAN in use (performance indicators, performance information)^c , Voice over WLAN (performance indicators, WLAN)^c , WAN backup (performance indicators, quantity structure and performance)^c , WAN trends (performance indicators, quantity structure and performance)^c , Way of internet access (performance indicators, security indicators (blackberry))^c , Way of internet access (performance indicators, security indicators (iPhone))^c , Way of internet access (performance indicators, security indicators (other))^c , Way of internet access (performance indicators, security indicators (windows phone))^c , Web meeting (performance indicators, tools)^c , Working life of active LAN components (performance indicators, additional information)^c

is disjoint with Cost Indicator^c

Personal Information Management (PIM) (performance indicators, quantity structure and performance (blackberry))^c

IRI: `https://w3id.org/bmontology#MobileDevices_PerformanceIndicators_QuantityStructureAndPerformanceBlackberry_PersonalInformationManagementPIM`

This is a performance indicator of the mobile devices service, categorized into performance indicators as well as quantity structure and performance (blackberry). This indicator captures whether the platform offers PIM.

has super-classes Mobile Devices (Blackberry)^c Performance Indicator^c Software resource indicator^c

Personal Information Management (PIM) (performance indicators, quantity structure and performance (iPhone))^c

IRI: `https://w3id.org/bmontology#MobileDevices_PerformanceIndicators_QuantityStructureAndPerformanceIPhone_PersonalInformationManagementPIM`

This is a performance indicator of the mobile devices service, categorized into performance indicators as well as quantity structure and performance (iPhone). This indicator captures whether the platform offers PIM.

has super-classes Mobile Devices (iPhone)^c Performance Indicator^c

Personal Information Management (PIM) (performance indicators, quantity structure and performance (other))^c

IRI: `https://w3id.org/bmontology#MobileDevices_PerformanceIndicators_QuantityStructureAndPerformanceOther_PersonalInformationManagementPIM`

This is a performance indicator of the mobile devices service, categorized into performance indicators as well as quantity structure and performance (other). This indicator captures whether the platform offers PIM.

has super-classes Mobile Devices (Others)^c Performance Indicator^c Software resource indicator^c

Personal Information Management (PIM) (performance indicators, quantity structure and performance (windows phone))^c

IRI: `https://w3id.org/bmontology#MobileDevices_PerformanceIndicators_QuantityStructureAndPerformanceWindowsPhone_PersonalInformationManagementPIM`

This is a performance indicator of the mobile devices service, categorized into performance indicators as well as quantity structure and performance (windows phone). This indicator captures whether the platform offers PIM.

has super-classes Mobile Devices (Windows Phone)^c Performance Indicator^c Software resource indicator^c

Personnel (cost indicators, active components)^c

IRI: `https://w3id.org/bmontology#LAN_CostIndicators_ActiveComponents_Personnel`

This is a cost indicator of the LAN service, categorized into cost indicators as well as active components. This indicator captures the personnel costs for active components, security environment, monitoring and administration environment and WLAN.

has super-classes Cost Indicator^c Human resource indicator^c LAN^c

Personnel (cost indicators, blackberry)^c

IRI: `https://w3id.org/bmontology#MobileDevices_CostIndicators_Blackberry_Personnel`

This is a cost indicator of the mobile devices service, categorized into cost indicators as well as blackberry. This indicator captures the personnel costs of the mobile devices module.

has super-classes Cost Indicator^c Human resource indicator^c Mobile Devices (Blackberry)^c

Personnel (cost indicators, classical telephony)[c]

IRI: `https://w3id.org/bmontology#Telephony_CostIndicators_ClassicalTelephony_Personnel`

This is a cost indicator of the telephony service, categorized into cost indicators as well as classical telephony. This indicator captures the personnel costs involved in the telephony module.

has super-classes Cost Indicator[c] Human resource indicator[c] Telephony[c]

Personnel (cost indicators, conferencing (incl. video conferencing tools))[c]

IRI: `https://w3id.org/bmontology#Collaboration_CostIndicators_ConferencingInclVideoConferencingTools_Personnel`

This is a cost indicator of the collaboration service, categorized into cost indicators as well as conferencing (incl. video conferencing tools). This indicator captures the personnel costs involved in the collaboration module.

has super-classes Collaboration[c] Cost Indicator[c] Human resource indicator[c]

Personnel (cost indicators, cost indicator (medium))[c]

IRI: `https://w3id.org/bmontology#DedicatedServer_CostIndicators_CostIndicatorMedium_Personnel`

This is a cost indicator of the dedicated server service, categorized into cost indicators as well as cost indicator (medium). This indicator captures the total personnel costs for IT employees that are involved in the dedicated servers (yearly).

has super-classes Cost Indicator[c] Dedicated server (medium)[c] Human resource indicator[c]

Personnel (cost indicators, cost indicators (large))[c]

IRI: `https://w3id.org/bmontology#DedicatedServer_CostIndicators_CostIndicatorsLarge_Personnel`

This is a cost indicator of the dedicated server service, categorized into cost indicators as well as cost indicators (large). This indicator captures the total personnel costs for IT employees that are involved in the dedicated servers (yearly).

has super-classes Cost Indicator^c Dedicated server (large)^c Human resource indicator^c

Personnel (cost indicators, cost indicators (small))^c

IRI: `https://w3id.org/bmontology#DedicatedServer_CostIndicators_CostIndicatorsSmall_Personnel`

This is a cost indicator of the dedicated server service, categorized into cost indicators as well as cost indicators (small). This indicator captures the total personnel costs for IT employees that are involved in the dedicated servers (yearly).

has super-classes Cost Indicator^c Dedicated server (small)^c Human resource indicator^c

Personnel (cost indicators, cost indicators)^c

IRI: `https://w3id.org/bmontology#Backup_CostIndicators_CostIndicators_Personnel`

This is a cost indicator of the backup service, categorized into cost indicators as well as cost indicators. This indicator captures the total personnel costs for IT employees that are involved in this module (yearly).

has super-classes Backup^c Cost Indicator^c Human resource indicator^c

Personnel (cost indicators, desktop)^c

IRI: `https://w3id.org/bmontology#Workplace_CostIndicators_Desktop_Personnel`

This is a cost indicator of the workplace service, categorized into cost indicators as well as desktop. This indicator captures the total operating costs (excl. service desk performance).

has super-classes Cost Indicator^c Human resource indicator^c Workplace^c

Personnel (cost indicators, high)^c

IRI: `https://w3id.org/bmontology#Storage_CostIndicators_High_Personnel`

This is a cost indicator of the storage service, categorized into cost indicators as well as high. This indicator captures the total personnel costs for IT employees that are involved in the storage module (yearly).

has super-classes Cost Indicator^c Human resource indicator^c Storage (High)^c

Personnel (cost indicators, iPhone)^c

IRI: `https://w3id.org/bmontology#MobileDevices_CostIndicators_IPhone_Personnel`

This is a cost indicator of the mobile devices service, categorized into cost indicators as well as iPhone. This indicator captures the personnel costs of the mobile devices module.

has super-classes Cost Indicator^c Human resource indicator^c Mobile Devices (iPhone)^c

Personnel (cost indicators, laptop)^c

IRI: `https://w3id.org/bmontology#Workplace_CostIndicators_Laptop_Personnel`

This is a cost indicator of the workplace service, categorized into cost indicators as well as laptop. This indicator captures the total operating costs (excl. service desk performance).

has super-classes Cost Indicator^c Human resource indicator^c Workplace^c

Personnel (cost indicators, low)^c

IRI: `https://w3id.org/bmontology#Storage_CostIndicators_Low_Personnel`

This is a cost indicator of the storage service, categorized into cost indicators as well as low. This indicator captures the total personnel costs for IT employees that are involved in the storage module (yearly).

has super-classes Cost Indicator^c Human resource indicator^c Storage (Low)^c

Personnel (cost indicators, lync and other applications (without telephony))^c

IRI: `https://w3id.org/bmontology#Collaboration_CostIndicators_LyncAndOtherApplicationsWithoutTelephony_Personnel`

This is a cost indicator of the collaboration service, categorized into cost indicators as well as lync and other applications (without telephony). This indicator captures the personnel costs involved in the collaboration module.

has super-classes Collaboration^c Cost Indicator^c Human resource indicator^c

Personnel (cost indicators, medium)^c

IRI: `https://w3id.org/bmontology#Storage_CostIndicators_Medium_Personnel`

This is a cost indicator of the storage service, categorized into cost indicators as well as medium. This indicator captures the total personnel costs for IT employees that are involved in the storage module (yearly).

has super-classes Cost Indicator^c Human resource indicator^c Storage (Medium)^c

Personnel (cost indicators, monitoring and administration environment)^c

IRI: `https://w3id.org/bmontology#LAN_CostIndicators_MonitoringAndAdministrationEnvironment_Personnel`

This is a cost indicator of the LAN service, categorized into cost indicators as well as monitoring and administration environment. This indicator captures the personnel costs for active components, security environment, monitoring and administration environment and WLAN.

has super-classes Cost Indicator^c Human resource indicator^c LAN^c

Personnel (cost indicators, others)^c

IRI: `https://w3id.org/bmontology#MobileDevices_CostIndicators_Others_Personnel`

This is a cost indicator of the mobile devices service, categorized into cost indicators as well as others. This indicator captures the personnel costs of the mobile devices module.

has super-classes Cost Indicator^c Human resource indicator^c Mobile Devices (Others)^c

Personnel (cost indicators, security environment)^c

IRI: `https://w3id.org/bmontology#LAN_CostIndicators_SecurityEnvironment_Personnel`

This is a cost indicator of the LAN service, categorized into cost indicators as well as security environment. This indicator captures the personnel costs for active components, security environment, monitoring and administration environment and WLAN.

has super-classes Cost Indicator^c Human resource indicator^c LAN^c

Personnel (cost indicators, sharePoint and other applications)^c

IRI: `https://w3id.org/bmontology#Collaboration_CostIndicators_SharePointAndOtherApplications_Personnel`

This is a cost indicator of the collaboration service, categorized into cost indicators as well as sharePoint and other applications. This indicator captures the personnel costs involved in the collaboration module.

has super-classes Collaboration^c Cost Indicator^c Human resource indicator^c

Personnel (cost indicators, SSL VPN access)^c

IRI: `https://w3id.org/bmontology#RemoteAccessService_CostIndicators_SSLVPNAccess_Personnel`

This is a cost indicator of the remote access service service, categorized into cost indicators as well as SSL VPN access. This indicator captures the personnel costs for RAS per connection.

has super-classes Cost Indicator^c Human resource indicator^c Remote access service^c

Personnel (cost indicators, standard mass connection)^c

IRI: `https://w3id.org/bmontology#RemoteAccessService_CostIndicators_StandardMassConnection_Personnel`

This is a cost indicator of the remote access service service, categorized into cost indicators as well as standard mass connection. This indicator captures the personnel costs for RAS per connection.

has super-classes Cost Indicator^c Human resource indicator^c Remote access service^c

Personnel (cost indicators, total costs of guest systems)^c

IRI: `https://w3id.org/bmontology#VirtualServer_CostIndicators_TotalCostsOfGuestSystems_Personnel`

This is a cost indicator of the virtual server service, categorized into cost indicators as well as total costs of guest systems. This indicator captures the total personnel costs for IT employees that are involved in the guest systems (yearly).

has super-classes Cost Indicator^c Human resource indicator^c Virtual server^c

Personnel (cost indicators, total costs of host systems)^c

IRI: `https://w3id.org/bmontology#VirtualServer_CostIndicators_TotalCostsOfHostSystems_Personnel`

This is a cost indicator of the virtual server service, categorized into cost indicators as well as total costs of host systems. This indicator captures the total personnel costs for IT employees that are involved in the host systems (yearly).

has super-classes Cost Indicator^c Human resource indicator^c Virtual server^c

Personnel (cost indicators, total costs)^c

IRI: `https://w3id.org/bmontology#FileService_CostIndicators_TotalCosts_Personnel`

This is a cost indicator of the file service service, categorized into cost indicators as well as total costs. This indicator captures the personnel costs involved in the file service module.

has super-classes Cost Indicator^c File Service^c Human resource indicator^c

Personnel (cost indicators, total costs)^c

IRI: `https://w3id.org/bmontology#Mailbox_CostIndicators_TotalCosts_Personnel`

This is a cost indicator of the mailbox service, categorized into cost indicators as well as total costs. This indicator captures the personnel costs involved in the mailbox module.

has super-classes Cost Indicator^c Human resource indicator^c Mailbox^c

Personnel (cost indicators, total costs)^c

IRI: `https://w3id.org/bmontology#SAPBasis_CostIndicators_TotalCosts_Personnel`

This is a cost indicator of the SAP basis service, categorized into cost indicators as well as total costs. This indicator captures the monthly personnel costs in total for IT employees that are involved in the basic technical SAP operations and the corresponding administration tasks..

has super-classes Cost Indicator^c Human resource indicator^c SAP basis^c

Personnel (cost indicators, total costs)^c

IRI: `https://w3id.org/bmontology#TerminalServer_CostIndicators_TotalCosts_Personnel`

This is a cost indicator of the terminal server service, categorized into cost indicators as well as total costs. This indicator captures the total personnel costs for IT employees that are involved in the terminal servers (yearly).

has super-classes Cost Indicator^c Human resource indicator^c Terminal server^c

Personnel (cost indicators, variant 1 (high availability))^c

IRI: `https://w3id.org/bmontology#Database_CostIndicators_Variant1HighAvailability_Personnel`

This is a cost indicator of the database service, categorized into cost indicators as well as variant 1 (high availability). This indicator captures the internal personnel costs.

has super-classes Cost Indicator^c Database (Variant 1)^c Human resource indicator^c

Personnel (cost indicators, variant 2)^c

IRI: `https://w3id.org/bmontology#Database_CostIndicators_Variant2_Personnel`

This is a cost indicator of the database service, categorized into cost indicators as well as variant 2. This indicator captures the internal personnel costs.

has super-classes Cost Indicator^c Datenbanken (Variante 2)^c Human resource indicator^c

Personnel (cost indicators, voIP)^c

IRI: `https://w3id.org/bmontology#Telephony_CostIndicators_VoIP_Personnel`

This is a cost indicator of the telephony service, categorized into cost indicators as well as voIP. This indicator captures the personnel costs involved in the telephony module.

has super-classes Cost Indicator^c Human resource indicator^c Telephony^c

Personnel (cost indicators, VPN client)^c

IRI: `https://w3id.org/bmontology#RemoteAccessService_CostIndicators_VPNClient_Personnel`

This is a cost indicator of the remote access service service, categorized into cost indicators as well as VPN client. This indicator captures the personnel costs for RAS per connection.

has super-classes Cost Indicator^c Human resource indicator^c Remote access service^c

Personnel (cost indicators, VPN tunel to business partners)^c

IRI: `https://w3id.org/bmontology#RemoteAccessService_CostIndicators_VPNTunelToBusinessPartners_Personnel`

This is a cost indicator of the remote access service service, categorized into cost indicators as well as VPN tunel to business partners. This indicator captures the personnel costs for RAS per connection.

has super-classes Cost Indicator^c Human resource indicator^c Remote access service^c

Personnel (cost indicators, windows phone)^c

IRI: `https://w3id.org/bmontology#MobileDevices_CostIndicators_WindowsPhone_Personnel`

This is a cost indicator of the mobile devices service, categorized into cost indicators as well as windows phone. This indicator captures the personnel costs of the mobile devices module.

has super-classes Cost Indicator^c Human resource indicator^c Mobile Devices (Windows Phone)^c

Personnel (cost indicators, WLAN)^c

IRI: `https://w3id.org/bmontology#LAN_CostIndicators_WLAN_Personnel`

This is a cost indicator of the LAN service, categorized into cost indicators as well as WLAN. This indicator captures the personnel costs for active components, security environment, monitoring and administration environment and WLAN.

has super-classes Cost Indicator^c Human resource indicator^c LAN^c

Personnel employee service desk management (cost indicators, total costs)^c

IRI: `https://w3id.org/bmontology#Servicedesk_CostIndicators_TotalCosts_PersonnelEmployeeServiceDeskManagement`

This is a cost indicator of the servicedesk service, categorized into cost indicators as well as total costs. This indicator captures the internal personnel costs for employees of the service desk management.

has super-classes Cost Indicator^c Human resource indicator^c Servicedesk^c

Personnel service desk agents (first level) (cost indicators, total costs)^{c}

IRI: `https://w3id.org/bmontology#Servicedesk_CostIndicators_TotalCosts_PersonnelServiceDeskAgentsFirstLevel`

This is a cost indicator of the servicedesk service, categorized into cost indicators as well as total costs. This indicator captures the internal personnel costs for employees of service desk agents (first level).

has super-classes Cost Indicator^{c} Human resource indicator^{c} Servicedesk^{c}

Platform (cost indicators, others)^{c}

IRI: `https://w3id.org/bmontology#MobileDevices_CostIndicators_Others_Platform`

This is a cost indicator of the mobile devices service, categorized into cost indicators as well as others. This indicator captures which platforms (besides Blackberry, Windows Mobile and/or iPhone) are additionally described.

has super-classes Cost Indicator^{c} Mobile Devices (Others)^{c}

Platform (performance indicators, quantity structure and performance (other))^{c}

IRI: `https://w3id.org/bmontology#MobileDevices_PerformanceIndicators_QuantityStructureAndPerformanceOther_Platform`

This is a performance indicator of the mobile devices service, categorized into performance indicators as well as quantity structure and performance (other). This indicator captures which platforms (besides Blackberry, Windows Mobile and/or iPhone) are additionally described.

has super-classes Mobile Devices (Others)^{c} Performance Indicator^{c} Software resource indicator^{c}

Platform (performance indicators, security indicators (other))^c

IRI: `https://w3id.org/bmontology#MobileDevices_PerformanceIndicators_SecurityIndicatorsOther_Platform`

This is a performance indicator of the mobile devices service, categorized into performance indicators as well as security indicators (other). This indicator captures which platforms (besides Blackberry, Windows Mobile and/or iPhone) are additionally described.

has super-classes Mobile Devices (Others)^c Performance Indicator^c Software resource indicator^c

Platform remote wipe offered (performance indicators, security indicators (blackberry))^c

IRI: `https://w3id.org/bmontology#MobileDevices_PerformanceIndicators_SecurityIndicatorsBlackberry_PlatformRemoteWipeOffered`

This is a performance indicator of the mobile devices service, categorized into performance indicators as well as security indicators (blackberry). This indicator captures whether devices may be resetted remotely.

has super-classes Mobile Devices (Blackberry)^c Performance Indicator^c Software resource indicator^c

Platform remote wipe offered (performance indicators, security indicators (iPhone))^c

IRI: `https://w3id.org/bmontology#MobileDevices_PerformanceIndicators_SecurityIndicatorsIPhone_PlatformRemoteWipeOffered`

This is a performance indicator of the mobile devices service, categorized into performance indicators as well as security indicators (iPhone). This indicator captures whether devices may be resetted remotely.

has super-classes Mobile Devices (iPhone)^c Performance Indicator^c

Platform remote wipe offered (performance indicators, security indicators (other))^c

IRI: https://w3id.org/bmontology#MobileDevices_PerformanceIndicators_SecurityIndicatorsOther_PlatformRemoteWipeOffered

This is a performance indicator of the mobile devices service, categorized into performance indicators as well as security indicators (other). This indicator captures whether devices may be resetted remotely.

has super-classes Mobile Devices (Others)^c Performance Indicator^c

Platform remote wipe offered (performance indicators, security indicators (windows phone))^c

IRI: https://w3id.org/bmontology#MobileDevices_PerformanceIndicators_SecurityIndicatorsWindowsPhone_PlatformRemoteWipeOffered

This is a performance indicator of the mobile devices service, categorized into performance indicators as well as security indicators (windows phone). This indicator captures whether devices may be resetted remotely.

has super-classes Mobile Devices (Windows Phone)^c Performance Indicator^c

Portion LX port (performance indicators, port information)^c

IRI: https://w3id.org/bmontology#LAN_PerformanceIndicators_PortInformation_PortionLXPort

This is a performance indicator of the LAN service, categorized into performance indicators as well as port information. This indicator captures the percentage of LX ports.

has super-classes Hardware resource indicator^c LAN^c Performance Indicator^c

Portion of access ports with NAC (performance indicators, port information)^c

IRI: https://w3id.org/bmontology#LAN_PerformanceIndicators_PortInformation_PortionOfAccessPortsWithNAC

This is a performance indicator of the LAN service, categorized into performance indicators as well as port information. This indicator captures the percentage of access ports having network access control (NAC).

has super-classes Hardware resource indicator^c LAN^c Performance Indicator^c

Portion of costs in service desk for other modules (cost indicators, total costs)^c

IRI: `https://w3id.org/bmontology#Servicedesk_CostIndicators_TotalCosts_PortionOfCostsInServiceDeskForOtherModules`

This is a cost indicator of the servicedesk service, categorized into cost indicators as well as total costs. This indicator captures how service desk costs are distributed among other modules.

has super-classes Cost Indicator^c Servicedesk^c

Portion QoS for video (Portion of ports) (performance indicators, port information)^c

IRI: `https://w3id.org/bmontology#LAN_PerformanceIndicators_PortInformation_PortionQoSForVideoPortionOfPorts`

This is a performance indicator of the LAN service, categorized into performance indicators as well as port information. This indicator captures the proportion of ports for QoS of video.

has super-classes LAN^c Performance Indicator^c

Portion QoS for VoIP (Portion of ports) (performance indicators, port information)^c

IRI: `https://w3id.org/bmontology#LAN_PerformanceIndicators_PortInformation_PortionQoSForVoIPPortionOfPorts`

This is a performance indicator of the LAN service, categorized into performance indicators as well as port information. This indicator captures the proportion of ports for QoS of VoIP.

has super-classes LAN^c Performance Indicator^c

Primary storage volume to be backed up (performance indicators, quantity structure and performance)^c

IRI: `https://w3id.org/bmontology#Backup_PerformanceIndicators_QuantityStructureAndPerformance_PrimaryStorageVolumeToBeBackedUp`

This is a performance indicator of the backup service, categorized into performance indicators as well as quantity structure and performance. This indicator captures the primary storage volume which is to be ensured.

has super-classes Backup^c Quantity indicator^c

Primary used backup technology (cost recording) (performance indicators, quantity structure and performance)^c

IRI: `https://w3id.org/bmontology#Backup_PerformanceIndicators_QuantityStructureAndPerformance_PrimaryUsedBackupTechnologyCostRecording`

This is a performance indicator of the backup service, categorized into performance indicators as well as quantity structure and performance. This indicator captures which backup technology is mainly used including the recording of its costs.

has super-classes Backup^c Performance Indicator^c

Private usage allowed (performance indicators, security indicators (blackberry))^c

IRI: `https://w3id.org/bmontology#MobileDevices_PerformanceIndicators_SecurityIndicatorsBlackberry_PrivateUsageAllowed`

This is a performance indicator of the mobile devices service, categorized into performance indicators as well as security indicators (blackberry). This indicator captures whether devices may be used privately by users.

has super-classes Mobile Devices (Blackberry)^c Performance Indicator^c

Private usage allowed (performance indicators, security indicators (iPhone))^c

IRI: `https://w3id.org/bmontology#MobileDevices_PerformanceIndicators_SecurityIndicatorsIPhone_PrivateUsageAllowed`

This is a performance indicator of the mobile devices service, categorized into performance indicators as well as security indicators (iPhone). This indicator captures whether devices may be used privately by users.

has super-classes Mobile Devices (iPhone)^c Performance Indicator^c

Private usage allowed (performance indicators, security indicators (other))^c

IRI: `https://w3id.org/bmontology#MobileDevices_PerformanceIndicators_SecurityIndicatorsOther_PrivateUsageAllowed`

This is a performance indicator of the mobile devices service, categorized into performance indicators as well as security indicators (other). This indicator captures whether devices may be used privately by users.

has super-classes Mobile Devices (Others)^c Performance Indicator^c

Private usage allowed (performance indicators, security indicators (windows phone))^c

IRI: `https://w3id.org/bmontology#MobileDevices_PerformanceIndicators_SecurityIndicatorsWindowsPhone_PrivateUsageAllowed`

This is a performance indicator of the mobile devices service, categorized into performance indicators as well as security indicators (windows phone). This indicator captures whether devices may be used privately by users.

has super-classes Mobile Devices (Windows Phone)^c Performance Indicator^c

Processing of Non-IT services (performance indicators, quantity structure and performance)^c

IRI: `https://w3id.org/bmontology#Servicedesk_PerformanceIndicators_QuantityStructureAndPerformance_ProcessingOfNonITServices`

This is a performance indicator of the servicedesk service, categorized into performance indicators as well as quantity structure and performance. This indicator captures whether non-IT services are processed by the service desk.

has super-classes Performance Indicator^c Servicedesk^c

Proportion of backup (Agents) (performance indicators, quantity structure and performance)^c

IRI: `https://w3id.org/bmontology#Backup_PerformanceIndicators_QuantityStructureAndPerformance_ProportionOfBackupAgents`

This is a performance indicator of the backup service, categorized into performance indicators as well as quantity structure and performance. This indicator captures the percentage of agents (e.g., for databases) of the storage volume per week.

has super-classes Backup^c Performance Indicator^c

Proportion of backup (Files) (performance indicators, quantity structure and performance)^c

IRI: `https://w3id.org/bmontology#Backup_PerformanceIndicators_QuantityStructureAndPerformance_ProportionOfBackupFiles`

This is a performance indicator of the backup service, categorized into performance indicators as well as quantity structure and performance. This indicator captures the percentage of files regarding the storage volume of one week.

has super-classes Backup^c Performance Indicator^c

Proportion of backup (NDMP) (performance indicators, quantity structure and performance)^c

IRI: https://w3id.org/bmontology#Backup_PerformanceIndicators_QuantityStructureAndPerformance_ProportionOfBackupNDMP

This is a performance indicator of the backup service, categorized into performance indicators as well as quantity structure and performance. This indicator captures the percentage of the Network Data Management Protocol (NDMP) of the storage volume per week.

has super-classes Backup^c Performance Indicator^c

Provider SLA WAN (performance indicators, quantity structure and performance)^c

IRI: https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureAndPerformance_ProviderSLAWAN

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure and performance. This indicator captures the provider SLA for WAN.

has super-classes Quality indicator^c WAN^c

PUE (Power Usage Effectiveness) (data center levy, basic data)^c

IRI: https://w3id.org/bmontology#BasicData_DataCenterLevy_BasicData_PUEPowerUsageEffectiveness

This is an indicator of the basic data service, categorized into data center levy as well as basic data. This indicator captures the efficiency of a computer center regarding its power consumption.

has super-classes Basic data^c Hardware resource indicator^c

Quality indicator^c

IRI: https://w3id.org/bmontology#QualityIndicator

Classifies quality indicators

has super-classes Performance Indicator^c

has sub-classes Are SLAs offered (performance indicators, conferencing (incl. video conferencing tools))^c , Are SLAs offered (performance indicators, lync and other applications (without telephony))^c , Are SLAs offered (performance indicators, sharePoint and other applications)^c , Availability (performance indicators, service level)^c , Delivery time (performance indicators, service level of IMAC processes)^c , Duration until image is available (performance indicators, service level of IMAC processes)^c , Duration until mass rollout of patch installations at clients are freed (performance indicators, service level of IMAC processes)^c , Duration until patch publication (performance indicators, service level of IMAC processes)^c , Ensured availability (performance indicators, additional information)^c , Ensured availability (performance indicators, cross-system)^c , Ensured availability (performance indicators, quantity structure (large))^c , Ensured availability (performance indicators, quantity structure (medium))^c , Ensured availability (performance indicators, quantity structure (small))^c , Ensured availability (performance indicators, quantity structure and performance)^c , Ensured availability (performance indicators, quantity structure and performance)^c , Ensured availability (performance indicators, quantity structure and performance)^c , Ensured availability (performance indicators, quantity structure)^c , Ensured availability (performance indicators, quantity structure)^c , Ensured availability (performance indicators, service level of IMAC processes)^c , Ensured availability (performance indicators, variant 1 (high availability))^c , Ensured availability (performance indicators, variant 2)^c , Guaranteed performance (performance indicators, quantity structure and performance)^c , High availability (performance indicators, variant 2)^c , IMAC completion according to SLA (performance indicators, service level of IMAC processes)^c , Provider SLA WAN (performance indicators, quantity structure and performance)^c , Recovery time (performance indicators, service level of IMAC processes)^c , Response time for calls (performance indicators, service level)^c , Response time in hours IMAC (performance indicators, service level of IMAC processes)^c , Response time web service (performance indicators, service level)^c , SLA (performance indicators, SSL VPN access)^c , SLA (performance indicators, VPN client)^c , SLA (performance indicators, VPN tunel to business partners)^c , SLA (performance indicators, standard mass connection)^c , SLA for backup available (performance indicators, quantity structure and performance)^c , SLA for recovery available (performance indicators, quantity structure and performance)^c , Solution rate first level (performance indicators, service level)^c , Throughput time first level (performance indicators, service level)^c , Time for service providers (performance indicators, service level of IMAC processes)^c

Quantity indicator^c

IRI: `https://w3id.org/bmontology#QuantityIndicator`

Classifies quantity indicators

has super-classes Performance Indicator^c

has sub-classes Backup volume (performance indicators, quantity structure and performance)^c , Customer (Number of users) (performance indicators, general)^c , DB size (performance indicators, additional information)^c , Ensured storage volume in data backup system (performance indicators, quantity structure and performance)^c , File service user (performance indicators, quantity structure)^c , Number of IT developers (FTE) (performance indicators, basic data)^c , Number of IT users (performance indicators, basic data)^c , Number of Runtime errors (performance indicators, quantity structure and performance)^c , Number of WLAN controller (performance indicators, WLAN)^c , Number of access point (performance indicators, WLAN)^c , Number of access ports 1 Gbit with PoE (performance indicators, quantity structure)^c , Number of access ports 1 Gbit without PoE (performance indicators, quantity structure)^c , Number of access ports 100Mbit with PoE (performance indicators, quantity structure)^c , Number of access ports 100Mbit without PoE (performance indicators, quantity structure)^c , Number of active devices in the organization (performance indicators, general indicators)^c , Number of application server (performance indicators, additional information)^c , Number of authorized users (performance indicators, SSL VPN access)^c , Number of authorized users (performance indicators, VPN client)^c , Number of authorized users (performance indicators, standard mass connection)^c , Number of backup instances (performance indicators, quantity structure and performance)^c , Number of backup servers (performance indicators, quantity structure and performance)^c , Number of clients (performance indicators, quantity structure and performance)^c , Number of computer centers (computer center levy, basic data)^c , Number of connected devices using access ports (performance indicators, quantity structure)^c , Number of connections to business partners RAS VPN tunnel (performance indicators, VPN tunel to business partners)^c , Number of cores (performance indicators, host systems)^c , Number of countries managed by the IT (performance indicators, basic data)^c , Number of database version (performance indicators, variant 1 (high availability))^c , Number of database version (performance indicators, variant 2)^c , Number of databases (performance indicators, variant 1 (high availability))^c , Number of databases (performance indicators, variant 2)^c , Number of dedicated servers (performance indicators, quantity structure and performance)^c , Number of devices (performance indicators, performance indicators)^c , Number of distributed packages per year (performance indicators, quantity structure and performance)^c , Number of distributed packages per year (performance indicators, service level of IMAC processes)^c , Number of employees (general organization data, basic data)^c , Number of employees in service desk management (FTE) (performance indicators, quantity structure and performance)^c , Number of end devices (this platform) (performance indicators, quantity structure and performance (blackberry))^c , Number of end devices (this platform) (performance indicators, quantity structure and performance (iPhone))^c , Number of end devices (this platform) (performance indicators, quantity structure and performance (other))^c , Number of end devices (this platform) (performance indicators, quantity structure and performance (windows phone))^c , Number of external IT employees (FTE) (performance indicators, basic data)^c , Number of external personnel (FTE) (performance indicators, SSL VPN access)^c , Number of external personnel (FTE) (performance indicators, VPN client)^c , Number of external personnel (FTE) (performance indicators, VPN tunel to business partners)^c , Number of external personnel (FTE) (performance indicators, conferencing (incl. video conferencing tools))^c , Number of external personnel (FTE) (performance indicators, cross-system)^c , Number of external personnel (FTE) (performance indicators, lync and other applications (without telephony))^c , Number of external personnel (FTE) (performance indicators, performance indicators)^c , Number of external personnel (FTE) (performance indicators, quantity structure (large))^c , Number of external personnel (FTE) (performance indicators, quantity structure (medium))^c , Number of external personnel (FTE) (performance indicators, quantity structure (small))^c , Number of external personnel (FTE) (performance indicators, quantity structure and performance)^c , Number of external personnel (FTE) (performance indicators, quantity structure and performance)^c , Number of external personnel (FTE) (performance indicators, quantity structure and performance)^c , Number of external personnel (FTE) (performance indicators, quantity structure and performance)^c , Number of external personnel (FTE) (performance indicators, quantity structure and performance)^c , Number of external personnel (FTE) (performance indicators, quantity structure and performance)^c , Number of external personnel (FTE) (performance indicators, quantity structure)^c , Number of external personnel (FTE) (performance indicators, quantity structure)^c , Number of external personnel (FTE) (performance indicators, quantity structure)^c , Number of external personnel (FTE) (performance indicators, sharePoint and other applications)^c , Number of external personnel (FTE) (performance indicators, standard mass connection)^c , Number of external personnel (FTE) (performance indicators, variant 1 (high availability))^c , Number of external personnel (FTE) (performance indicators, variant 2)^c , Number of external personnel WLAN (FTE) (performance indicators, WLAN)^c , Number of external personnel per platform (FTE) (performance indicators, performance information)^c , Number of external personnel per platform (FTE) (performance indicators, quantity structure and performance (blackberry))^c , Number of external personnel per platform (FTE) (performance indicators, quantity structure and performance (iPhone))^c , Number of external personnel per platform (FTE) (performance indicators, quantity structure and performance (other))^c , Number of external personnel per platform (FTE) (performance indicators, quantity structure and performance (windows phone))^c , Number of full users (performance indicators, quantity structure and performance)^c , Number of guest systems (performance indicators, guest system)^c , Number of guest systems (performance indicators, quantity structure and performance)^c , Number of incident tickets per year (performance indicators, quantity structure and performance)^c , Number of incidents (performance indicators, additional information)^c , Number of internal IT employees (FTE) (performance indicators, basic data)^c , Number of internal personnel (FTE) (performance indicators, SSL VPN access)^c , Number of internal personnel (FTE) (performance indicators, VPN client)^c , Number of internal personnel (FTE) (performance indicators, VPN tunel to business partners)^c , Number of internal personnel (FTE) (performance indicators, conferencing (incl. video conferencing tools))^c , Number of internal personnel (FTE) (performance indicators, cross-system)^c , Number of internal personnel (FTE) (performance indicators, lync and other applications (without telephony))^c , Number of internal personnel (FTE) (performance indicators, performance indicators)^c , Number of internal personnel (FTE) (performance indicators, quantity structure (large))^c , Number of internal personnel (FTE) (performance indicators, quantity structure (medium))^c , Number of internal personnel (FTE) (performance indicators, quantity structure (small))^c , Number of internal personnel (FTE) (performance indicators, quantity structure and performance)^c , Number of internal personnel (FTE) (performance indicators, quantity structure and performance)^c , Number of internal personnel (FTE) (performance indicators, quantity structure and performance)^c , Number of internal personnel (FTE) (performance indicators, quantity structure and performance)^c , Number of internal personnel (FTE) (performance indicators, quantity structure and performance)^c , Number of internal personnel (FTE) (performance indicators, quantity structure and performance)^c , Number of internal personnel (FTE) (performance indicators, quantity structure)^c , Number of internal personnel (FTE) (performance indicators, quantity structure)^c , Number of internal personnel (FTE) (performance indicators, quantity structure)^c , Number of internal personnel (FTE) (performance indicators, sharePoint and other applications)^c , Number of internal personnel (FTE) (performance indicators, standard mass connection)^c , Number of internal personnel (FTE) (performance indicators, variant 1 (high availability))^c , Number of internal personnel (FTE) (performance indicators, variant 2)^c , Number of internal personnel WLAN (FTE) (performance indicators, WLAN)^c , Number of internal personnel per plantform (FTE) (performance indicators, performance information)^c , Number of internal personnel per plantform (FTE) (performance indicators, quantity structure and performance (blackberry))^c , Number of internal personnel per plantform (FTE) (performance indicators, quantity structure and performance (iPhone))^c , Number of internal personnel per plantform (FTE) (performance indicators, quantity structure and performance (other))^c , Number of internal personnel per plantform (FTE) (performance indicators, quantity structure and performance (windows phone))^c , Number of languages (performance indicators, quantity structure and performance)^c , Number of libraries (disk & tapes) (performance indicators, quantity structure and performance)^c , Number of light users (performance indicators, quantity structure and performance)^c , Number of location video WAN APA (performance indicators, quantity structure (APA))^c , Number of locations (performance indicators, general)^c , Number of locations (performance indicators, quantity structure (other countries))^c , Number of locations APA (performance indicators, quantity structure (APA))^c , Number of locations Brazil (performance indicators, quantity structure (SA))^c , Number of locations China (performance indicators, quantity structure (APA))^c , Number of locations EMEA (performance indicators, quantity structure (EMEA))^c , Number of locations Germany (performance indicators, quantity structure (EMEA))^c , Number of locations India (performance indicators, quantity structure (APA))^c , Number of locations Mexico (performance indicators, quantity structure (NA))^c , Number of locations NA (performance indicators, quantity structure (NA))^c , Number of locations Russia (performance indicators, quantity structure (EMEA))^c , Number of locations SA (performance indicators, quantity structure (SA))^c , Number of locations South Africa (performance indicators, quantity structure (EMEA))^c , Number of locations Turkey (performance indicators, quantity structure (EMEA))^c , Number of locations USA (performance indicators, quantity structure (NA))^c , Number of locations VoIP WAN (performance indicators, quantity structure (other countries))^c , Number of locations VoIP WAN APA (performance indicators, quantity structure (APA))^c , Number of locations VoIP WAN Brazil (performance indicators, quantity structure (SA))^c , Number of locations VoIP WAN China (performance indicators, quantity structure (APA))^c , Number of locations VoIP WAN EMEA (performance indicators, quantity structure (EMEA))^c , Number of locations VoIP WAN Germany (performance indicators, quantity structure (EMEA))^c , Number of locations VoIP WAN India (performance indicators, quantity structure (APA))^c , Number of locations VoIP WAN Mexico (performance indicators, quantity structure (NA))^c , Number of locations VoIP WAN NA (performance indicators, quantity structure (NA))^c , Number of locations VoIP WAN Russia (performance indicators, quantity structure (EMEA))^c , Number of locations VoIP WAN SA (performance indicators, quantity structure (SA))^c , Number of locations VoIP WAN South Africa (performance indicators, quantity structure (EMEA))^c , Number of locations VoIP WAN Turkey (performance indicators, quantity structure (EMEA))^c , Number of locations VoIP WAN USA (performance indicators, quantity structure (NA))^c , Number of locations VoIP WAN other APA (performance indicators, quantity structure (APA))^c , Number of locations VoIP WAN other EMEA (performance indicators, quantity structure (EMEA))^c , Number of locations VoIP WAN other NA (performance indicators, quantity structure (NA))^c , Number of locations VoIP WAN other SA (performance indicators, quantity structure (SA))^c , Number of locations other APA (performance indicators, quantity structure (APA))^c , Number of locations other EMEA (performance indicators, quantity structure (EMEA))^c , Number of locations other NA (performance indicators, quantity structure (NA))^c , Number of locations other SA (performance indicators, quantity structure (SA))^c , Number of locations prioritization WAN (performance indicators, quantity structure (other countries))^c , Number of locations prioritization WAN APA (performance indicators, quantity structure (APA))^c , Number of locations prioritization WAN Brazil (performance indicators, quantity structure (SA))^c , Number of locations prioritization WAN China (performance indicators, quantity structure (APA))^c , Number of locations prioritization WAN EMEA (performance indicators, quantity structure (EMEA))^c , Number of locations prioritization WAN Germany (performance indicators, quantity structure (EMEA))^c , Number of locations prioritization WAN India (performance indicators, quantity structure (APA))^c , Number of locations 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India (performance indicators, quantity structure (APA))^c , Number of locations video WAN Mexico (performance indicators, quantity structure (NA))^c , Number of locations video WAN NA (performance indicators, quantity structure (NA))^c , Number of locations video WAN Russia (performance indicators, quantity structure (EMEA))^c , Number of locations video WAN SA (performance indicators, quantity structure (SA))^c , Number of locations video WAN South Africa (performance indicators, quantity structure (EMEA))^c , Number of locations video WAN Turkey (performance indicators, quantity structure (EMEA))^c , Number of locations video WAN UA (performance indicators, quantity structure (NA))^c , Number of locations video WAN other APA (performance indicators, quantity structure (APA))^c , Number of locations video WAN other EMEA (performance indicators, quantity structure (EMEA))^c , Number of locations video WAN other NA (performance indicators, quantity structure (NA))^c , Number of 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(performance indicators, quantity structure (SA))^c , Number of long running batch processes (performance indicators, quantity structure and performance)^c , Number of mailboxes (performance indicators, quantity structure)^c , Number of mailservers (performance indicators, quantity structure)^c , Number of maintaned phone numbers (performance indicators, quantity structure (classical telephony))^c , Number of managed locations (performance indicators, performance information)^c , Number of managed phone numbers (performance indicators, quantity structure (voIP))^c , Number of module users (performance indicators, BC: basic system)^c , Number of module users (performance indicators, CS: customer service)^c , Number of module users (performance indicators, EC: corporate controlling)^c , Number of module users (performance indicators, FI: finance)^c , Number of module users (performance indicators, MM: materials management)^c , Number of module users (performance indicators, PM: plant maintenance)^c , Number of module users (performance indicators, PP: production planning and control)^c , Number of module users (performance indicators, SD: sales and distribution)^c , Number of module users (performance indicators, co: controlling)^c , Number of other access ports (performance indicators, quantity structure)^c , Number of passive devices in the organization (performance indicators, general indicators)^c , Number of patch cycles per year (performance indicators, quantity structure and performance)^c , Number of physical hosts (performance indicators, quantity structure and performance)^c , Number of physical hosts in the server farm (performance indicators, host systems)^c , Number of providers WLAN (performance indicators, quantity structure and performance)^c , Number of servers (performance indicators, quantity structure (large))^c , Number of servers (performance indicators, quantity structure (small))^c , Number of servers (platform-specific) (performance indicators, quantity structure (medium))^c , Number of servers (platform-specific) (performance indicators, quantity structure and performance (blackberry))^c , Number of servers (platform-specific) (performance indicators, quantity structure and performance (iPhone))^c , Number of servers (platform-specific) (performance indicators, quantity structure and performance (other))^c , Number of servers (platform-specific) (performance indicators, quantity structure and performance (windows phone))^c , Number of service desk agents, first level (FTE) (performance indicators, quantity structure and performance)^c , Number of service requests per year (performance indicators, quantity structure and performance)^c , Number of snapshots in primary storage per day (performance indicators, quantity structure and performance)^c , Number of supported users (performance indicators, quantity structure and performance)^c , Number of system lines (Landscape) (performance indicators, quantity structure and performance)^c , Number of systems (ERP + HR) (performance indicators, quantity structure and performance)^c , Number of systems (Landscape) (performance indicators, quantity structure and performance)^c , Number of systems to be secured (performance indicators, quantity structure and performance)^c , Number of sytem lines (ERP + HR) (performance indicators, quantity structure and performance)^c , Number of tape drives (performance indicators, quantity structure and performance)^c , Number of telephony end devices (performance indicators, quantity structure (classical telephony))^c , Number of telephony end devices (performance indicators, quantity structure (voIP))^c , Number of used operation systems (performance indicators, cross-system)^c , Number of used operation systems (performance indicators, quantity structure and performance)^c , Number of users China (performance indicators, quantity structure (APA))^c , Number of users (performance indicators, conferencing (incl. video conferencing tools))^c , Number of users (performance indicators, lync and other applications (without telephony))^c , Number of users (performance indicators, quantity structure (other countries))^c , Number of users (performance indicators, sharePoint and other applications)^c , Number of users APA (performance indicators, quantity structure (APA))^c , Number of users Brazil (performance indicators, quantity structure (SA))^c , Number of users EMEA (performance indicators, quantity structure (EMEA))^c , Number of users Germany (performance indicators, quantity structure (EMEA))^c , Number of users India (performance indicators, quantity structure (APA))^c , Number of users Mail (performance indicators, quantity structure)^c , Number of users Mexico (performance indicators, quantity structure (NA))^c , Number of users NA (performance indicators, quantity structure (NA))^c , Number of users Russia (performance indicators, quantity structure (EMEA))^c , Number of users SA (performance indicators, quantity structure (SA))^c , Number of users South Africa (performance indicators, quantity structure (EMEA))^c , Number of users Turkey (performance indicators, quantity structure (EMEA))^c , Number of users USA (performance indicators, quantity structure (NA))^c , Number of users concurrent (performance indicators, quantity structure and performance)^c , Number of users other APA (performance indicators, quantity structure (APA))^c , Number of users other EMEA (performance indicators, quantity structure (EMEA))^c , Number of users other NA (performance indicators, quantity structure (NA))^c , Number of users other SA (performance indicators, quantity structure (SA))^c , Number of users supported from the cental location (performance indicators, quantity structure (classical telephony))^c , Number of users supported from the cental location (performance indicators, quantity structure (voIP))^c , Number of users total (performance indicators, quantity structure and performance)^c , Number of working students / intern (performance indicators, basic data)^c , Number of workplaces (desktop) (performance indicators, quantity structure and performance)^c , Number of workplaces (laptop) (performance indicators, quantity structure and performance)^c , Operationally used storage volume (performance indicators, quantity structure (high))^c , Operationally used storage volume (performance indicators, quantity structure (low))^c , Operationally used storage volume (performance indicators, quantity structure (medium))^c , Patch cycles (performance indicators, quantity structure (large))^c , Patch cycles (performance indicators, quantity structure (medium))^c , Patch cycles (performance indicators, quantity structure (small))^c , Patch cycles (performance indicators, variant 1 (high availability))^c , Patch cycles (performance indicators, variant 2)^c , Primary storage volume to be backed up (performance indicators, quantity structure and performance)^c , Storage volume (performance indicators, variant 1 (high availability))^c , Storage volume (performance indicators, variant 2)^c , Total capacity (gross) incl. reserves (performance indicators, quantity structure (high))^c , Total capacity (gross) incl. reserves (performance indicators, quantity structure (low))^c , Total capacity (gross) incl. reserves (performance indicators, quantity structure (medium))^c , Total capacity (net) (performance indicators, quantity structure)^c , Total capacity (net) incl. reserves (performance indicators, quantity structure (high))^c , Total capacity (net) incl. reserves (performance indicators, quantity structure (low))^c , Total capacity (net) incl. reserves (performance indicators, quantity structure (medium))^c , Total disk storage (performance indicators, guest system)^c , Total disk storage (performance indicators, host systems)^c , Total main memory (RAM) (performance indicators, host systems)^c , Total number of virtual cores (performance indicators, guest system)^c , Total size of assigned RAM (performance indicators, guest system)^c , Total storage size of mailboxes (performance indicators, quantity structure)^c , Used capacity (performance indicators, quantity structure)^c , Volume reserves (performance indicators, quantity structure (high))^c , Volume reserves (performance indicators, quantity structure (low))^c , Volume reserves (performance indicators, quantity structure (medium))^c

Questionnaire of an individual benchmark^{c}

IRI: `https://w3id.org/bmontology#Questionnaire`

Represents a (physical) questionnaire of an individual benchmark

has super-classes information realizationphysical objectrealizessomeIndicator^{c} is reporting for^{op} onlyBenchmark^{c} is reporting for^{op} exactly 1 Benchmark^{c} has Label^{dp} somestring

has sub-classes IT service questionnaire^{c} , Service segment questionnaire^{c}

is in domain of categorizes indicator^{op} , has sub-questionnaire^{op} , is child of^{op} , is reporting for^{op}

is in range of has indicator categorizaion^{op} , has reporting^{op} , has sub-questionnaire^{op} , is child of^{op}

is disjoint with Indicator^{c}

Range of service 'telephony' in other countries (performance indicators, performance information)^{c}

IRI: `https://w3id.org/bmontology#Telephony_PerformanceIndicators_PerformanceInformation_RangeOfServiceTelephonyInOtherCountries`

This is a performance indicator of the telephony service, categorized into performance indicators as well as performance information. This indicator captures whether the performance of the telephony is also available to other countries.

has super-classes Performance Indicator^{c} Telephony^{c}

Recovery time (performance indicators, service level of IMAC processes)^{c}

IRI: `https://w3id.org/bmontology#IMAC_PerformanceIndicators_ServiceLevelOfIMACProcesses_RecoveryTime`

This is a performance indicator of the IMAC service, categorized into performance indicators as well as service level of IMAC processes. This indicator captures the number of hours required for recovery.

has super-classes IMAC^{c} Quality indicator^{c}

Recovery time in category low (performance indicators, quantity structure and performance)^c

IRI: `https://w3id.org/bmontology#Storage_PerformanceIndicators_QuantityStructureAndPerformance_RecoveryTimeInCategoryLow`

This is a performance indicator of the storage service, categorized into performance indicators as well as quantity structure and performance. This indicator captures how much time is required for recovering the storage.

has super-classes Performance Indicator^c Storage (Low)^c

Redundancy of computer centers (IT and development, basic data)^c

IRI: `https://w3id.org/bmontology#BasicData_ITAndDevelopment_BasicData_RedundancyOfComputerCenters`

This is an indicator of the basic data service, categorized into IT and development as well as basic data. This indicator captures the degree of redundancy of the computer center.

has super-classes Basic data^c Hardware resource indicator^c

Redundant uplinks of access and distribution switches (performance indicators, performance and architecture)^c

IRI: `https://w3id.org/bmontology#LAN_PerformanceIndicators_PerformanceAndArchitecture_RedundantUplinksOfAccessAndDistributionSwitches`

This is a performance indicator of the LAN service, categorized into performance indicators as well as performance and architecture. This indicator captures whether redundant uplinks or access or distribution switches exist.

has super-classes Hardware resource indicator^c LAN^c Performance Indicator^c

Remote access service^c

IRI: `https://w3id.org/bmontology#RemoteAccessServiceIndicator`

Classifies indicators belonging to the remote acces service

has super-classes Service template dimension for indicator classification^c

has sub-classes Access points (performance indicators, SSL VPN access)^c , Access points (performance indicators, VPN client)^c , Access points (performance indicators, VPN tunel to business partners)^c , Access points (performance indicators, standard mass connection)^c , Backend and client systems (performance indicators, SSL VPN access)^c , Backend and client systems (performance indicators, VPN client)^c , Backend and client systems (performance indicators, VPN tunel to business partners)^c , Backend and client systems (performance indicators, standard mass connection)^c , Client software (cost indicators, SSL VPN access)^c , Client software (cost indicators, VPN client)^c , Client software (cost indicators, VPN tunel to business partners)^c , Client software (cost indicators, standard mass connection)^c , Cost rate FTE (performance indicators, SSL VPN access)^c , Cost rate FTE (performance indicators, VPN client)^c , Cost rate FTE (performance indicators, VPN tunel to business partners)^c , Cost rate FTE (performance indicators, standard mass connection)^c , External services (cost indicators, SSL VPN access)^c , External services (cost indicators, VPN client)^c , External services (cost indicators, VPN tunel to business partners)^c , External services (cost indicators, standard mass connection)^c , Infrastructure - backend (cost indicators, SSL VPN access)^c , Infrastructure - backend (cost indicators, VPN client)^c , Infrastructure - backend (cost indicators, VPN tunel to business partners)^c , Infrastructure - backend (cost indicators, standard mass connection)^c , Infrastructure - decentral (cost indicators, SSL VPN access)^c , Infrastructure - decentral (cost indicators, VPN client)^c , Infrastructure - decentral (cost indicators, VPN tunel to business partners)^c , Infrastructure - decentral (cost indicators, standard mass connection)^c , Number of authorized users (performance indicators, SSL VPN access)^c , Number of authorized users (performance indicators, VPN client)^c , Number of authorized users (performance indicators, standard mass connection)^c , Number of connections to business partners RAS VPN tunnel (performance indicators, VPN tunel to business partners)^c , Number of external personnel (FTE) (performance indicators, SSL VPN access)^c , Number of external personnel (FTE) (performance indicators, VPN client)^c , Number of external personnel (FTE) (performance indicators, VPN tunel to business partners)^c , Number of external personnel (FTE) (performance indicators, standard mass connection)^c , Number of incidents (performance indicators, additional information)^c , Number of internal personnel (FTE) (performance indicators, SSL VPN access)^c , Number of internal personnel (FTE) (performance indicators, VPN client)^c , Number of internal personnel (FTE) (performance indicators, VPN tunel to business partners)^c , Number of internal personnel (FTE) (performance indicators, standard mass connection)^c , Others (cost indicators, SSL VPN access)^c , Others (cost indicators, VPN client)^c , Others (cost indicators, VPN tunel to business partners)^c , Others (cost indicators, standard mass connection)^c , Own computers allowed for external employees (performance indicators, additional information)^c , Personnel (cost indicators, SSL VPN access)^c , Personnel (cost indicators, VPN client)^c , Personnel (cost indicators, VPN tunel to business partners)^c , Personnel (cost indicators, standard mass connection)^c , SLA (performance indicators, SSL VPN access)^c , SLA (performance indicators, VPN client)^c , SLA (performance indicators, VPN tunel to business partners)^c , SLA (performance indicators, standard mass connection)^c , Security checks for foreign computers of external employees (performance indicators, additional information)^c , Type of sourcing (performance indicators, additional information)^c

is disjoint with Backup^c , Basic data^c , Collaboration^c , Database^c , Dedicated server^c , File Service^c , IMAC^c , LAN^c , Mailbox^c , Mobile devices^c , SAP basis^c , SAP modules^c , Servicedesk^c , Storage^c , Telephony^c , Terminal server^c , Virtual server^c , WAN^c , Workplace^c

Renewal of end devices (performance indicators, general indicators)^c

IRI: `https://w3id.org/bmontology#MobileDevices_PerformanceIndicators_GeneralIndicators_RenewalOfEndDevices`

This is a performance indicator of the mobile devices service, categorized into performance indicators as well as general indicators. This indicator captures how renewal of devices is done.

has super-classes Mobile devices^c Performance Indicator^c

Reporting (performance indicators, technology)^c

IRI: `https://w3id.org/bmontology#Servicedesk_PerformanceIndicators_Technology_Reporting`

This is a performance indicator of the servicedesk service, categorized into performance indicators as well as technology. This indicator captures the reporting system which is used within the organization.

has super-classes Performance Indicator^c Servicedesk^c Software resource indicator^c

Resource dimension for indicator classification^c

IRI: `https://w3id.org/bmontology#ResourceIndicator`

Classifies indicators based on depending resources

is equivalent to Hardware resource indicator^c orHuman resource indicator^c orSoftware resource indicator^c

has super-classes Indicator^c

has sub-classes Hardware resource indicator^c , Human resource indicator^c , Software resource indicator^c

Response time for calls (performance indicators, service level)^c

IRI: `https://w3id.org/bmontology#Servicedesk_PerformanceIndicators_ServiceLevel_ResponseTimeForCalls`

This is a performance indicator of the servicedesk service, categorized into performance indicators as well as service level. This indicator captures the number of seconds that are required for 80% of all phone calls to be answered.

has super-classes Quality indicator^c Servicedesk^c

Response time in hours IMAC (performance indicators, service level of IMAC processes)^c

IRI: `https://w3id.org/bmontology#IMAC_PerformanceIndicators_ServiceLevelOfIMACProcesses_ResponseTimeInHoursIMAC`

This is a performance indicator of the IMAC service, categorized into performance indicators as well as service level of IMAC processes. This indicator captures the number of hours starting with the registration of a request (call) until the start of the IMAC processes (input seperated by install, move, add, change).

has super-classes IMAC^c Quality indicator^c

Response time web service (performance indicators, service level)^c

IRI: `https://w3id.org/bmontology#Servicedesk_PerformanceIndicators_ServiceLevel_ResponseTimeWebService`

This is a performance indicator of the servicedesk service, categorized into performance indicators as well as service level. This indciator catures the number of seconds that are required for 90% of all tickets to be processed via web service.

has super-classes Quality indicator^c Servicedesk^c

Revenue (general organization data, basic data)^c

IRI: `https://w3id.org/bmontology#BasicData_GeneralOrganizationData_BasicData_Revenue`

This is an indicator of the basic data service, categorized into general organization data as well as basic data. This indicator captures the revenue of the organizational units supported by the IT.

has super-classes Basic data^c

RFC processing (performance indicators, additional information)^c

IRI: `https://w3id.org/bmontology#SAPBasis_PerformanceIndicators_AdditionalInformation_RFCProcessing`

This is a performance indicator of the SAP basis service, categorized into performance indicators as well as additional information. This indicator captures all RFCs (Remote Function Calls) per day.

has super-classes Performance Indicator^c SAP basis^c

S/MIME email encryption (performance indicators, security indicators (blackberry))^c

IRI: `https://w3id.org/bmontology#MobileDevices_PerformanceIndicators_SecurityIndicatorsBlackberry_SMIMEEmailEncryption`

This is a performance indicator of the mobile devices service, categorized into performance indicators as well as security indicators (blackberry). This indicator captures whether the devices are using S/MIME email encryption.

has super-classes Mobile Devices (Blackberry)^c Performance Indicator^c

S/MIME email encryption (performance indicators, security indicators (iPhone))^c

IRI: `https://w3id.org/bmontology#MobileDevices_PerformanceIndicators_SecurityIndicatorsIPhone_SMIMEEmailEncryption`

This is a performance indicator of the mobile devices service, categorized into performance indicators as well as security indicators (iPhone). This indicator captures whether the devices are using S/MIME email encryption.

has super-classes Mobile Devices (iPhone)^c Performance Indicator^c

S/MIME email encryption (performance indicators, security indicators (other))^c

IRI: `https://w3id.org/bmontology#MobileDevices_PerformanceIndicators_SecurityIndicatorsOther_SMIMEEmailEncryption`

This is a performance indicator of the mobile devices service, categorized into performance indicators as well as security indicators (other). This indicator captures whether the devices are using S/MIME email encryption.

has super-classes Mobile Devices (Others)^c Performance Indicator^c

S/MIME email encryption (performance indicators, security indicators (windows phone))^c

IRI: `https://w3id.org/bmontology#MobileDevices_PerformanceIndicators_SecurityIndicatorsWindowsPhone_SMIMEEmailEncryption`

This is a performance indicator of the mobile devices service, categorized into performance indicators as well as security indicators (windows phone). This indicator captures whether the devices are using S/MIME email encryption.

has super-classes Mobile Devices (Windows Phone)^c Performance Indicator^c

Sandbox (performance indicators, security indicators (blackberry))^c

IRI: `https://w3id.org/bmontology#MobileDevices_PerformanceIndicators_SecurityIndicatorsBlackberry_Sandbox`

This is a performance indicator of the mobile devices service, categorized into performance indicators as well as security indicators (blackberry). This indicator captures whether a sandbox solution is used.

has super-classes Mobile Devices (Blackberry)^c Performance Indicator^c Software resource indicator^c

Sandbox (performance indicators, security indicators (iPhone))^c

IRI: `https://w3id.org/bmontology#MobileDevices_PerformanceIndicators_SecurityIndicatorsIPhone_Sandbox`

This is a performance indicator of the mobile devices service, categorized into performance indicators as well as security indicators (iPhone). This indicator captures whether a sandbox solution is used.

has super-classes Mobile Devices (iPhone)^c Performance Indicator^c Software resource indicator^c

Sandbox (performance indicators, security indicators (other))^c

IRI: `https://w3id.org/bmontology#MobileDevices_PerformanceIndicators_SecurityIndicatorsOther_Sandbox`

This is a performance indicator of the mobile devices service, categorized into performance indicators as well as security indicators (other). This indicator captures whether a sandbox solution is used.

has super-classes Mobile Devices (Others)^c Performance Indicator^c Software resource indicator^c

Sandbox (performance indicators, security indicators (windows phone))^c

IRI: `https://w3id.org/bmontology#MobileDevices_PerformanceIndicators_SecurityIndicatorsWindowsPhone_Sandbox`

This is a performance indicator of the mobile devices service, categorized into performance indicators as well as security indicators (windows phone). This indicator captures whether a sandbox solution is used.

has super-classes Mobile Devices (Windows Phone)^c Performance Indicator^c Software resource indicator^c

SAP basis^c

IRI: `https://w3id.org/bmontology#SAPBasisIndicator`

Classifies SAP basis indicators

has super-classes Service template dimension for indicator classification^c

has sub-classes 24/7 service / regular office hours (performance indicators, quantity structure and performance)^c , Backup strategy (performance indicators, quantity structure and performance)^c , Batch processing (performance indicators, additional information)^c , DB size (performance indicators, additional information)^c , Dialog processing (performance indicators, additional information)^c , Dialog response time (performance indicators, additional information)^c , Ensured availability (performance indicators, quantity structure and performance)^c , External services (cost indicators, total costs)^c , Hardware (cost indicators, total costs)^c , Hardware maintenance (cost indicators, total costs)^c , License costs (cost indicators, total costs)^c , Master data and avoidance of redundancy (performance indicators, quantity structure and performance)^c , Master data central or decentral (performance indicators, quantity structure and performance)^c , Master data management (performance indicators, quantity structure and performance)^c , Modules in use (performance indicators, additional information)^c , Number of Runtime errors (performance indicators, quantity structure and performance)^c , Number of application server (performance indicators, additional information)^c , Number of clients (performance indicators, quantity structure and performance)^c , Number of external personnel (FTE) (performance indicators, quantity structure and performance)^c , Number of full users (performance indicators, quantity structure and performance)^c , Number of internal personnel (FTE) (performance indicators, quantity structure and performance)^c , Number of light users (performance indicators, quantity structure and performance)^c , Number of long running batch processes (performance indicators, quantity structure and performance)^c , Number of system lines (Landscape) (performance indicators, quantity structure and performance)^c , Number of systems (ERP + HR) (performance indicators, quantity structure and performance)^c , Number of systems (Landscape) (performance indicators, quantity structure and performance)^c , Number of sytem lines (ERP + HR) (performance indicators, quantity structure and performance)^c , Offetting backup (cost indicators, total costs)^c , Offsetting Server (cost indicators, total costs)^c , Offsetting Storage (cost indicators, total costs)^c , Others (cost indicators, total costs)^c , Personnel (cost indicators, total costs)^c , RFC processing (performance indicators, additional information)^c , SAPS value (performance indicators, quantity structure and performance)^c , Software (cost indicators, total costs)^c , Software maintenance (cost indicators, total costs)^c , Type of sourcing (performance indicators, quantity structure and performance)^c

is disjoint with Backup^c , Basic data^c , Collaboration^c , Database^c , Dedicated server^c , File Service^c , IMAC^c , LAN^c , Mailbox^c , Mobile devices^c , Remote access service^c , SAP modules^c , Servicedesk^c , Storage^c , Telephony^c , Terminal server^c , Virtual server^c , WAN^c , Workplace^c

SAP modules^c

IRI: `https://w3id.org/bmontology#SAPModulesIndicator`

Classifies SAP module indicators

has super-classes Service template dimension for indicator classification^c

has sub-classes Administration costs (cost indicators, BC: basic system)^c , Administration costs (cost indicators, CS: customer service)^c , Administration costs (cost indicators, EC: corporate controlling)^c , Administration costs (cost indicators, FI: finance)^c , Administration costs (cost indicators, MM: materials management)^c , Administration costs (cost indicators, PM: plant maintenance)^c , Administration costs (cost indicators, PP: production planning and control)^c , Administration costs (cost indicators, SD: sales and distribution)^c , Administration costs (cost indicators, co: controlling)^c , Customer (Number of users) (performance indicators, general)^c , Degree of coverage (performance indicators, general)^c , Degree of maturity SAP ERP (performance indicators, general)^c , Degree of maturity of the module (performance indicators, BC: basic system)^c , Degree of maturity of the module (performance indicators, CS: customer service)^c , Degree of maturity of the module (performance indicators, EC: corporate controlling)^c , Degree of maturity of the module (performance indicators, FI: finance)^c , Degree of maturity of the module (performance indicators, MM: materials management)^c , Degree of maturity of the module (performance indicators, PM: plant maintenance)^c , Degree of maturity of the module (performance indicators, PP: production planning and control)^c , Degree of maturity of the module (performance indicators, SD: sales and distribution)^c , Degree of maturity of the module (performance indicators, co: controlling)^c , Dynamics of changes (performance indicators, general)^c , Effort of external administration (FTE) (performance indicators, BC: basic system)^c , Effort of external administration (FTE) (performance indicators, CS: customer service)^c , Effort of external administration (FTE) (performance indicators, EC: corporate controlling)^c , Effort of external administration (FTE) (performance indicators, FI: finance)^c , Effort of external administration (FTE) (performance indicators, MM: materials management)^c , Effort of external administration (FTE) (performance indicators, PM: plant maintenance)^c , Effort of external administration (FTE) (performance indicators, PP: production planning and control)^c , Effort of external administration (FTE) (performance indicators, SD: sales and distribution)^c , Effort of external administration (FTE) (performance indicators, co: controlling)^c , Effort of external maintenance (FTE) (performance indicators, BC: basic system)^c , Effort of external maintenance (FTE) (performance indicators, CS: customer service)^c , Effort of external maintenance (FTE) (performance indicators, EC: corporate controlling)^c , Effort of external maintenance (FTE) (performance indicators, FI: finance)^c , Effort of external maintenance (FTE) (performance indicators, MM: materials management)^c , Effort of external maintenance (FTE) (performance indicators, PM: plant maintenance)^c , Effort of external maintenance (FTE) (performance indicators, PP: production planning and control)^c , Effort of external maintenance (FTE) (performance indicators, SD: sales and distribution)^c , Effort of external maintenance (FTE) (performance indicators, co: controlling)^c , Effort of in-house development (performance indicators, BC: basic system)^c , Effort of in-house development (performance indicators, CS: customer service)^c , Effort of in-house development (performance indicators, EC: corporate controlling)^c , Effort of in-house development (performance indicators, FI: finance)^c , Effort of in-house development (performance indicators, MM: materials management)^c , Effort of in-house development (performance indicators, PM: plant maintenance)^c , Effort of in-house development (performance indicators, PP: production planning and control)^c , Effort of in-house development (performance indicators, SD: sales and distribution)^c , Effort of in-house development (performance indicators, co: controlling)^c , Effort of internal administration (FTE) (performance indicators, BC: basic system)^c , Effort of internal administration (FTE) (performance indicators, CS: customer service)^c , Effort of internal administration (FTE) (performance indicators, EC: corporate controlling)^c , Effort of internal administration (FTE) (performance indicators, FI: finance)^c , Effort of internal administration (FTE) (performance indicators, MM: materials management)^c , Effort of internal administration (FTE) (performance indicators, PM: plant maintenance)^c , Effort of internal administration (FTE) (performance indicators, PP: production planning and control)^c , Effort of internal administration (FTE) (performance indicators, SD: sales and distribution)^c , Effort of internal administration (FTE) (performance indicators, co: controlling)^c , Effort of internal maintenance (FTE) (performance indicators, BC: basic system)^c , Effort of internal maintenance (FTE) (performance indicators, CS: customer service)^c , Effort of internal maintenance (FTE) (performance indicators, EC: corporate controlling)^c , Effort of internal maintenance (FTE) (performance indicators, FI: finance)^c , Effort of internal maintenance (FTE) (performance indicators, MM: materials management)^c , Effort of internal maintenance (FTE) (performance indicators, PM: plant maintenance)^c , Effort of internal maintenance (FTE) (performance indicators, PP: production planning and control)^c , Effort of internal maintenance (FTE) (performance indicators, SD: sales and distribution)^c , Effort of internal maintenance (FTE) (performance indicators, co: controlling)^c , Further submodules (performance indicators, BC: basic system)^c , Further submodules (performance indicators, CS: customer service)^c , Further submodules (performance indicators, EC: corporate controlling)^c , Further submodules (performance indicators, FI: finance)^c , Further submodules (performance indicators, MM: materials management)^c , Further submodules (performance indicators, PM: plant maintenance)^c , Further submodules (performance indicators, PP: production planning and control)^c , Further submodules (performance indicators, SD: sales and distribution)^c , Further submodules (performance indicators, co: controlling)^c , Governance (performance indicators, general)^c , Interfaces (performance indicators, general)^c , Internationality (performance indicators, general)^c , Is the module used in production (performance indicators, BC: basic system)^c , Is the module used in production (performance indicators, CS: customer service)^c , Is the module used in production (performance indicators, EC: corporate controlling)^c , Is the module used in production (performance indicators, FI: finance)^c , Is the module used in production (performance indicators, MM: materials management)^c , Is the module used in production (performance indicators, PM: plant maintenance)^c , Is the module used in production (performance indicators, PP: production planning and control)^c , Is the module used in production (performance indicators, SD: sales and distribution)^c , Is the module used in production (performance indicators, co: controlling)^c , Maintenance costs (cost indicators, BC: basic system)^c , Maintenance costs (cost indicators, CS: customer service)^c , Maintenance costs (cost indicators, EC: corporate controlling)^c , Maintenance costs (cost indicators, FI: finance)^c , Maintenance costs (cost indicators, MM: materials management)^c , Maintenance costs (cost indicators, PM: plant maintenance)^c , Maintenance costs (cost indicators, PP: production planning and control)^c , Maintenance costs (cost indicators, SD: sales and distribution)^c , Maintenance costs (cost indicators, co: controlling)^c , Module adaption (performance indicators, BC: basic system)^c , Module adaption (performance indicators, CS: customer service)^c , Module adaption (performance indicators, EC: corporate controlling)^c , Module adaption (performance indicators, FI: finance)^c , Module adaption (performance indicators, MM: materials management)^c , Module adaption (performance indicators, PM: plant maintenance)^c , Module adaption (performance indicators, PP: production planning and control)^c , Module adaption (performance indicators, SD: sales and distribution)^c , Module adaption (performance indicators, co: controlling)^c , Number of locations (performance indicators, general)^c , Number of module users (performance indicators, BC: basic system)^c , Number of module users (performance indicators, CS: customer service)^c , Number of module users (performance indicators, EC: corporate controlling)^c , Number of module users (performance indicators, FI: finance)^c , Number of module users (performance indicators, MM: materials management)^c , Number of module users (performance indicators, PM: plant maintenance)^c , Number of module users (performance indicators, PP: production planning and control)^c , Number of module users (performance indicators, SD: sales and distribution)^c , Number of module users (performance indicators, co: controlling)^c

is disjoint with Backup^c , Basic data^c , Collaboration^c , Database^c , Dedicated server^c , File Service^c , IMAC^c , LAN^c , Mailbox^c , Mobile devices^c , Remote access service^c , SAP basis^c , Servicedesk^c , Storage^c , Telephony^c , Terminal server^c , Virtual server^c , WAN^c , Workplace^c

SAPS value (performance indicators, quantity structure and performance)^c

IRI: `https://w3id.org/bmontology#SAPBasis_PerformanceIndicators_QuantityStructureAndPerformance_SAPSValue`

This is a performance indicator of the SAP basis service, categorized into performance indicators as well as quantity structure and performance. This indicator captures the SAPS value (SAP Application Performance Standard).

has super-classes Performance Indicator^c SAP basis^c

Security checks for foreign computers of external employees (performance indicators, additional information)[c]

IRI: `https://w3id.org/bmontology#RemoteAccessService_PerformanceIndicators_AdditionalInformation_SecurityChecksForForeignComputersOfExternalEmployees`

This is a performance indicator of the remote access service service, categorized into performance indicators as well as additional information. This indicator captures whether foreign computers of external employees are checked for security for the purpose of RAS.

has super-classes Performance Indicator[c] Remote access service[c]

Security settings based on a central policy (performance indicators, security indicators (blackberry))[c]

IRI: `https://w3id.org/bmontology#MobileDevices_PerformanceIndicators_SecurityIndicatorsBlackberry_SecuritySettingsBasedOnACentralPolicy`

This is a performance indicator of the mobile devices service, categorized into performance indicators as well as security indicators (blackberry). This indicator captures whether security settings are predefined via a central policy.

has super-classes Mobile Devices (Blackberry)[c] Performance Indicator[c]

Security settings based on a central policy (performance indicators, security indicators (iPhone))[c]

IRI: `https://w3id.org/bmontology#MobileDevices_PerformanceIndicators_SecurityIndicatorsIPhone_SecuritySettingsBasedOnACentralPolicy`

This is a performance indicator of the mobile devices service, categorized into performance indicators as well as security indicators (iPhone). This indicator captures whether security settings are predefined via a central policy.

has super-classes Mobile Devices (iPhone)[c] Performance Indicator[c]

Security settings based on a central policy (performance indicators, security indicators (other))^c

IRI: https://w3id.org/bmontology#MobileDevices_PerformanceIndicators_SecurityIndicatorsOther_SecuritySettingsBasedOnACentralPolicy

This is a performance indicator of the mobile devices service, categorized into performance indicators as well as security indicators (other). This indicator captures whether security settings are predefined via a central policy.

has super-classes Mobile Devices (Others)^c Performance Indicator^c

Security settings based on a central policy (performance indicators, security indicators (windows phone))^c

IRI: https://w3id.org/bmontology#MobileDevices_PerformanceIndicators_SecurityIndicatorsWindowsPhone_SecuritySettingsBasedOnACentralPolicy

This is a performance indicator of the mobile devices service, categorized into performance indicators as well as security indicators (windows phone). This indicator captures whether security settings are predefined via a central policy.

has super-classes Mobile Devices (Windows Phone)^c Performance Indicator^c

Self services (performance indicators, included)^c

IRI: https://w3id.org/bmontology#Servicedesk_PerformanceIndicators_Included_SelfServices

This is a performance indicator of the servicedesk service, categorized into performance indicators as well as included. This indicator captures whether a self service exists within the service desk.

has super-classes Performance Indicator^c Servicedesk^c

Service desk communication (performance indicators, quantity structure and performance)^c

IRI: https://w3id.org/bmontology#Servicedesk_PerformanceIndicators_QuantityStructureAndPerformance_ServiceDeskCommunication

This is a performance indicator of the servicedesk service, categorized into performance indicators as well as quantity structure and performance. This indicator captures how communication with the service desk is done.

has super-classes Performance Indicator^c Servicedesk^c

Service requests (performance indicators, included)^c

IRI: `https://w3id.org/bmontology#Servicedesk_PerformanceIndicators_Included_ServiceRequests`

This is a performance indicator of the servicedesk service, categorized into performance indicators as well as included. This indicator captures whether service requests are processed in the service desk.

has super-classes Performance Indicator^c Servicedesk^c

Service segment questionnaire^c

IRI: `https://w3id.org/bmontology#ITServiceSegment`

Represents a questionnaire classified as service segment

has super-classes Questionnaire of an individual benchmark^c has sub-questionnaire^{op} onlyService segment questionnaire^c

is disjoint with IT service questionnaire^c

Service template dimension for indicator classification^c

IRI: `https://w3id.org/bmontology#ServiceTemplateIndicator`

Classifies indicators based on a service template

has super-classes Indicator^c

has sub-classes Backup^c , Basic data^c , Collaboration^c , Database^c , Dedicated server^c , File Service^c , IMAC^c , LAN^c , Mailbox^c , Mobile devices^c , Remote access service^c , SAP basis^c , SAP modules^c , Servicedesk^c , Storage^c , Telephony^c , Terminal server^c , Virtual server^c , WAN^c , Workplace^c

Servicedesk^{c}

IRI: `https://w3id.org/bmontology#ServicedeskIndicator`

Classifies service desk indicators

has super-classes Service template dimension for indicator classification^{c}

has sub-classes ACD system (performance indicators, technology)^{c} , Availability (performance indicators, service level)^{c} , Dedicated or shared service desk (performance indicators, quantity structure and performance)^{c} , Distribution of tickets (performance indicators, quantity structure and performance)^{c} , External services (cost indicators, total costs)^{c} , First level support (performance indicators, included)^{c} , Interface self service (performance indicators, technology)^{c} , Knowledge management (performance indicators, technology)^{c} , Location of first level support (performance indicators, quantity structure and performance)^{c} , Main scope (performance indicators, quantity structure and performance)^{c} , Maintenance costs service desk tool (cost indicators, total costs)^{c} , Number of employees in service desk management (FTE) (performance indicators, quantity structure and performance)^{c} , Number of incident tickets per year (performance indicators, quantity structure and performance)^{c} , Number of languages (performance indicators, quantity structure and performance)^{c} , Number of service desk agents, first level (FTE) (performance indicators, quantity structure and performance)^{c} , Number of service requests per year (performance indicators, quantity structure and performance)^{c} , Number of supported users (performance indicators, quantity structure and performance)^{c} , Other technologie (performance indicators, technology)^{c} , Others (cost indicators, total costs)^{c} , Personnel employee service desk management (cost indicators, total costs)^{c} , Personnel service desk agents (first level) (cost indicators, total costs)^{c} , Portion of costs in service desk for other modules (cost indicators, total costs)^{c} , Processing of Non-IT services (performance indicators, quantity structure and performance)^{c} , Reporting (performance indicators, technology)^{c} , Response time for calls (performance indicators, service level)^{c} , Response time web service (performance indicators, service level)^{c} , Self services (performance indicators, included)^{c} , Service desk communication (performance indicators, quantity structure and performance)^{c} , Service requests (performance indicators, included)^{c} , Solution rate first level (performance indicators, service level)^{c} , Throughput time first level (performance indicators, service level)^{c} , Ticket system (performance indicators, technology)^{c} , Type of sourcing (performance indicators, quantity structure and performance)^{c} , User management (performance indicators, included)^{c}

is disjoint with Backup^{c} , Basic data^{c} , Collaboration^{c} , Database^{c} , Dedicated server^{c} , File Service^{c} , IMAC^{c} , LAN^{c} , Mailbox^{c} , Mobile devices^{c} , Remote access service^{c} , SAP basis^{c} , SAP modules^{c} , Storage^{c} , Telephony^{c} , Terminal server^{c} , Virtual server^{c} , WAN^{c} , Workplace^{c}

SLA (performance indicators, SSL VPN access)^c

IRI: `https://w3id.org/bmontology#RemoteAccessService_PerformanceIndicators_SSLVPNAccess_SLA`

This is a performance indicator of the remote access service service, categorized into performance indicators as well as SSL VPN access. This indicator captures the SLA for RAS per connection.

has super-classes Quality indicator^c Remote access service^c

SLA (performance indicators, standard mass connection)^c

IRI: `https://w3id.org/bmontology#RemoteAccessService_PerformanceIndicators_StandardMassConnection_SLA`

This is a performance indicator of the remote access service service, categorized into performance indicators as well as standard mass connection. This indicator captures the SLA for RAS per connection.

has super-classes Quality indicator^c Remote access service^c

SLA (performance indicators, VPN client)^c

IRI: `https://w3id.org/bmontology#RemoteAccessService_PerformanceIndicators_VPNClient_SLA`

This is a performance indicator of the remote access service service, categorized into performance indicators as well as VPN client. This indicator captures the SLA for RAS per connection.

has super-classes Quality indicator^c Remote access service^c

SLA (performance indicators, VPN tunel to business partners)^c

IRI: `https://w3id.org/bmontology#RemoteAccessService_PerformanceIndicators_VPNTunelToBusinessPartners_SLA`

This is a performance indicator of the remote access service service, categorized into performance indicators as well as VPN tunel to business partners. This indicator captures the SLA for RAS per connection.

has super-classes Quality indicator^c Remote access service^c

SLA for backup available (performance indicators, quantity structure and performance)^c

IRI: https://w3id.org/bmontology#Backup_PerformanceIndicators_QuantityStructureAndPerformance_SLAForBackupAvailable

This is a performance indicator of the backup service, categorized into performance indicators as well as quantity structure and performance. This indicator captures whether a backup of data is availabl (including the description of a SLA for each backup technology).

has super-classes Backup^c Quality indicator^c

SLA for recovery available (performance indicators, quantity structure and performance)^c

IRI: https://w3id.org/bmontology#Backup_PerformanceIndicators_QuantityStructureAndPerformance_SLAForRecoveryAvailable

This is a performance indicator of the backup service, categorized into performance indicators as well as quantity structure and performance. This indicator captures whether a SLA for recovery is available (including the description of a SLA for each backup technology).

has super-classes Backup^c Quality indicator^c

Social Enterprise Collaboration (performance indicators, tools)^c

IRI: https://w3id.org/bmontology#Collaboration_PerformanceIndicators_Tools_SocialEnterpriseCollaboration

This is a performance indicator of the collaboration service, categorized into performance indicators as well as tools. This indicator captures whether this kind of collaboration is used in the organization.

has super-classes Collaboration^c Performance Indicator^c Software resource indicator^c

Social Media Collaboration (performance indicators, tools)^c

IRI: `https://w3id.org/bmontology#Collaboration_PerformanceIndicators_Tools_SocialMediaCollaboration`

This is a performance indicator of the collaboration service, categorized into performance indicators as well as tools. This indicator captures whether social networks are used for collaboration and whether private usage of social network is allowed.

has super-classes Collaboration^c Performance Indicator^c Software resource indicator^c

Software (cost indicators, active components)^c

IRI: `https://w3id.org/bmontology#LAN_CostIndicators_ActiveComponents_Software`

This is a cost indicator of the LAN service, categorized into cost indicators as well as active components. This indicator captures the software costs for active components, the security monitoring and administration environment and WLAN.

has super-classes Cost Indicator^c LAN^c Software resource indicator^c

Software (cost indicators, blackberry)^c

IRI: `https://w3id.org/bmontology#MobileDevices_CostIndicators_Blackberry_Software`

This is a cost indicator of the mobile devices service, categorized into cost indicators as well as blackberry. This indicator captures the software costs for the mobile devices module.

has super-classes Cost Indicator^c Mobile Devices (Blackberry)^c Software resource indicator^c

Software (cost indicators, classical telephony)^c

IRI: `https://w3id.org/bmontology#Telephony_CostIndicators_ClassicalTelephony_Software`

This is a cost indicator of the telephony service, categorized into cost indicators as well as classical telephony. This indicator captures the software costs for the telephony module.

has super-classes Cost Indicator^c Software resource indicator^c Telephony^c

Software (cost indicators, conferencing (incl. video conferencing tools))^c

IRI: `https://w3id.org/bmontology#Collaboration_CostIndicators_ConferencingInclVideoConferencingTools_Software`

This is a cost indicator of the collaboration service, categorized into cost indicators as well as conferencing (incl. video conferencing tools). This indicator capture the software costs.

has super-classes Collaboration^c Cost Indicator^c Software resource indicator^c

Software (cost indicators, cost indicator (medium))^c

IRI: `https://w3id.org/bmontology#DedicatedServer_CostIndicators_CostIndicatorMedium_Software`

This is a cost indicator of the dedicated server service, categorized into cost indicators as well as cost indicator (medium). This indicator captures the software costs for the dedicated server module.

has super-classes Cost Indicator^c Dedicated server (medium)^c Software resource indicator^c

Software (cost indicators, cost indicators (large))^c

IRI: `https://w3id.org/bmontology#DedicatedServer_CostIndicators_CostIndicatorsLarge_Software`

This is a cost indicator of the dedicated server service, categorized into cost indicators as well as cost indicators (large). This indicator captures the software costs for the dedicated server module.

has super-classes Cost Indicator^c Dedicated server (large)^c Software resource indicator^c

Software (cost indicators, cost indicators (small))^c

IRI: `https://w3id.org/bmontology#DedicatedServer_CostIndicators_CostIndicatorsSmall_Software`

This is a cost indicator of the dedicated server service, categorized into cost indicators as well as cost indicators (small). This indicator captures the software costs for the dedicated server module.

has super-classes Cost Indicator^c Dedicated server (small)^c Software resource indicator^c

Software (cost indicators, cost indicators)^c

IRI: `https://w3id.org/bmontology#Backup_CostIndicators_CostIndicators_Software`

This is a cost indicator of the backup service, categorized into cost indicators as well as cost indicators. This indicator captures the costs for software involved in the backup module.

has super-classes Backup^c Cost Indicator^c Software resource indicator^c

Software (cost indicators, desktop)^c

IRI: `https://w3id.org/bmontology#Workplace_CostIndicators_Desktop_Software`

This is a cost indicator of the workplace service, categorized into cost indicators as well as desktop. This indicator captures the costs of software stack to be compared (Desktop).

has super-classes Cost Indicator^c Software resource indicator^c Workplace^c

Software (cost indicators, high)^c

IRI: `https://w3id.org/bmontology#Storage_CostIndicators_High_Software`

This is a cost indicator of the storage service, categorized into cost indicators as well as high. This indicator captures the costs for software involved in the storage module.

has super-classes Cost Indicator^c Software resource indicator^c Storage (High)^c

Software (cost indicators, iPhone)^c

IRI: `https://w3id.org/bmontology#MobileDevices_CostIndicators_IPhone_Software`

This is a cost indicator of the mobile devices service, categorized into cost indicators as well as iPhone. This indicator captures the software costs for the mobile devices module.

has super-classes Cost Indicator^c Mobile Devices (iPhone)^c Software resource indicator^c

Software (cost indicators, laptop)^c

IRI: `https://w3id.org/bmontology#Workplace_CostIndicators_Laptop_Software`

This is a cost indicator of the workplace service, categorized into cost indicators as well as laptop. This indicator captures the costs of software stack to be compared (Laptop).

has super-classes Cost Indicator^c Software resource indicator^c Workplace^c

Software (cost indicators, low)^c

IRI: `https://w3id.org/bmontology#Storage_CostIndicators_Low_Software`

This is a cost indicator of the storage service, categorized into cost indicators as well as low. This indicator captures the costs for software involved in the storage module.

has super-classes Cost Indicator^c Software resource indicator^c Storage (Low)^c

Software (cost indicators, lync and other applications (without telephony))^c

IRI: `https://w3id.org/bmontology#Collaboration_CostIndicators_LyncAndOtherApplicationsWithoutTelephony_Software`

This is a cost indicator of the collaboration service, categorized into cost indicators as well as lync and other applications (without telephony). This indicator captures the software costs for the collaboration module.

has super-classes Collaboration^c Cost Indicator^c Software resource indicator^c

Software (cost indicators, medium)^c

IRI: `https://w3id.org/bmontology#Storage_CostIndicators_Medium_Software`

This is a cost indicator of the storage service, categorized into cost indicators as well as medium. This indicator captures the costs for software involved in the storage module.

has super-classes Cost Indicator^c Software resource indicator^c Storage (Medium)^c

Software (cost indicators, monitoring and administration environment)^c

IRI: `https://w3id.org/bmontology#LAN_CostIndicators_MonitoringAndAdministrationEnvironment_Software`

This is a cost indicator of the LAN service, categorized into cost indicators as well as monitoring and administration environment. This indicator captures the software costs for active components, security environment, monitoring and administration environment and WLAN.

has super-classes Cost Indicator^c LAN^c Software resource indicator^c

Software (cost indicators, others)^c

IRI: `https://w3id.org/bmontology#MobileDevices_CostIndicators_Others_Software`

This is a cost indicator of the mobile devices service, categorized into cost indicators as well as others. This indicator captures the software costs for the mobile devices module.

has super-classes Cost Indicator^c Mobile Devices (Others)^c Software resource indicator^c

Software (cost indicators, security environment)^c

IRI: `https://w3id.org/bmontology#LAN_CostIndicators_SecurityEnvironment_Software`

This is a cost indicator of the LAN service, categorized into cost indicators as well as security environment. This indicator captures the software costs for active components, security environment, monitoring and administration environment and WLAN.

has super-classes Cost Indicator^c LAN^c Software resource indicator^c

Software (cost indicators, sharePoint and other applications)^c

IRI: `https://w3id.org/bmontology#Collaboration_CostIndicators_SharePointAndOtherApplications_Software`

This is a cost indicator of the collaboration service, categorized into cost indicators as well as sharePoint and other applications. This indicator capture the software costs.

has super-classes Collaboration^c Cost Indicator^c Software resource indicator^c

Software (cost indicators, total costs of guest systems)^c

IRI: `https://w3id.org/bmontology#VirtualServer_CostIndicators_TotalCostsOfGuestSystems_Software`

This is a cost indicator of the virtual server service, categorized into cost indicators as well as total costs of guest systems. This indicator captures the license costs for software at guest systems.

has super-classes Cost Indicator^c Software resource indicator^c Virtual server^c

Software (cost indicators, total costs of host systems)^c

IRI: `https://w3id.org/bmontology#VirtualServer_CostIndicators_TotalCostsOfHostSystems_Software`

This is a cost indicator of the virtual server service, categorized into cost indicators as well as total costs of host systems. This indicator captures the costs for software host systems.

has super-classes Cost Indicator^c Software resource indicator^c Virtual server^c

Software (cost indicators, total costs)^c

IRI: `https://w3id.org/bmontology#FileService_CostIndicators_TotalCosts_Software`

This is a cost indicator of the file service service, categorized into cost indicators as well as total costs. This indicator captures the software costs for the file service module.

has super-classes Cost Indicator^c File Service^c Software resource indicator^c

Software (cost indicators, total costs)^c

IRI: `https://w3id.org/bmontology#Mailbox_CostIndicators_TotalCosts_Software`

This is a cost indicator of the mailbox service, categorized into cost indicators as well as total costs. This indicator captures the software costs for the mailbox module.

has super-classes Cost Indicator^c Mailbox^c Software resource indicator^c

Software (cost indicators, total costs)^c

IRI: `https://w3id.org/bmontology#SAPBasis_CostIndicators_TotalCosts_Software`

This is a cost indicator of the SAP basis service, categorized into cost indicators as well as total costs. This indicator captures the licence costs for software used with SAP.

has super-classes Cost Indicator^c SAP basis^c Software resource indicator^c

Software (cost indicators, total costs)^c

IRI: `https://w3id.org/bmontology#TerminalServer_CostIndicators_TotalCosts_Software`

This is a cost indicator of the terminal server service, categorized into cost indicators as well as total costs. This indicator captures the cost for the terminal server module.

has super-classes Cost Indicator^c Software resource indicator^c Terminal server^c

Software (cost indicators, variant 1 (high availability))^c

IRI: `https://w3id.org/bmontology#Database_CostIndicators_Variant1HighAvailability_Software`

This is a cost indicator of the database service, categorized into cost indicators as well as variant 1 (high availability). This indicator captures the software costs for the database module.

has super-classes Cost Indicator^c Database (Variant 1)^c Software resource indicator^c

Software (cost indicators, variant 2)^c

IRI: `https://w3id.org/bmontology#Database_CostIndicators_Variant2_Software`

This is a cost indicator of the database service, categorized into cost indicators as well as variant 2. This indicator captures the software costs for the database module.

has super-classes Cost Indicator^c Datenbanken (Variante 2)^c Software resource indicator^c

Software (cost indicators, voIP)^c

IRI: `https://w3id.org/bmontology#Telephony_CostIndicators_VoIP_Software`

This is a cost indicator of the telephony service, categorized into cost indicators as well as voIP. This indicator captures the software costs for the telephony module.

has super-classes Cost Indicator^c Software resource indicator^c Telephony^c

Software (cost indicators, windows phone)^c

IRI: `https://w3id.org/bmontology#MobileDevices_CostIndicators_WindowsPhone_Software`

This is a cost indicator of the mobile devices service, categorized into cost indicators as well as windows phone. This indicator captures the software costs for the mobile devices module.

has super-classes Cost Indicator^c Mobile Devices (Windows Phone)^c Software resource indicator^c

Software (cost indicators, WLAN)^c

IRI: `https://w3id.org/bmontology#LAN_CostIndicators_WLAN_Software`

This is a cost indicator of the LAN service, categorized into cost indicators as well as WLAN. This indicator captures the software costs for active components, security environment, monitoring and administration environment and WLAN.

has super-classes Cost Indicator^c LAN^c Software resource indicator^c

Software Asset Management (SAM) (IT and development, basic data)^c

IRI: `https://w3id.org/bmontology#BasicData_ITAndDevelopment_BasicData_SoftwareAssetManagementSAM`

This is an indicator of the basic data service, categorized into IT and development as well as basic data. This indicator captures whether the IT uses a system for software asset management / license management.

has super-classes Basic data^c Software resource indicator^c

Software maintenance (cost indicators, active components)^c

IRI: `https://w3id.org/bmontology#LAN_CostIndicators_ActiveComponents_SoftwareMaintenance`

This is a cost indicator of the LAN service, categorized into cost indicators as well as active components. This indicator captures the costs involved in maintaining software.

has super-classes Cost Indicator^c Human resource indicator^c LAN^c

Software maintenance (cost indicators, blackberry)^c

IRI: `https://w3id.org/bmontology#MobileDevices_CostIndicators_Blackberry_SoftwareMaintenance`

This is a cost indicator of the mobile devices service, categorized into cost indicators as well as blackberry. This indicator captures the costs involved in maintaining software.

has super-classes Cost Indicator^c Human resource indicator^c Mobile Devices (Blackberry)^c

Software maintenance (cost indicators, classical telephony)^c

IRI: `https://w3id.org/bmontology#Telephony_CostIndicators_ClassicalTelephony_SoftwareMaintenance`

This is a cost indicator of the telephony service, categorized into cost indicators as well as classical telephony. This indicator captures the costs involved in maintaining software.

has super-classes Cost Indicator^c Human resource indicator^c Telephony^c

Software maintenance (cost indicators, conferencing (incl. video conferencing tools))^c

IRI: `https://w3id.org/bmontology#Collaboration_CostIndicators_ConferencingInclVideoConferencingTools_SoftwareMaintenance`

This is a cost indicator of the collaboration service, categorized into cost indicators as well as conferencing (incl. video conferencing tools). This indicator captures the costs involved in maintaining software.

has super-classes Collaboration^c Cost Indicator^c Human resource indicator^c

Software maintenance (cost indicators, cost indicator (medium))^c

IRI: `https://w3id.org/bmontology#DedicatedServer_CostIndicators_CostIndicatorMedium_SoftwareMaintenance`

This is a cost indicator of the dedicated server service, categorized into cost indicators as well as cost indicator (medium). This indicator captures the costs involved in maintaining the software for the dedicated server module.

has super-classes Cost Indicator^c Dedicated server (medium)^c Human resource indicator^c

Software maintenance (cost indicators, cost indicators (large))^c

IRI: `https://w3id.org/bmontology#DedicatedServer_CostIndicators_CostIndicatorsLarge_SoftwareMaintenance`

This is a cost indicator of the dedicated server service, categorized into cost indicators as well as cost indicators (large). This indicator captures the costs involved in maintaining the software for the dedicated server module.

has super-classes Cost Indicator^c Dedicated server (large)^c Human resource indicator^c

Software maintenance (cost indicators, cost indicators (small))^c

IRI: `https://w3id.org/bmontology#DedicatedServer_CostIndicators_CostIndicatorsSmall_SoftwareMaintenance`

This is a cost indicator of the dedicated server service, categorized into cost indicators as well as cost indicators (small). This indicator captures the costs involved in maintaining the software for the dedicated server module.

has super-classes Cost Indicator^c Dedicated server (small)^c Human resource indicator^c

Software maintenance (cost indicators, cost indicators)^c

IRI: `https://w3id.org/bmontology#Backup_CostIndicators_CostIndicators_SoftwareMaintenance`

This is a cost indicator of the backup service, categorized into cost indicators as well as cost indicators. This indicator captures the costs involved in maintaining software.

has super-classes Backup^c Cost Indicator^c Human resource indicator^c

Software maintenance (cost indicators, high)^c

IRI: `https://w3id.org/bmontology#Storage_CostIndicators_High_SoftwareMaintenance`

This is a cost indicator of the storage service, categorized into cost indicators as well as high. This indicator captures the costs involved in maintaining the software for the storage module.

has super-classes Cost Indicator^c Human resource indicator^c Storage (High)^c

Software maintenance (cost indicators, iPhone)^c

IRI: https://w3id.org/bmontology#MobileDevices_CostIndicators_IPhone_SoftwareMaintenance

This is a cost indicator of the mobile devices service, categorized into cost indicators as well as iPhone. This indicator captures the costs involved in maintaining software.

has super-classes Cost Indicator^c Human resource indicator^c Mobile Devices (iPhone)^c

Software maintenance (cost indicators, low)^c

IRI: https://w3id.org/bmontology#Storage_CostIndicators_Low_SoftwareMaintenance

This is a cost indicator of the storage service, categorized into cost indicators as well as low. This indicator captures the costs involved in maintaining the software for the storage module.

has super-classes Cost Indicator^c Human resource indicator^c Storage (Low)^c

Software maintenance (cost indicators, lync and other applications (without telephony))^c

IRI: https://w3id.org/bmontology#Collaboration_CostIndicators_LyncAndOtherApplicationsWithoutTelephony_SoftwareMaintenance

This is a cost indicator of the collaboration service, categorized into cost indicators as well as lync and other applications (without telephony). This indicator captures the costs involved in maintaining software.

has super-classes Collaboration^c Cost Indicator^c Human resource indicator^c

Software maintenance (cost indicators, medium)^c

IRI: https://w3id.org/bmontology#Storage_CostIndicators_Medium_SoftwareMaintenance

This is a cost indicator of the storage service, categorized into cost indicators as well as medium. This indicator captures the costs involved in maintaining the software for the storage module.

has super-classes Cost Indicator^c Human resource indicator^c Storage (Medium)^c

Software maintenance (cost indicators, monitoring and administration environment)^c

IRI: `https://w3id.org/bmontology#LAN_CostIndicators_MonitoringAndAdministrationEnvironment_SoftwareMaintenance`

This is a cost indicator of the LAN service, categorized into cost indicators as well as monitoring and administration environment. This indicator captures the costs involved in maintaining software.

has super-classes Cost Indicator^c Human resource indicator^c LAN^c

Software maintenance (cost indicators, others)^c

IRI: `https://w3id.org/bmontology#MobileDevices_CostIndicators_Others_SoftwareMaintenance`

This is a cost indicator of the mobile devices service, categorized into cost indicators as well as others. This indicator captures the costs involved in maintaining software.

has super-classes Cost Indicator^c Human resource indicator^c Mobile Devices (Others)^c

Software maintenance (cost indicators, security environment)^c

IRI: `https://w3id.org/bmontology#LAN_CostIndicators_SecurityEnvironment_SoftwareMaintenance`

This is a cost indicator of the LAN service, categorized into cost indicators as well as security environment. This indicator captures the costs involved in maintaining software.

has super-classes Cost Indicator^c Human resource indicator^c LAN^c

Software maintenance (cost indicators, sharePoint and other applications)^c

IRI: `https://w3id.org/bmontology#Collaboration_CostIndicators_SharePointAndOtherApplications_SoftwareMaintenance`

This is a cost indicator of the collaboration service, categorized into cost indicators as well as sharePoint and other applications. This indicator captures the costs involved in maintaining software.

has super-classes Collaboration^c Cost Indicator^c Human resource indicator^c

Software maintenance (cost indicators, total costs of guest systems)^c

IRI: `https://w3id.org/bmontology#VirtualServer_CostIndicators_TotalCostsOfGuestSystems_SoftwareMaintenance`

This is a cost indicator of the virtual server service, categorized into cost indicators as well as total costs of guest systems. This indicator captures the costs involved in maintaining the software for guest system.

has super-classes Cost Indicator^c Human resource indicator^c Virtual server^c

Software maintenance (cost indicators, total costs of host systems)^c

IRI: `https://w3id.org/bmontology#VirtualServer_CostIndicators_TotalCostsOfHostSystems_SoftwareMaintenance`

This is a cost indicator of the virtual server service, categorized into cost indicators as well as total costs of host systems. This indicator captures the costs involved in maintaining the software for host systems.

has super-classes Cost Indicator^c Human resource indicator^c Virtual server^c

Software maintenance (cost indicators, total costs)^c

IRI: `https://w3id.org/bmontology#FileService_CostIndicators_TotalCosts_SoftwareMaintenance`

This is a cost indicator of the file service service, categorized into cost indicators as well as total costs. This indicator captures the costs of software maintenance.

has super-classes Cost Indicator^c File Service^c Human resource indicator^c

Software maintenance (cost indicators, total costs)^c

IRI: `https://w3id.org/bmontology#Mailbox_CostIndicators_TotalCosts_SoftwareMaintenance`

This is a cost indicator of the mailbox service, categorized into cost indicators as well as total costs. This indicator captures the software maintenance costs for the mailbox module.

has super-classes Cost Indicator^c Human resource indicator^c Mailbox^c

Software maintenance (cost indicators, total costs)^c

IRI: `https://w3id.org/bmontology#SAPBasis_CostIndicators_TotalCosts_SoftwareMaintenance`

This is a cost indicator of the SAP basis service, categorized into cost indicators as well as total costs. This indicator captures the costs involved in maintaining software.

has super-classes Cost Indicator^c Human resource indicator^c SAP basis^c

Software maintenance (cost indicators, total costs)^c

IRI: `https://w3id.org/bmontology#TerminalServer_CostIndicators_TotalCosts_SoftwareMaintenance`

This is a cost indicator of the terminal server service, categorized into cost indicators as well as total costs. This indicator captures the costs involved in maintaining the software for the terminal server module.

has super-classes Cost Indicator^c Human resource indicator^c Terminal server^c

Software maintenance (cost indicators, variant 1 (high availability))^c

IRI: `https://w3id.org/bmontology#Database_CostIndicators_Variant1HighAvailability_SoftwareMaintenance`

This is a cost indicator of the database service, categorized into cost indicators as well as variant 1 (high availability). This indicator captures the costs involved in maintaining software.

has super-classes Cost Indicator^c Database (Variant 1)^c Human resource indicator^c

Software maintenance (cost indicators, variant 2)^c

IRI: `https://w3id.org/bmontology#Database_CostIndicators_Variant2_SoftwareMaintenance`

This is a cost indicator of the database service, categorized into cost indicators as well as variant 2. This indicator captures the costs involved in maintaining software.

has super-classes Cost Indicator^c Datenbanken (Variante 2)^c Human resource indicator^c

Software maintenance (cost indicators, voIP)^c

IRI: `https://w3id.org/bmontology#Telephony_CostIndicators_VoIP_SoftwareMaintenance`

This is a cost indicator of the telephony service, categorized into cost indicators as well as voIP. This indicator captures the costs involved in maintaining software.

has super-classes Cost Indicator^c Human resource indicator^c Telephony^c

Software maintenance (cost indicators, windows phone)^c

IRI: `https://w3id.org/bmontology#MobileDevices_CostIndicators_WindowsPhone_SoftwareMaintenance`

This is a cost indicator of the mobile devices service, categorized into cost indicators as well as windows phone. This indicator captures the costs involved in maintaining software.

has super-classes Cost Indicator^c Human resource indicator^c Mobile Devices (Windows Phone)^c

Software maintenance (cost indicators, WLAN)^c

IRI: `https://w3id.org/bmontology#LAN_CostIndicators_WLAN_SoftwareMaintenance`

This is a cost indicator of the LAN service, categorized into cost indicators as well as WLAN. This indicator captures the costs involved in maintaining software.

has super-classes Cost Indicator^c Human resource indicator^c LAN^c

Software resource indicator^c

IRI: `https://w3id.org/bmontology#SoftwareResourceIndicator`

Classifies software resource indicators

has super-classes Resource dimension for indicator classification^c

has sub-classes ACD system (performance indicators, technology)^c , Backup software (performance indicators, quantity structure and performance)^c , Batch processing (performance indicators, additional information)^c , CRM (performance indicators, quantity structure and performance (blackberry))^c , CRM (performance indicators, quantity structure and performance (iPhone))^c , CRM (performance indicators, quantity structure and performance (other))^c , CRM (performance indicators, quantity structure and performance (windows phone))^c , Client software (cost indicators, SSL VPN access)^c , Client software (cost indicators, VPN client)^c , Client software (cost indicators, VPN tunel to business partners)^c , Client software (cost indicators, standard mass connection)^c , DB size (performance indicators, additional information)^c , Database in use (performance indicators, variant 1 (high availability))^c , Database in use (performance indicators, variant 2)^c , Database systems (performance indicators, variant 1 (high availability))^c , Database systems (performance indicators, variant 2)^c , Document collaboration (performance indicators, tools)^c , IT costs applications (IT costs, basic data)^c , Information about admin environment (performance indicators, performance and architecture)^c , Instant messaging (performance indicators, tools)^c , Introsion detection systems (performance indicators, additional information)^c , Knowledge management (performance indicators, technology)^c , License costs (cost indicators, total costs)^c , Maintenance (cost indicators, desktop)^c , Maintenance (cost indicators, laptop)^c , Maintenance costs service desk tool (cost indicators, total costs)^c , Number of database version (performance indicators, variant 1 (high availability))^c , Number of database version (performance indicators, variant 2)^c , Number of databases (performance indicators, variant 1 (high availability))^c , Number of databases (performance indicators, variant 2)^c , On which platforms are the solutions based? (performance indicators, general indicators)^c , Operating system in use (performance indicators, variant 1 (high availability))^c , Operating system in use (performance indicators, variant 2)^c , Other technologie (performance indicators, technology)^c , Personal Information Management (PIM) (performance indicators, quantity structure and performance (blackberry))^c , Personal Information Management (PIM) (performance indicators, quantity structure and performance (other))^c , Personal Information Management (PIM) (performance indicators, quantity structure and performance (windows phone))^c , Platform (performance indicators, quantity structure and performance (other))^c , Platform (performance indicators, security indicators (other))^c , Platform remote wipe offered (performance indicators, security indicators (blackberry))^c , Reporting (performance indicators, technology)^c , Sandbox (performance indicators, security indicators (blackberry))^c , Sandbox (performance indicators, security indicators (iPhone))^c , Sandbox (performance indicators, security indicators (other))^c , Sandbox (performance indicators, security indicators (windows phone))^c , Social Enterprise Collaboration (performance indicators, tools)^c , Social Media Collaboration (performance indicators, tools)^c , Software (cost indicators, WLAN)^c , Software (cost indicators, active components)^c , Software (cost indicators, blackberry)^c , Software (cost indicators, classical telephony)^c , Software (cost indicators, conferencing (incl. video conferencing tools))^c , Software (cost indicators, cost indicator (medium))^c , Software (cost indicators, cost indicators (large))^c , Software (cost indicators, cost indicators (small))^c , Software (cost indicators, cost indicators)^c , Software (cost indicators, desktop)^c , Software (cost indicators, high)^c , Software (cost indicators, iPhone)^c , Software (cost indicators, laptop)^c , Software (cost indicators, low)^c , Software (cost indicators, lync and other applications (without telephony))^c , Software (cost indicators, medium)^c , Software (cost indicators, monitoring and administration environment)^c , Software (cost indicators, others)^c , Software (cost indicators, security environment)^c , Software (cost indicators, sharePoint and other applications)^c , Software (cost indicators, total costs of guest systems)^c , Software (cost indicators, total costs of host systems)^c , Software (cost indicators, total costs)^c , Software (cost indicators, total costs)^c , Software (cost indicators, total costs)^c , Software (cost indicators, total costs)^c , Software (cost indicators, variant 1 (high availability))^c , Software (cost indicators, variant 2)^c , Software (cost indicators, voIP)^c , Software (cost indicators, windows phone)^c , Software Asset Management (SAM) (IT and development, basic data)^c , Ticket system (performance indicators, technology)^c , Usage of iPass (performance indicators, general indicators)^c , Usage of telephone expense (performance indicators, general indicators)^c , Video conferencing (performance indicators, tools)^c , Virtualization technology in use (performance indicators, guest system)^c , Web meeting (performance indicators, tools)^c

is disjoint with Hardware resource indicator^c , Human resource indicator^c

Solution rate first level (performance indicators, service level)^c

IRI: `https://w3id.org/bmontology#Servicedesk_PerformanceIndicators_ServiceLevel_SolutionRateFirstLevel`

This is a performance indicator of the servicedesk service, categorized into performance indicators as well as service level. This indicator captures the solution rate in first level service.

has super-classes Quality indicator^c Servicedesk^c

Sourcing Platform - Maintenance (performance indicators, others (classical telephony))^c

IRI: `https://w3id.org/bmontology#Telephony_PerformanceIndicators_OthersClassicalTelephony_SourcingPlatformMaintenance`

This is a performance indicator of the telephony service, categorized into performance indicators as well as others (classical telephony). This indicator captures whether processes regarding the platform operation (e.g., administration, monitoring, maintenance, user management, security or performance management) are implemented internally or (partly) outsourced.

has super-classes Performance Indicator^c Telephony^c

Sourcing Platform - Maintenance (performance indicators, sourcing (voIP))^c

IRI: `https://w3id.org/bmontology#Telephony_PerformanceIndicators_SourcingVoIP_SourcingPlatformMaintenance`

This is a performance indicator of the telephony service, categorized into performance indicators as well as sourcing (voIP). This indicator captures whether processes regarding the platform operation (e.g., administration, monitoring, maintenance, user management, security or performance management) are implemented internally or (partly) outsourced.

has super-classes Performance Indicator^c Telephony^c

Sourcing Platform - Provision (performance indicators, others (classical telephony))^c

IRI: `https://w3id.org/bmontology#Telephony_PerformanceIndicators_OthersClassicalTelephony_SourcingPlatformProvision`

This is a performance indicator of the telephony service, categorized into performance indicators as well as others (classical telephony). This indicator captures whether processes regarding the provision of the platform (e.g., installation, configuration) are implemented internally or (partly) outsourced.

has super-classes Performance Indicator^c Telephony^c

Sourcing Platform - Provision (performance indicators, sourcing (voIP))^c

IRI: `https://w3id.org/bmontology#Telephony_PerformanceIndicators_SourcingVoIP_SourcingPlatformProvision`

This is a performance indicator of the telephony service, categorized into performance indicators as well as sourcing (voIP). This indicator captures whether processes regarding the provision of the platform (e.g., installation, configuration) are implemented internally or (partly) outsourced.

has super-classes Performance Indicator^c Telephony^c

Storage^c

IRI: `https://w3id.org/bmontology#StorageIndicator`

Classifies storage indicators

has super-classes Service template dimension for indicator classification^c

has sub-classes Category performance (performance indicators, quantity structure and performance)^c , Ensured availability (performance indicators, quantity structure and performance)^c , Estimated distribution storage architecture DASD (performance indicators, quantity structure and performance)^c , Estimated distribution storage architecture NAS (performance indicators, quantity structure and performance)^c , Estimated distribution storage architecture SAN (performance indicators, quantity structure and performance)^c , Number of external personnel (FTE) (performance indicators, quantity structure and performance)^c , Number of internal personnel (FTE) (performance indicators, quantity structure and performance)^c , Storage (High)^c , Storage (Low)^c , Storage (Medium)^c , Type of sourcing (performance indicators, quantity structure and performance)^c , Usage of snapshot technologies (performance indicators, quantity structure and performance)^c

is disjoint with Backup^c , Basic data^c , Collaboration^c , Database^c , Dedicated server^c , File Service^c , IMAC^c , LAN^c , Mailbox^c , Mobile devices^c , Remote access service^c , SAP basis^c , SAP modules^c , Servicedesk^c , Telephony^c , Terminal server^c , Virtual server^c , WAN^c , Workplace^c

Storage (High)^c

IRI: `https://w3id.org/bmontology#Storage_High_Indicator`

Classifies storage indicators having an availability of 99.9%

has super-classes Storage^c

has sub-classes Computer center levy (cost indicators, high)^c , External services (cost indicators, high)^c , Hardware (cost indicators, high)^c , Hardware maintenance (cost indicators, high)^c , Offsetting Server (cost indicators, high)^c , Operationally used storage volume (performance indicators, quantity structure (high))^c , Others (cost indicators, high)^c , Personnel (cost indicators, high)^c , Software (cost indicators, high)^c , Software maintenance (cost indicators, high)^c , Total capacity (gross) incl. reserves (performance indicators, quantity structure (high))^c , Total capacity (net) incl. reserves (performance indicators, quantity structure (high))^c , Volume reserves (performance indicators, quantity structure (high))^c

Storage (Low)^c

IRI: `https://w3id.org/bmontology#Storage_Low_Indicator`

Classifies storage indicators having an availability of 99%

has super-classes Storage^c

has sub-classes Computer center levy (cost indicators, low)^c , External services (cost indicators, low)^c , Hardware (cost indicators, low)^c , Hardware maintenance (cost indicators, low)^c , Offsetting Server (cost indicators, low)^c , Operationally used storage volume (performance indicators, quantity structure (low))^c , Others (cost indicators, low)^c , Personnel (cost indicators, low)^c , Recovery time in category low (performance indicators, quantity structure and performance)^c , Software (cost indicators, low)^c , Software maintenance (cost indicators, low)^c , Total capacity (gross) incl. reserves (performance indicators, quantity structure (low))^c , Total capacity (net) incl. reserves (performance indicators, quantity structure (low))^c , Volume reserves (performance indicators, quantity structure (low))^c

Storage (Medium)^c

IRI: `https://w3id.org/bmontology#Storage_Medium_Indicator`

Classifies storage indicators having an availability of 99.5%

has super-classes Storage^c

has sub-classes Computer center levy (cost indicators, medium)^c , External services (cost indicators, medium)^c , Hardware (cost indicators, medium)^c , Hardware maintenance (cost indicators, medium)^c , Offsetting Server (cost indicators, medium)^c , Operationally used storage volume (performance indicators, quantity structure (medium))^c , Others (cost indicators, medium)^c , Personnel (cost indicators, medium)^c , Software (cost indicators, medium)^c , Software maintenance (cost indicators, medium)^c , Total capacity (gross) incl. reserves (performance indicators, quantity structure (medium))^c , Total capacity (net) incl. reserves (performance indicators, quantity structure (medium))^c , Volume reserves (performance indicators, quantity structure (medium))^c

Storage internal/external (performance indicators, quantity structure and performance)^c

IRI: `https://w3id.org/bmontology#TerminalServer_PerformanceIndicators_QuantityStructureAndPerformance_StorageInternalexternal`

This is a performance indicator of the terminal server service, categorized into performance indicators as well as quantity structure and performance. This indicator captures whether the storage is internal or external.

has super-classes Hardware resource indicator^c Performance Indicator^c Terminal server^c

Storage period (default) (performance indicators, quantity structure and performance)^c

IRI: `https://w3id.org/bmontology#Backup_PerformanceIndicators_QuantityStructureAndPerformance_StoragePeriodDefault`

This is a performance indicator of the backup service, categorized into performance indicators as well as quantity structure and performance. This indicator captures the default storage period for data.

has super-classes Backup^c Performance Indicator^c

Storage volume (performance indicators, variant 1 (high availability))^c

IRI: `https://w3id.org/bmontology#Database_PerformanceIndicators_Variant1HighAvailability_StorageVolume`

This is a performance indicator of the database service, categorized into performance indicators as well as variant 1 (high availability). This indicator captures the storage volume (total - net) of the database.

has super-classes Database (Variant 1)^c Hardware resource indicator^c Quantity indicator^c

Storage volume (performance indicators, variant 2)^c

IRI: `https://w3id.org/bmontology#Database_PerformanceIndicators_Variant2_StorageVolume`

This is a performance indicator of the database service, categorized into performance indicators as well as variant 2. This indicator captures the storage volume (total - net) of the database.

has super-classes Datenbanken (Variante 2)^c Hardware resource indicator^c Quantity indicator^c

Structure of IT in the organization (performance indicators, basic data)^c

IRI: `https://w3id.org/bmontology#BasicData_PerformanceIndicators_BasicData_StructureOfITInTheOrganization`

This is a performance indicator of the basic data service, categorized into performance indicators as well as basic data. This indicator captures the structure of the IT in an organization.

has super-classes Basic data^c Performance Indicator^c

Sum of backup bandwidth (performance indicators, quantity structure (other countries))^c

IRI: https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureOtherCountries_SumOfBackupBandwidth

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (other countries). This indicator captures the sum of backup bandwidth of the WAN per country/region.

has super-classes Performance Indicator^c WAN^c

Sum of backup bandwidth APA (performance indicators, quantity structure (APA))^c

IRI: https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureAPA_SumOfBackupBandwidthAPA

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (APA). This indicator captures the sum of backup bandwidth of the WAN per country/region.

has super-classes Performance Indicator^c WAN^c

Sum of backup bandwidth Brazil (performance indicators, quantity structure (SA))^c

IRI: https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureSA_SumOfBackupBandwidthBrazil

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (SA). This indicator captures the sum of backup bandwidth of the WAN per country/region.

has super-classes Performance Indicator^c WAN^c

Sum of backup bandwidth China (performance indicators, quantity structure (APA))^c

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureAPA_SumOfBackupBandwidthChina`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (APA). This indicator captures the sum of backup bandwidth of the WAN per country/region.

has super-classes Performance Indicator^c WAN^c

Sum of backup bandwidth EMEA (performance indicators, quantity structure (EMEA))^c

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureEMEA_SumOfBackupBandwidthEMEA`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (EMEA). This indicator captures the sum of backup bandwidth of the WAN per country/region.

has super-classes Performance Indicator^c WAN^c

Sum of backup bandwidth Germany (performance indicators, quantity structure (EMEA))^c

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureEMEA_SumOfBackupBandwidthGermany`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (EMEA). This indicator captures the sum of backup bandwidth of the WAN per country/region.

has super-classes Performance Indicator^c WAN^c

Sum of backup bandwidth India (performance indicators, quantity structure (APA))^c

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureAPA_SumOfBackupBandwidthIndia`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (APA). This indicator captures the sum of backup bandwidth of the WAN per country/region.

has super-classes Performance Indicator^c WAN^c

Sum of backup bandwidth Mexico (performance indicators, quantity structure (NA))^c

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureNA_SumOfBackupBandwidthMexico`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (NA). This indicator captures the sum of backup bandwidth of the WAN per country/region.

has super-classes Performance Indicator^c WAN^c

Sum of backup bandwidth NA (performance indicators, quantity structure (NA))^c

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureNA_SumOfBackupBandwidthNA`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (NA). This indicator captures the sum of backup bandwidth of the WAN per country/region.

has super-classes Performance Indicator^c WAN^c

Sum of backup bandwidth other APA (performance indicators, quantity structure (APA))^c

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureAPA_SumOfBackupBandwidthOtherAPA`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (APA). This indicator captures the sum of backup bandwidth of the WAN per country/region.

has super-classes Performance Indicator^c WAN^c

Sum of backup bandwidth other EMEA (performance indicators, quantity structure (EMEA))^c

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureEMEA_SumOfBackupBandwidthOtherEMEA`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (EMEA). This indicator captures the sum of backup bandwidth of the WAN per country/region.

has super-classes Performance Indicator^c WAN^c

Sum of backup bandwidth other NA (performance indicators, quantity structure (NA))^c

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureNA_SumOfBackupBandwidthOtherNA`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (NA). This indicator captures the sum of backup bandwidth of the WAN per country/region.

has super-classes Performance Indicator^c WAN^c

Sum of backup bandwidth other SA (performance indicators, quantity structure (SA))^c

IRI: https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureSA_SumOfBackupBandwidthOtherSA

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (SA). This indicator captures the sum of backup bandwidth of the WAN per country/region.

has super-classes Performance Indicator^c WAN^c

Sum of backup bandwidth Russia (performance indicators, quantity structure (EMEA))^c

IRI: https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureEMEA_SumOfBackupBandwidthRussia

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (EMEA). This indicator captures the sum of backup bandwidth of the WAN per country/region.

has super-classes Performance Indicator^c WAN^c

Sum of backup bandwidth SA (performance indicators, quantity structure (SA))^c

IRI: https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureSA_SumOfBackupBandwidthSA

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (SA). This indicator captures the sum of backup bandwidth of the WAN per country/region.

has super-classes Performance Indicator^c WAN^c

Sum of backup bandwidth South Africa (performance indicators, quantity structure (EMEA))^c

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureEMEA_SumOfBackupBandwidthSouthAfrica`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (EMEA). This indicator captures the sum of backup bandwidth of the WAN per country/region.

has super-classes Performance Indicator^c WAN^c

Sum of backup bandwidth Turkey (performance indicators, quantity structure (EMEA))^c

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureEMEA_SumOfBackupBandwidthTurkey`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (EMEA). This indicator captures the sum of backup bandwidth of the WAN per country/region.

has super-classes Performance Indicator^c WAN^c

Sum of backup bandwidth USA (performance indicators, quantity structure (NA))^c

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureNA_SumOfBackupBandwidthUSA`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (NA). This indicator captures the sum of backup bandwidth of the WAN per country/region.

has super-classes Performance Indicator^c WAN^c

Sum primary bandwidth (performance indicators, quantity structure (other countries))[c]

IRI: https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureOtherCountries_SumPrimaryBandwidth

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (other countries). This indicator captures the sum of primary bandwidth of the WAN per country/region.

has super-classes Performance Indicator[c] WAN[c]

Sum primary bandwidth APA (performance indicators, quantity structure (APA))[c]

IRI: https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureAPA_SumPrimaryBandwidthAPA

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (APA). This indicator captures the sum of primary bandwidth of the WAN per country/region.

has super-classes Performance Indicator[c] WAN[c]

Sum primary bandwidth Brazil (performance indicators, quantity structure (SA))[c]

IRI: https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureSA_SumPrimaryBandwidthBrazil

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (SA). This indicator captures the sum of primary bandwidth of the WAN per country/region.

has super-classes Performance Indicator[c] WAN[c]

Sum primary bandwidth China (performance indicators, quantity structure (APA))^c

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureAPA_SumPrimaryBandwidthChina`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (APA). This indicator captures the sum of primary bandwidth of the WAN per country/region.

has super-classes Performance Indicator^c WAN^c

Sum primary bandwidth EMEA (performance indicators, quantity structure (EMEA))^c

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureEMEA_SumPrimaryBandwidthEMEA`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (EMEA). This indicator captures the sum of primary bandwidth of the WAN per country/region.

has super-classes Performance Indicator^c WAN^c

Sum primary bandwidth Germany (performance indicators, quantity structure (EMEA))^c

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureEMEA_SumPrimaryBandwidthGermany`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (EMEA). This indicator captures the sum of primary bandwidth of the WAN per country/region.

has super-classes Performance Indicator^c WAN^c

Sum primary bandwidth India (performance indicators, quantity structure (APA))^c

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureAPA_SumPrimaryBandwidthIndia`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (APA). This indicator captures the sum of primary bandwidth of the WAN per country/region.

has super-classes Performance Indicator^c WAN^c

Sum primary bandwidth Mexico (performance indicators, quantity structure (NA))^c

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureNA_SumPrimaryBandwidthMexico`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (NA). This indicator captures the sum of primary bandwidth of the WAN per country/region.

has super-classes Performance Indicator^c WAN^c

Sum primary bandwidth NA (performance indicators, quantity structure (NA))^c

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureNA_SumPrimaryBandwidthNA`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (NA). This indicator captures the sum of primary bandwidth of the WAN per country/region.

has super-classes Performance Indicator^c WAN^c

Sum primary bandwidth other APA (performance indicators, quantity structure (APA))^c

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureAPA_SumPrimaryBandwidthOtherAPA`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (APA). This indicator captures the sum of primary bandwidth of the WAN per country/region.

has super-classes Performance Indicator^c WAN^c

Sum primary bandwidth other EMEA (performance indicators, quantity structure (EMEA))^c

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureEMEA_SumPrimaryBandwidthOtherEMEA`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (EMEA). This indicator captures the sum of primary bandwidth of the WAN per country/region.

has super-classes Performance Indicator^c WAN^c

Sum primary bandwidth other NA (performance indicators, quantity structure (NA))^c

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureNA_SumPrimaryBandwidthOtherNA`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (NA). This indicator captures the sum of primary bandwidth of the WAN per country/region.

has super-classes Performance Indicator^c WAN^c

Sum primary bandwidth other SA (performance indicators, quantity structure (SA))^c

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureSA_SumPrimaryBandwidthOtherSA`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (SA). This indicator captures the sum of primary bandwidth of the WAN per country/region.

has super-classes Performance Indicator^c WAN^c

Sum primary bandwidth Russia (performance indicators, quantity structure (EMEA))^c

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureEMEA_SumPrimaryBandwidthRussia`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (EMEA). This indicator captures the sum of primary bandwidth of the WAN per country/region.

has super-classes Performance Indicator^c WAN^c

Sum primary bandwidth SA (performance indicators, quantity structure (SA))^c

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureSA_SumPrimaryBandwidthSA`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (SA). This indicator captures the sum of primary bandwidth of the WAN per country/region.

has super-classes Performance Indicator^c WAN^c

Sum primary bandwidth South Africa (performance indicators, quantity structure (EMEA))^{c}

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureEMEA_SumPrimaryBandwidthSouthAfrica`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (EMEA). This indicator captures the sum of primary bandwidth of the WAN per country/region.

has super-classes Performance Indicator^{c} WAN^{c}

Sum primary bandwidth Turkey (performance indicators, quantity structure (EMEA))^{c}

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureEMEA_SumPrimaryBandwidthTurkey`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (EMEA). This indicator captures the sum of primary bandwidth of the WAN per country/region.

has super-classes Performance Indicator^{c} WAN^{c}

Sum primary bandwidth USA (performance indicators, quantity structure (NA))^{c}

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureNA_SumPrimaryBandwidthUSA`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure (NA). This indicator captures the sum of primary bandwidth of the WAN per country/region.

has super-classes Performance Indicator^{c} WAN^{c}

Support of users having broken devices (performance indicators, general indicators)[c]

IRI: `https://w3id.org/bmontology#MobileDevices_PerformanceIndicators_GeneralIndicators_SupportOfUsersHavingBrokenDevices`

This is a performance indicator of the mobile devices service, categorized into performance indicators as well as general indicators. This indicator captures the scope of the end device support in case of failure.

has super-classes Mobile devices[c] Performance Indicator[c]

Telephony[c]

IRI: `https://w3id.org/bmontology#TelephonyIndicator`

Classifies telephony indicators

has super-classes Service template dimension for indicator classification[c]

has sub-classes Added value of VoIP (performance indicators, performance information)[c] , External services (cost indicators, classical telephony)[c] , External services (cost indicators, voIP)[c] , Hardware (cost indicators, classical telephony)[c] , Hardware (cost indicators, voIP)[c] , Hardware maintenance (cost indicators, classical telephony)[c] , Hardware maintenance (cost indicators, voIP)[c] , Manufacturer of telephony platform (performance indicators, performance information)[c] , Number of external personnel per platform (FTE) (performance indicators, performance information)[c] , Number of internal personnel per plantform (FTE) (performance indicators, performance information)[c] , Number of maintaned phone numbers (performance indicators, quantity structure (classical telephony))[c] , Number of managed locations (performance indicators, performance information)[c] , Number of managed phone numbers (performance indicators, quantity structure (voIP))[c] , Number of telephony end devices (performance indicators, quantity structure (classical telephony))[c] , Number of telephony end devices (performance indicators, quantity structure (voIP))[c] , Number of users supported from the cental location (performance indicators, quantity structure (classical telephony))[c] , Number of users supported from the cental location (performance indicators, quantity structure (voIP))[c] , Offetting backup (cost indicators, classical telephony)[c] , Offetting backup (cost indicators, voIP)[c] , Offsetting Server (cost indicators, classical telephony)[c] , Offsetting Server (cost indicators, voIP)[c] , Offsetting Storage (cost indicators, classical telephony)[c] , Offsetting Storage (cost indicators, voIP)[c] , Other end devices (performance indicators, others (classical telephony))[c] , Other end devices (performance indicators, sourcing (voIP))[c] , Others (cost indicators, classical telephony)[c] , Others (cost indicators, voIP)[c] , Personnel (cost indicators, classical telephony)[c] , Personnel (cost indicators, voIP)^c , Range of service 'telephony' in other countries (performance indicators, performance information)^c , Software (cost indicators, classical telephony)^c , Software (cost indicators, voIP)^c , Software maintenance (cost indicators, classical telephony)^c , Software maintenance (cost indicators, voIP)^c , Sourcing Platform - Maintenance (performance indicators, others (classical telephony))^c , Sourcing Platform - Maintenance (performance indicators, sourcing (voIP))^c , Sourcing Platform - Provision (performance indicators, others (classical telephony))^c , Sourcing Platform - Provision (performance indicators, sourcing (voIP))^c , Voice over W-LAN in use (performance indicators, performance information)^c

is disjoint with Backup^c , Basic data^c , Collaboration^c , Database^c , Dedicated server^c , File Service^c , IMAC^c , LAN^c , Mailbox^c , Mobile devices^c , Remote access service^c , SAP basis^c , SAP modules^c , Servicedesk^c , Storage^c , Terminal server^c , Virtual server^c , WAN^c , Workplace^c

Terminal server^c

IRI: `https://w3id.org/bmontology#TerminalServerIndicator`

Classifies terminal server indicators

has super-classes Service template dimension for indicator classification^c

has sub-classes Backup strategy (performance indicators, quantity structure and performance)^c , Ensured availability (performance indicators, quantity structure and performance)^c , External services (cost indicators, total costs)^c , Hardware (cost indicators, total costs)^c , Hardware maintenance (cost indicators, total costs)^c , Number of dedicated servers (performance indicators, quantity structure and performance)^c , Number of external personnel (FTE) (performance indicators, quantity structure and performance)^c , Number of guest systems (performance indicators, quantity structure and performance)^c , Number of internal personnel (FTE) (performance indicators, quantity structure and performance)^c , Number of patch cycles per year (performance indicators, quantity structure and performance)^c , Number of physical hosts (performance indicators, quantity structure and performance)^c , Number of users concurrent (performance indicators, quantity structure and performance)^c , Number of users total (performance indicators, quantity structure and performance)^c , Offered services (performance indicators, quantity structure and performance)^c , Offsetting Server (cost indicators, total costs)^c , Offsetting Storage (cost indicators, total costs)^c , Others (cost indicators, total costs)^c , Personnel (cost indicators, total costs)^c , Software (cost indicators, total costs)^c , Software maintenance (cost indicators, total costs)^c , Storage internal/external (performance indicators, quantity structure and performance)^c , Type of sourcing (performance indicators, quantity structure and performance)^c

is disjoint with Backup^c , Basic data^c , Collaboration^c , Database^c , Dedicated server^c , File Service^c , IMAC^c , LAN^c , Mailbox^c , Mobile devices^c , Remote access service^c

, SAP basis^c , SAP modules^c , Servicedesk^c , Storage^c , Telephony^c , Virtual server^c , WAN^c , Workplace^c

Throughput time first level (performance indicators, service level)^c

IRI: https://w3id.org/bmontology#Servicedesk_PerformanceIndicators_ServiceLevel_ThroughputTimeFirstLevel

This is a performance indicator of the servicedesk service, categorized into performance indicators as well as service level. This indicator captures the average processing time of a ticket (recording to solution by the first level support).

has super-classes Quality indicator^c Servicedesk^c

Ticket system (performance indicators, technology)^c

IRI: https://w3id.org/bmontology#Servicedesk_PerformanceIndicators_Technology_TicketSystem

This is a performance indicator of the servicedesk service, categorized into performance indicators as well as technology. This indicator captures the ticket sytem which is used within the organization.

has super-classes Performance Indicator^c Servicedesk^c Software resource indicator^c

Time for service providers (performance indicators, service level of IMAC processes)^c

IRI: https://w3id.org/bmontology#IMAC_PerformanceIndicators_ServiceLevelOfIMACProcesses_TimeForServiceProviders

This is a performance indicator of the IMAC service, categorized into performance indicators as well as service level of IMAC processes. This indicator captures the number of days the service provider may take to complete the action (seperated by install, move, add, change).

has super-classes IMAC^c Quality indicator^c

Total area of computer centers (data center levy, basic data)[c]

IRI: `https://w3id.org/bmontology#BasicData_DataCenterLevy_BasicData_TotalAreaOfComputerCenters`

This is an indicator of the basic data service, categorized into data center levy as well as basic data. This indicator captures the total area of computer centers (square meters).

has super-classes Basic data[c] Hardware resource indicator[c]

Total capacity (gross) incl. reserves (performance indicators, quantity structure (high))[c]

IRI: `https://w3id.org/bmontology#Storage_PerformanceIndicators_QuantityStructureHigh_TotalCapacityGrossInclReserves`

This is a performance indicator of the storage service, categorized into performance indicators as well as quantity structure (high). This indicator captures the total capacity of storage in TiB per indicator group.

has super-classes Hardware resource indicator[c] Quantity indicator[c] Storage (High)[c]

Total capacity (gross) incl. reserves (performance indicators, quantity structure (low))[c]

IRI: `https://w3id.org/bmontology#Storage_PerformanceIndicators_QuantityStructureLow_TotalCapacityGrossInclReserves`

This is a performance indicator of the storage service, categorized into performance indicators as well as quantity structure (low). This indicator captures the total capacity of storage in TiB per indicator group.

has super-classes Hardware resource indicator[c] Quantity indicator[c] Storage (Low)[c]

Total capacity (gross) incl. reserves (performance indicators, quantity structure (medium))[c]

IRI: `https://w3id.org/bmontology#Storage_PerformanceIndicators_QuantityStructureMedium_TotalCapacityGrossInclReserves`

This is a performance indicator of the storage service, categorized into performance indicators as well as quantity structure (medium). This indicator captures the total capacity of storage in TiB per indicator group.

has super-classes Hardware resource indicator^c Quantity indicator^c Storage (Medium)^c

Total capacity (net) (performance indicators, quantity structure)^c

IRI: `https://w3id.org/bmontology#FileService_PerformanceIndicators_QuantityStructure_TotalCapacityNet`

This is a performance indicator of the file service service, categorized into performance indicators as well as quantity structure. This indicator captures the total capacity of storage in GiB reserved for file server.

has super-classes File Service^c Hardware resource indicator^c Quantity indicator^c

Total capacity (net) incl. reserves (performance indicators, quantity structure (high))^c

IRI: `https://w3id.org/bmontology#Storage_PerformanceIndicators_QuantityStructureHigh_TotalCapacityNetInclReserves`

This is a performance indicator of the storage service, categorized into performance indicators as well as quantity structure (high). This indicator captures the total capacity of storage in TiB per indicator group.

has super-classes Hardware resource indicator^c Quantity indicator^c Storage (High)^c

Total capacity (net) incl. reserves (performance indicators, quantity structure (low))^c

IRI: `https://w3id.org/bmontology#Storage_PerformanceIndicators_QuantityStructureLow_TotalCapacityNetInclReserves`

This is a performance indicator of the storage service, categorized into performance indicators as well as quantity structure (low). This indicator captures the total capacity of storage in TiB per indicator group.

has super-classes Hardware resource indicator^c Quantity indicator^c Storage (Low)^c

Total capacity (net) incl. reserves (performance indicators, quantity structure (medium))^c

IRI: `https://w3id.org/bmontology#Storage_PerformanceIndicators_QuantityStructureMedium_TotalCapacityNetInclReserves`

This is a performance indicator of the storage service, categorized into performance indicators as well as quantity structure (medium). This indicator captures the total capacity of storage in TiB per indicator group.

has super-classes Hardware resource indicator^c Quantity indicator^c Storage (Medium)^c

Total costs per computer center (data center levy, basic data)^c

IRI: `https://w3id.org/bmontology#BasicData_DataCenterLevy_BasicData_TotalCostsPerComputerCenter`

This is a cost indicator of the basic data service, categorized into data center levy as well as basic data. This indicator captures the total costs of the computer centers.

has super-classes Basic data^c Cost Indicator^c Human resource indicator^c

Total disk storage (performance indicators, guest system)^c

IRI: `https://w3id.org/bmontology#VirtualServer_PerformanceIndicators_GuestSystem_TotalDiskStorage`

This is a performance indicator of the virtual server service, categorized into performance indicators as well as guest system. This indicator captures the total size of the assigned disc storage of guest systems.

has super-classes Hardware resource indicator^c Quantity indicator^c Virtual server^c

Total disk storage (performance indicators, host systems)^c

IRI: `https://w3id.org/bmontology#VirtualServer_PerformanceIndicators_HostSystems_TotalDiskStorage`

This is a performance indicator of the virtual server service, categorized into performance indicators as well as host systems. This indicator captures the total size of the assigned disc storage of host systems.

has super-classes Hardware resource indicator^c Quantity indicator^c Virtual server^c

Total main memory (RAM) (performance indicators, host systems)^c

IRI: `https://w3id.org/bmontology#VirtualServer_PerformanceIndicators_HostSystems_TotalMainMemoryRAM`

This is a performance indicator of the virtual server service, categorized into performance indicators as well as host systems. This indicator captures the total size of the main memory of host systems used for logical systems.

has super-classes Hardware resource indicator^c Quantity indicator^c Virtual server^c

Total number of virtual cores (performance indicators, guest system)^c

IRI: `https://w3id.org/bmontology#VirtualServer_PerformanceIndicators_GuestSystem_TotalNumberOfVirtualCores`

This is a performance indicator of the virtual server service, categorized into performance indicators as well as guest system. This indicator captures the number of all virtual core available to guest systems.

has super-classes Quantity indicator^c Virtual server^c

Total size of assigned RAM (performance indicators, guest system)^c

IRI: `https://w3id.org/bmontology#VirtualServer_PerformanceIndicators_GuestSystem_TotalSizeOfAssignedRAM`

This is a performance indicator of the virtual server service, categorized into performance indicators as well as guest system. This indicator captures the total size of assigned RAM for all guest systems.

has super-classes Hardware resource indicator^c Quantity indicator^c Virtual server^c

Total storage size of mailboxes (performance indicators, quantity structure)^c

IRI: `https://w3id.org/bmontology#Mailbox_PerformanceIndicators_QuantityStructure_TotalStorageSizeOfMailboxes`

This is a performance indicator of the mailbox service, categorized into performance indicators as well as quantity structure. This indicator captures how much storage is required in total.

has super-classes Mailbox^c Quantity indicator^c

Type dimension for indicator classification^c

IRI: `https://w3id.org/bmontology#TypeIndicator`

Classifies indicators based on its type

is equivalent to Cost Indicator^c orPerformance Indicator^c

has super-classes Indicator^c

has sub-classes Cost Indicator^c , Performance Indicator^c

Type of service delivery (performance indicators, quantity structure and performance (blackberry))^c

IRI: `https://w3id.org/bmontology#MobileDevices_PerformanceIndicators_QuantityStructureAndPerformanceBlackberry_TypeOfServiceDelivery`

This is a performance indicator of the mobile devices service, categorized into performance indicators as well as quantity structure and performance (blackberry). This indicator captures the type of service provision.

has super-classes Mobile Devices (Blackberry)^c Performance Indicator^c

Type of service delivery (performance indicators, quantity structure and performance (iPhone))^c

IRI: `https://w3id.org/bmontology#MobileDevices_PerformanceIndicators_QuantityStructureAndPerformanceIPhone_TypeOfServiceDelivery`

This is a performance indicator of the mobile devices service, categorized into performance indicators as well as quantity structure and performance (iPhone). This indicator captures the type of service provision.

has super-classes Mobile Devices (iPhone)^c Performance Indicator^c

Type of service delivery (performance indicators, quantity structure and performance (other))^c

IRI: `https://w3id.org/bmontology#MobileDevices_PerformanceIndicators_QuantityStructureAndPerformanceOther_TypeOfServiceDelivery`

This is a performance indicator of the mobile devices service, categorized into performance indicators as well as quantity structure and performance (other). This indicator captures the type of service provision.

has super-classes Mobile Devices (Others)^c Performance Indicator^c

Type of service delivery (performance indicators, quantity structure and performance (windows phone))^c

IRI: `https://w3id.org/bmontology#MobileDevices_PerformanceIndicators_QuantityStructureAndPerformanceWindowsPhone_TypeOfServiceDelivery`

This is a performance indicator of the mobile devices service, categorized into performance indicators as well as quantity structure and performance (windows phone). This indicator captures the type of service provision.

has super-classes Mobile Devices (Windows Phone)^c Performance Indicator^c

Type of sourcing (performance indicators, additional information)^c

IRI: `https://w3id.org/bmontology#LAN_PerformanceIndicators_AdditionalInformation_TypeOfSourcing`

This is a performance indicator of the LAN service, categorized into performance indicators as well as additional information. This indicator captures the type of service provision of the module.

has super-classes LAN^c Performance Indicator^c

Type of sourcing (performance indicators, additional information)^c

IRI: `https://w3id.org/bmontology#RemoteAccessService_PerformanceIndicators_AdditionalInformation_TypeOfSourcing`

This is a performance indicator of the remote access service service, categorized into performance indicators as well as additional information. This indicator captures the type of service provision of the module.

has super-classes Performance Indicator^c Remote access service^c

Type of sourcing (performance indicators, cross-system)^c

IRI: `https://w3id.org/bmontology#VirtualServer_PerformanceIndicators_CrossSystem_TypeOfSourcing`

This is a performance indicator of the virtual server service, categorized into performance indicators as well as cross-system. This indicator captures the type of service provision of the module.

has super-classes Performance Indicator^c Virtual server^c

Type of sourcing (performance indicators, performance indicators)^c

IRI: `https://w3id.org/bmontology#IMAC_PerformanceIndicators_PerformanceIndicators_TypeOfSourcing`

This is a performance indicator of the IMAC service, categorized into performance indicators as well as performance indicators. This indicator captures the type of service provision of the module.

has super-classes IMAC^c Performance Indicator^c

Type of sourcing (performance indicators, quantity structure (large))^c

IRI: `https://w3id.org/bmontology#DedicatedServer_PerformanceIndicators_QuantityStructureLarge_TypeOfSourcing`

This is a performance indicator of the dedicated server service, categorized into performance indicators as well as quantity structure (large). This indicator captures the type of service provision of the module.

has super-classes Dedicated server (large)^c Performance Indicator^c

Type of sourcing (performance indicators, quantity structure (medium))^c

IRI: `https://w3id.org/bmontology#DedicatedServer_PerformanceIndicators_QuantityStructureMedium_TypeOfSourcing`

This is a performance indicator of the dedicated server service, categorized into performance indicators as well as quantity structure (medium). This indicator captures the type of service provision of the module.

has super-classes Dedicated server (medium)^c Performance Indicator^c

Type of sourcing (performance indicators, quantity structure (small))^c

IRI: `https://w3id.org/bmontology#DedicatedServer_PerformanceIndicators_QuantityStructureSmall_TypeOfSourcing`

This is a performance indicator of the dedicated server service, categorized into performance indicators as well as quantity structure (small). This indicator captures the type of service provision of the module.

has super-classes Dedicated server (small)^c Performance Indicator^c

Type of sourcing (performance indicators, quantity structure and performance)^c

IRI: `https://w3id.org/bmontology#Backup_PerformanceIndicators_QuantityStructureAndPerformance_TypeOfSourcing`

This is a performance indicator of the backup service, categorized into performance indicators as well as quantity structure and performance. This indicator captures the type of service provision of the module.

has super-classes Backup^c Performance Indicator^c

Type of sourcing (performance indicators, quantity structure and performance)^c

IRI: `https://w3id.org/bmontology#SAPBasis_PerformanceIndicators_QuantityStructureAndPerformance_TypeOfSourcing`

This is a performance indicator of the SAP basis service, categorized into performance indicators as well as quantity structure and performance. This indicator captures the type of service provision of the module.

has super-classes Performance Indicator^c SAP basis^c

Type of sourcing (performance indicators, quantity structure and performance)^c

IRI: `https://w3id.org/bmontology#Servicedesk_PerformanceIndicators_QuantityStructureAndPerformance_TypeOfSourcing`

This is a performance indicator of the servicedesk service, categorized into performance indicators as well as quantity structure and performance. This indicator captures the type of service provision of the module.

has super-classes Performance Indicator^c Servicedesk^c

Type of sourcing (performance indicators, quantity structure and performance)^c

IRI: `https://w3id.org/bmontology#Storage_PerformanceIndicators_QuantityStructureAndPerformance_TypeOfSourcing`

This is a performance indicator of the storage service, categorized into performance indicators as well as quantity structure and performance. This indicator captures the type of service provision of the module.

has super-classes Performance Indicator^c Storage^c

Type of sourcing (performance indicators, quantity structure and performance)^c

IRI: `https://w3id.org/bmontology#TerminalServer_PerformanceIndicators_QuantityStructureAndPerformance_TypeOfSourcing`

This is a performance indicator of the terminal server service, categorized into performance indicators as well as quantity structure and performance. This indicator captures the type of service provision of the module.

has super-classes Performance Indicator^c Terminal server^c

Type of sourcing (performance indicators, quantity structure and performance)^c

IRI: `https://w3id.org/bmontology#Workplace_PerformanceIndicators_QuantityStructureAndPerformance_TypeOfSourcing`

This is a performance indicator of the workplace service, categorized into performance indicators as well as quantity structure and performance. This indicator captures the type of service provision of the module.

has super-classes Performance Indicator^c Workplace^c

Type of sourcing (performance indicators, quantity structure)^c

IRI: `https://w3id.org/bmontology#FileService_PerformanceIndicators_QuantityStructure_TypeOfSourcing`

This is a performance indicator of the file service service, categorized into performance indicators as well as quantity structure. This indicator captures the type of service provision of the module.

has super-classes File Service^c Performance Indicator^c

Type of sourcing (performance indicators, quantity structure)^c

IRI: `https://w3id.org/bmontology#Mailbox_PerformanceIndicators_QuantityStructure_TypeOfSourcing`

This is a performance indicator of the mailbox service, categorized into performance indicators as well as quantity structure. This indicator captures the type of service provision of the module.

has super-classes Mailbox^c Performance Indicator^c

Type of sourcing (performance indicators, variant 1 (high availability))^c

IRI: `https://w3id.org/bmontology#Database_PerformanceIndicators_Variant1HighAvailability_TypeOfSourcing`

This is a performance indicator of the database service, categorized into performance indicators as well as variant 1 (high availability). This indicator captures the type of service provision of the module.

has super-classes Database (Variant 1)^c Performance Indicator^c

Type of sourcing (performance indicators, variant 2)^c

IRI: `https://w3id.org/bmontology#Database_PerformanceIndicators_Variant2_TypeOfSourcing`

This is a performance indicator of the database service, categorized into performance indicators as well as variant 2. This indicator captures the type of service provision of the module.

has super-classes Datenbanken (Variante 2)^c Performance Indicator^c

Types of tape drives (performance indicators, quantity structure and performance)^c

IRI: `https://w3id.org/bmontology#Backup_PerformanceIndicators_QuantityStructureAndPerformance_TypesOfTapeDrives`

This is a performance indicator of the backup service, categorized into performance indicators as well as quantity structure and performance. This indicator captures the tape drive types that are used in the organization.

has super-classes Backup^c Hardware resource indicator^c Performance Indicator^c

Usage of BLOB files (performance indicators, variant 1 (high availability))^c

IRI: `https://w3id.org/bmontology#Database_PerformanceIndicators_Variant1HighAvailability_UsageOfBLOBFiles`

This is a performance indicator of the database service, categorized into performance indicators as well as variant 1 (high availability). This indicator captures whether BLOB files may be stored in the database.

has super-classes Database (Variant 1)^c Performance Indicator^c

Usage of BLOB files (performance indicators, variant 2)^c

IRI: `https://w3id.org/bmontology#Database_PerformanceIndicators_Variant2_UsageOfBLOBFiles`

This is a performance indicator of the database service, categorized into performance indicators as well as variant 2. This indicator captures whether BLOB files may be stored in the database.

has super-classes Datenbanken (Variante 2)^c Performance Indicator^c

Usage of iPass (performance indicators, general indicators)^c

IRI: `https://w3id.org/bmontology#MobileDevices_PerformanceIndicators_GeneralIndicators_UsageOfIPass`

This is a performance indicator of the mobile devices service, categorized into performance indicators as well as general indicators. This indicator capture whether iPass or similar technologies are used for the mobile internet connection.

has super-classes Mobile devices^c Performance Indicator^c Software resource indicator^c

Usage of snapshot technologies (performance indicators, quantity structure and performance)^c

IRI: `https://w3id.org/bmontology#Storage_PerformanceIndicators_QuantityStructureAndPerformance_UsageOfSnapshotTechnologies`

This is a performance indicator of the storage service, categorized into performance indicators as well as quantity structure and performance. This indicator captures the used snapshot technology.

has super-classes Performance Indicator^c Storage^c

Usage of snapshots of primary storage for restore (performance indicators, quantity structure and performance)^c

IRI: `https://w3id.org/bmontology#Backup_PerformanceIndicators_QuantityStructureAndPerformance_UsageOfSnapshotsOfPrimaryStorageForRestore`

This is a performance indicator of the backup service, categorized into performance indicators as well as quantity structure and performance. This indicator captures whether snapshots are ued in the primary storage.

has super-classes Backup^c Performance Indicator^c

Usage of telephone expense (performance indicators, general indicators)^c

IRI: `https://w3id.org/bmontology#MobileDevices_PerformanceIndicators_GeneralIndicators_UsageOfTelephoneExpense`

This is a performance indicator of the mobile devices service, categorized into performance indicators as well as general indicators. This indicator captures whether a telephone expense is used for the internal administration of contracts.

has super-classes Mobile devices^c Performance Indicator^c Software resource indicator^c

Usage scenarios (performance indicators, conferencing (incl. video conferencing tools))^c

IRI: `https://w3id.org/bmontology#Collaboration_PerformanceIndicators_ConferencingInclVideoConferencingTools_UsageScenarios`

This is a performance indicator of the collaboration service, categorized into performance indicators as well as conferencing (incl. video conferencing tools). This indicator captures the type of usage for this kind of collaboration tool.

has super-classes Collaboration^c Performance Indicator^c

Usage scenarios (performance indicators, lync and other applications (without telephony))^c

IRI: `https://w3id.org/bmontology#Collaboration_PerformanceIndicators_LyncAndOtherApplicationsWithoutTelephony_UsageScenarios`

This is a performance indicator of the collaboration service, categorized into performance indicators as well as lync and other applications (without telephony). This indicator captures the type of usage for this kind of collaboration tool.

has super-classes Collaboration^c Performance Indicator^c

Usage scenarios (performance indicators, sharePoint and other applications)^c

IRI: `https://w3id.org/bmontology#Collaboration_PerformanceIndicators_SharePointAndOtherApplications_UsageScenarios`

This is a performance indicator of the collaboration service, categorized into performance indicators as well as sharePoint and other applications. This indicator captures the type of usage for this kind of collaboration tool.

has super-classes Collaboration^c Performance Indicator^c

Usage WAN (performance indicators, quantity structure and performance)^{c}

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureAndPerformance_UsageWAN`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure and performance. This indicator captures for which purpses the WAN is mainly used.

has super-classes Performance Indicator^{c} WAN^{c}

Used capacity (performance indicators, quantity structure)^{c}

IRI: `https://w3id.org/bmontology#FileService_PerformanceIndicators_QuantityStructure_UsedCapacity`

This is a performance indicator of the file service service, categorized into performance indicators as well as quantity structure. This indicator captures the capacity used for file services.

has super-classes File Service^{c} Quantity indicator^{c}

User management (performance indicators, included)^{c}

IRI: `https://w3id.org/bmontology#Servicedesk_PerformanceIndicators_Included_UserManagement`

This is a performance indicator of the servicedesk service, categorized into performance indicators as well as included. This indicator captures whether a reduced user management is used within the service desk.

has super-classes Performance Indicator^{c} Servicedesk^{c}

Video conferencing (performance indicators, tools)^{c}

IRI: `https://w3id.org/bmontology#Collaboration_PerformanceIndicators_Tools_VideoConferencing`

This is a performance indicator of the collaboration service, categorized into performance indicators as well as tools. This indicator captures whether this kind of collaboration is used in the organization.

has super-classes Collaboration^c Performance Indicator^c Software resource indicator^c

Virtual server^c

IRI: `https://w3id.org/bmontology#VirtualServerIndicator`

Classifies virtual server indicators

has super-classes Service template dimension for indicator classification^c

has sub-classes Backup strategy (performance indicators, cross-system)^c , Computer center levy (cost indicators, total costs of host systems)^c , Degree of virtualization (performance indicators, cross-system)^c , Ensured availability (performance indicators, cross-system)^c , External services (cost indicators, total costs of guest systems)^c , External services (cost indicators, total costs of host systems)^c , Factor of redundancy (performance indicators, host systems)^c , Hardware (cost indicators, total costs of host systems)^c , Hardware maintenance (cost indicators, total costs of host systems)^c , Installation supported by automation (performance indicators, cross-system)^c , Number of cores (performance indicators, host systems)^c , Number of external personnel (FTE) (performance indicators, cross-system)^c , Number of guest systems (performance indicators, guest system)^c , Number of internal personnel (FTE) (performance indicators, cross-system)^c , Number of physical hosts in the server farm (performance indicators, host systems)^c , Number of used operation systems (performance indicators, cross-system)^c , Others (cost indicators, total costs of guest systems)^c , Others (cost indicators, total costs of host systems)^c , Personnel (cost indicators, total costs of guest systems)^c , Personnel (cost indicators, total costs of host systems)^c , Software (cost indicators, total costs of guest systems)^c , Software (cost indicators, total costs of host systems)^c , Software maintenance (cost indicators, total costs of guest systems)^c , Software maintenance (cost indicators, total costs of host systems)^c , Total disk storage (performance indicators, guest system)^c , Total disk storage (performance indicators, host systems)^c , Total main memory (RAM) (performance indicators, host systems)^c , Total number of virtual cores (performance indicators, guest system)^c , Total size of assigned RAM (performance indicators, guest system)^c , Type of sourcing (performance indicators, cross-system)^c , Virtualization technology in use (performance indicators, guest system)^c

is disjoint with Backup^c , Basic data^c , Collaboration^c , Database^c , Dedicated server^c , File Service^c , IMAC^c , LAN^c , Mailbox^c , Mobile devices^c , Remote access service^c , SAP basis^c , SAP modules^c , Servicedesk^c , Storage^c , Telephony^c , Terminal server^c , WAN^c , Workplace^c

Virtualization technology in use (performance indicators, guest system)^c

IRI: `https://w3id.org/bmontology#VirtualServer_PerformanceIndicators_GuestSystem_VirtualizationTechnologyInUse`

This is a performance indicator of the virtual server service, categorized into performance indicators as well as guest system. This indicator captures the used virtualization technology.

has super-classes Performance Indicator^c Software resource indicator^c Virtual server^c

Voice over W-LAN in use (performance indicators, performance information)^c

IRI: `https://w3id.org/bmontology#Telephony_PerformanceIndicators_PerformanceInformation_VoiceOverWLANInUse`

This is a performance indicator of the telephony service, categorized into performance indicators as well as performance information. This indicator captures whether telephony using Voice over WLAN is used in the organization.

has super-classes Performance Indicator^c Telephony^c

Voice over WLAN (performance indicators, WLAN)^c

IRI: `https://w3id.org/bmontology#LAN_PerformanceIndicators_WLAN_VoiceOverWLAN`

This is a performance indicator of the LAN service, categorized into performance indicators as well as WLAN. This indicator captures whether Voice over WLAN is used.

has super-classes LAN^c Performance Indicator^c

Volume reserves (performance indicators, quantity structure (high))^c

IRI: `https://w3id.org/bmontology#Storage_PerformanceIndicators_QuantityStructureHigh_VolumeReserves`

This is a performance indicator of the storage service, categorized into performance indicators as well as quantity structure (high). This indicator captures the total reserved volume of storage in TiB per indicator group.

has super-classes Quantity indicator^c Storage (High)^c

Volume reserves (performance indicators, quantity structure (low))^c

IRI: `https://w3id.org/bmontology#Storage_PerformanceIndicators_QuantityStructureLow_VolumeReserves`

This is a performance indicator of the storage service, categorized into performance indicators as well as quantity structure (low). This indicator captures the total reserved volume of storage in TiB per indicator group.

has super-classes Quantity indicator^c Storage (Low)^c

Volume reserves (performance indicators, quantity structure (medium))^c

IRI: `https://w3id.org/bmontology#Storage_PerformanceIndicators_QuantityStructureMedium_VolumeReserves`

This is a performance indicator of the storage service, categorized into performance indicators as well as quantity structure (medium). This indicator captures the total reserved volume of storage in TiB per indicator group.

has super-classes Quantity indicator^c Storage (Medium)^c

WAN^c

IRI: `https://w3id.org/bmontology#WANIndicator`

Classifies WAN indicators

has super-classes Service template dimension for indicator classification^c

has sub-classes Bandwidth management (performance indicators, quantity structure and performance)^c , Contract term WAN (performance indicators, quantity structure and performance)^c , Costs APA (cost indicators, WAN APA)^c , Costs Brazil (cost indicators, WAN SA)^c , Costs China (cost indicators, WAN APA)^c , Costs EMEA (cost indicators, WAN EMEA)^c , Costs Germany (cost indicators, WAN EMEA)^c , Costs India (cost indicators, WAN APA)^c , Costs Mexico (cost indicators, WAN NA)^c , Costs NA (cost indicators, WAN NA)^c , Costs Russia (cost indicators, WAN EMEA)^c , Costs SA (cost indicators, WAN SA)^c , Costs South Africa (cost indicators, WAN EMEA)^c , Costs Turkey (cost indicators, WAN EMEA)^c , Costs USA (cost indicators, WAN NA)^c , Costs other APA (cost indicators, WAN APA)^c , Costs other EMEA (cost indicators, WAN EMEA)^c , Costs other NA (cost indicators, WAN NA)^c , Costs other SA (cost indicators, WAN SA)^c , Costs other countries (cost indicators, WAN other countries)^c , Number of external personnel (FTE) (performance indicators, quantity structure and performance)^c , Number of internal personnel (FTE) (performance indicators, quantity structure and performance)^c , Number of location video WAN APA (performance indicators, quantity structure (APA))^c , Number of locations (performance indicators, quantity structure (other countries))^c , Number of locations APA (performance indicators, quantity structure (APA))^c , Number of locations Brazil (performance indicators, quantity structure (SA))^c , Number of locations China (performance indicators, quantity structure (APA))^c , Number of locations EMEA (performance indicators, quantity structure (EMEA))^c , Number of locations Germany (performance indicators, quantity structure (EMEA))^c , Number of locations India (performance indicators, quantity structure (APA))^c , Number of locations Mexico (performance indicators, quantity structure (NA))^c , Number of locations NA (performance indicators, quantity structure (NA))^c , Number of locations Russia (performance indicators, quantity structure (EMEA))^c , Number of locations SA (performance indicators, quantity structure (SA))^c , Number of locations South Africa (performance indicators, quantity structure (EMEA))^c , Number of locations Turkey (performance indicators, quantity structure (EMEA))^c , Number of locations USA (performance indicators, quantity structure (NA))^c , Number of locations VoIP WAN (performance indicators, quantity structure (other countries))^c , Number of locations VoIP WAN APA (performance indicators, quantity structure (APA))^c , Number of locations VoIP WAN Brazil (performance indicators, quantity structure (SA))^c , Number of locations VoIP WAN China (performance indicators, quantity structure (APA))^c , Number of locations VoIP WAN EMEA (performance indicators, quantity structure (EMEA))^c , Number of locations VoIP WAN Germany (performance indicators, quantity structure (EMEA))^c , Number of locations 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indicators, quantity structure (APA))^c , Number of locations without prioritization WAN Brazil (performance indicators, quantity structure (SA))^c , Number of locations without prioritization WAN China (performance indicators, quantity structure (APA))^c , Number of locations without prioritization WAN EMEA (performance indicators, quantity structure (EMEA))^c , Number of locations without prioritization WAN Germany (performance indicators, quantity structure (EMEA))^c , Number of locations without prioritization WAN India (performance indicators, quantity structure (APA))^c , Number of locations without prioritization WAN Mexico (performance indicators, quantity structure (NA))^c , Number of locations without prioritization WAN NA (performance indicators, quantity structure (NA))^c , Number of locations without prioritization WAN Russia (performance indicators, quantity structure (EMEA))^c , Number of locations without prioritization WAN SA (performance indicators, quantity structure (SA))^c , Number of locations without prioritization WAN South Africa (performance indicators, quantity structure (EMEA))^c , Number of locations without prioritization WAN Turkey (performance indicators, quantity structure (EMEA))^c , Number of locations without prioritization WAN USA (performance indicators, quantity structure (NA))^c , Number of locations without prioritization WAN other APA (performance indicators, quantity structure (APA))^c , Number of locations without prioritization WAN other EMEA (performance indicators, quantity structure (EMEA))^c , Number of locations without prioritization WAN other NA (performance indicators, quantity structure (NA))^c , Number of locations without prioritization WAN other SA (performance indicators, quantity structure (SA))^c , Number of providers WLAN (performance indicators, quantity structure and performance)^c , Number of users China (performance indicators, quantity structure (APA))^c , Number of users (performance indicators, quantity structure (other countries))^c , Number of users APA (performance indicators, quantity structure (APA))^c , Number of users Brazil (performance indicators, quantity structure (SA))^c , Number of users EMEA (performance indicators, quantity structure (EMEA))^c , Number of users Germany (performance indicators, quantity structure (EMEA))^c , Number of users India (performance indicators, quantity structure (APA))^c , Number of users Mexico (performance indicators, quantity structure (NA))^c , Number of users NA (performance indicators, quantity structure (NA))^c , Number of users Russia (performance indicators, quantity structure (EMEA))^c , Number of users SA (performance indicators, quantity structure (SA))^c , Number of users South Africa (performance indicators, quantity structure (EMEA))^c , Number of users Turkey (performance indicators, quantity structure (EMEA))^c , Number of users USA (performance indicators, quantity structure (NA))^c , Number of users other APA (performance indicators, quantity structure (APA))^c , Number of users other EMEA (performance indicators, quantity structure (EMEA))^c , Number of users other NA (performance indicators, quantity structure (NA))^c , Number of users other SA (performance indicators, quantity structure (SA))^c , Provider SLA WAN (performance indicators, quantity structure and performance)^c , Sum of backup bandwidth (performance indicators, quantity structure (other countries))^c , Sum of backup bandwidth APA (performance indicators, quantity structure (APA))^c , Sum of backup bandwidth Brazil (performance indicators, quantity structure (SA))^c , Sum of backup bandwidth China (performance indicators, quantity structure (APA))^c , Sum of backup bandwidth EMEA (performance indicators, quantity structure (EMEA))^c , Sum of backup bandwidth Germany (performance indicators, quantity structure (EMEA))^c , Sum of backup bandwidth India (performance indicators, quantity structure (APA))^c , Sum of backup 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structure (other countries))^c , Sum primary bandwidth APA (performance indicators, quantity structure (APA))^c , Sum primary bandwidth Brazil (performance indicators, quantity structure (SA))^c , Sum primary bandwidth China (performance indicators, quantity structure (APA))^c , Sum primary bandwidth EMEA (performance indicators, quantity structure (EMEA))^c , Sum primary bandwidth Germany (performance indicators, quantity structure (EMEA))^c , Sum primary bandwidth India (performance indicators, quantity structure (APA))^c , Sum primary bandwidth Mexico (performance indicators, quantity structure (NA))^c , Sum primary bandwidth NA (performance indicators, quantity structure (NA))^c , Sum primary bandwidth Russia (performance indicators, quantity structure (EMEA))^c , Sum primary bandwidth SA (performance indicators, quantity structure (SA))^c , Sum primary bandwidth South Africa (performance indicators, quantity structure (EMEA))^c , Sum primary bandwidth Turkey (performance indicators, quantity structure (EMEA))^c , Sum primary bandwidth USA (performance indicators, quantity structure (NA))^c , Sum primary bandwidth other APA (performance indicators, quantity structure (APA))^c , Sum primary bandwidth other EMEA (performance indicators, quantity structure (EMEA))^c , Sum primary bandwidth other NA (performance indicators, quantity structure (NA))^c , Sum primary bandwidth other SA (performance indicators, quantity structure (SA))^c , Usage WAN (performance indicators, quantity structure and performance)^c , WAN trends (performance indicators, quantity structure and performance)^c

is disjoint with Backup^c , Basic data^c , Collaboration^c , Database^c , Dedicated server^c , File Service^c , IMAC^c , LAN^c , Mailbox^c , Mobile devices^c , Remote access service^c , SAP basis^c , SAP modules^c , Servicedesk^c , Storage^c , Telephony^c , Terminal server^c , Virtual server^c , Workplace^c

WAN backup (performance indicators, quantity structure and performance)^c

IRI: `https://w3id.org/bmontology#Backup_PerformanceIndicators_QuantityStructureAndPerformance_WANBackup`

This is a performance indicator of the backup service, categorized into performance indicators as well as quantity structure and performance. This indicator captures whether a backup is performed via WAN.

has super-classes Backup^c Performance Indicator^c

WAN trends (performance indicators, quantity structure and performance)^c

IRI: `https://w3id.org/bmontology#WAN_PerformanceIndicators_QuantityStructureAndPerformance_WANTrends`

This is a performance indicator of the WAN service, categorized into performance indicators as well as quantity structure and performance. This indicator captures the trends of WAN.

has super-classes Performance Indicator^c WAN^c

Way of internet access (performance indicators, security indicators (blackberry))^c

IRI: `https://w3id.org/bmontology#MobileDevices_PerformanceIndicators_SecurityIndicatorsBlackberry_WayOfInternetAccess`

This is a performance indicator of the mobile devices service, categorized into performance indicators as well as security indicators (blackberry). This indicator captures the way the internet can be accessed.

has super-classes Mobile Devices (Blackberry)^c Performance Indicator^c

Way of internet access (performance indicators, security indicators (iPhone))^c

IRI: https://w3id.org/bmontology#MobileDevices_PerformanceIndicators_SecurityIndicatorsIPhone_WayOfInternetAccess

This is a performance indicator of the mobile devices service, categorized into performance indicators as well as security indicators (iPhone). This indicator captures the way the internet can be accessed.

has super-classes Mobile Devices (iPhone)^c Performance Indicator^c

Way of internet access (performance indicators, security indicators (other))^c

IRI: https://w3id.org/bmontology#MobileDevices_PerformanceIndicators_SecurityIndicatorsOther_WayOfInternetAccess

This is a performance indicator of the mobile devices service, categorized into performance indicators as well as security indicators (other). This indicator captures the way the internet can be accessed.

has super-classes Mobile Devices (Others)^c Performance Indicator^c

Way of internet access (performance indicators, security indicators (windows phone))^c

IRI: https://w3id.org/bmontology#MobileDevices_PerformanceIndicators_SecurityIndicatorsWindowsPhone_WayOfInternetAccess

This is a performance indicator of the mobile devices service, categorized into performance indicators as well as security indicators (windows phone). This indicator captures the way the internet can be accessed.

has super-classes Mobile Devices (Windows Phone)^c Performance Indicator^c

Web meeting (performance indicators, tools)^c

IRI: https://w3id.org/bmontology#Collaboration_PerformanceIndicators_Tools_WebMeeting

This is a performance indicator of the collaboration service, categorized into performance indicators as well as tools. This indicator captures whether this kind of collaboration is used in the organization.

has super-classes Collaboration^c Performance Indicator^c Software resource indicator^c

Working life of active LAN components (performance indicators, additional information)^c

IRI: `https://w3id.org/bmontology#LAN_PerformanceIndicators_AdditionalInformation_WorkingLifeOfActiveLANComponents`

This is a performance indicator of the LAN service, categorized into performance indicators as well as additional information. This indicator captures the working life of the active LAN components (years).

has super-classes LAN^c Performance Indicator^c

Workplace^c

IRI: `https://w3id.org/bmontology#WorkplaceIndicator`

Classifies workplace indicators

has super-classes Service template dimension for indicator classification^c

has sub-classes Equipment of a default workingplace computer (desktop/laptop) (performance indicators, quantity structure and performance)^c , External services (cost indicators, desktop)^c , External services (cost indicators, laptop)^c , Hardware (cost indicators, desktop)^c , Hardware (cost indicators, laptop)^c , Maintenance (cost indicators, desktop)^c , Maintenance (cost indicators, laptop)^c , Number of distributed packages per year (performance indicators, quantity structure and performance)^c , Number of external personnel (FTE) (performance indicators, quantity structure and performance)^c , Number of internal personnel (FTE) (performance indicators, quantity structure and performance)^c , Number of used operation systems (performance indicators, quantity structure and performance)^c , Number of workplaces (desktop) (performance indicators, quantity structure and performance)^c , Number of workplaces (laptop) (performance indicators, quantity structure and performance)^c , Offsetting Install (cost indicators, desktop)^c , Offsetting Install (cost indicators, laptop)^c , Others (cost indicators, desktop)^c , Others (cost indicators, laptop)^c , Personnel (cost indicators, desktop)^c , Personnel (cost indicators, laptop)^c , Software (cost indicators, desktop)^c , Software (cost indicators, laptop)^c , Type of sourcing (performance indicators, quantity structure and performance)^c

is disjoint with Backup^c , Basic data^c , Collaboration^c , Database^c , Dedicated server^c , File Service^c , IMAC^c , LAN^c , Mailbox^c , Mobile devices^c , Remote access service^c , SAP basis^c , SAP modules^c , Servicedesk^c , Storage^c , Telephony^c , Terminal server^c , Virtual server^c , WAN^c

Object Properties

- categorizes indicator
- has benchmark
- has indicator categorizaion
- has indicator declaration
- has indicator measurement
- has organization
- has reporting
- has sub-questionnaire
- is benchmark of
- is child of
- is included in the participation
- is indicator declaration of
- is organization of
- is reporting for
- measures indicator
- participation includes

categorizes indicator^{op}

IRI: `https://w3id.org/bmontology#categorizesIndicator`

Categorizes an indicator using a (benchmark-specific) questionnaire

has super-properties realizes

has domain Questionnaire of an individual benchmark^c

has range Indicator^{c}

is inverse of has indicator categorizaion^{op}

has sub-property chains has sub-questionnaire^{op} ocategorizes indicator^{op}

has benchmark^{op}

IRI: `https://w3id.org/bmontology#hasBenchmark`

Links a participation with a benchmark

has super-properties participation includes^{op}

has domain Participation^{c}

has range Benchmark^{c}

is inverse of is benchmark of^{op}

has indicator categorizaion^{op}

IRI: `https://w3id.org/bmontology#hasIndicatorCategorization`

Categorizes an indicator using a (benchmark-specific) questionnaire

has super-properties is realized by

has domain Indicator^{c}

has range Questionnaire of an individual benchmark^{c}

is inverse of categorizes indicator^{op}

has indicator declaration^{op}

IRI: `https://w3id.org/bmontology#hasIndicatorDeclaration`

Links a participation with an indicator declaration

has super-properties participation includes^{op}

has domain Participation^{c}

has range Indicator Declaration^{c}

is inverse of is indicator declaration of^{op}

has indicator measurement^{op}

IRI: `https://w3id.org/bmontology#hasIndicatorMeasurement`

Links an indicator declaration with the indicator the given value belongs to

has super-properties has region

has domain Indicator^{c}

has range Indicator Declaration^{c}

is inverse of measures indicator^{op}

has organization^{op}

IRI: `https://w3id.org/bmontology#hasOrganization`

Links a participation with its organization

has super-properties participation includes^{op}

has domain Participation^{c}

has range organization

is inverse of is organization of^{op}

has reporting^{op}

IRI: `https://w3id.org/bmontology#hasReporting`

Links a benchmark with its reporting

has super-properties associated with

has domain Benchmark^{c}

has range Questionnaire of an individual benchmark^{c}

is inverse of is reporting for^{op}

has sub-questionnaire^{op}

IRI: `https://w3id.org/bmontology#hasChild`

Extends a questionnaire by nesting further child questionnaires

has characteristics: transitive

has super-properties has part

has domain Questionnaire of an individual benchmark^{c}

has range Questionnaire of an individual benchmark^{c}

is inverse of is child of^{op}

is benchmark of^{op}

IRI: `https://w3id.org/bmontology#isBenchmarkOf`

Links a participation with a benchmark

has super-properties is included in the participation^{op}

has domain Benchmark^{c}

has range Participation^{c}

is inverse of has benchmark^{op}

is child of^{op}

IRI: `https://w3id.org/bmontology#isChildOf`

Extends a questionnaire by nesting further child questionnaires

has characteristics: transitive

has super-properties is part of

has domain Questionnaire of an individual benchmark^{c}

has range Questionnaire of an individual benchmark^{c}

is inverse of has sub-questionnaire^{op}

is included in the participation^{op}

IRI: `https://w3id.org/bmontology#isIncludedInParticipation`

Links a participation with involved entities

has super-properties has setting

has sub-properties is benchmark of^{op} , is indicator declaration of^{op} , is organization of^{op}

has domain organizationorBenchmark^{c} orIndicator Declaration^{c}

has range Participation^{c}

is inverse of participation includes^{op}

is indicator declaration of^{op}

IRI: `https://w3id.org/bmontology#isIndicatorDeclarationOf`

Links a participation with an indicator declaration

has super-properties is included in the participation^{op}

has domain Indicator Declaration^{c}

has range Participation^{c}

is inverse of has indicator declaration^{op}

is organization of^{op}

IRI: `https://w3id.org/bmontology#isOrganizationOf`

Links a participation with its organization

has super-properties is included in the participation^{op}

has domain organization

has range Participation^{c}

is inverse of has organization^{op}

is reporting for^{op}

IRI: `https://w3id.org/bmontology#isReportingFor`

Links a benchmark with its reporting

has super-properties associated with

has domain Questionnaire of an individual benchmark^{c}

has range Benchmark^{c}

is inverse of has reporting^{op}

measures indicator^{op}

IRI: `https://w3id.org/bmontology#measuresIndicator`

Links an indicator declaration with the indicator the given value belongs to

has super-properties is region for

has domain Indicator Declaration^{c}

has range Indicator^{c}

is inverse of has indicator measurement^{op}

participation includes^{op}

IRI: `https://w3id.org/bmontology#participationIncludes`

Links a participation with involved entities

has super-properties is setting for

has sub-properties has benchmark^{op} , has indicator declaration^{op} , has organization^{op}

has domain Participation^{c}

has range organizationorBenchmark^{c} orIndicator Declaration^{c}

is inverse of is included in the participation^{op}

Data Properties

- has Label
- has organization name
- has type
- has Value

has Label^{dp}

IRI: `https://w3id.org/bmontology#hasLabel`

Assigns a label

has super-properties has data value

has domain Benchmark^{c} orIndicator^{c} orQuestionnaire of an individual benchmark^{c}

has range string

has organization name^{dp}

IRI: `https://w3id.org/bmontology#hasOrgName`

Assings a name to an organization

has super-properties has data value

has domain organization

has range string

has type^{dp}

IRI: `https://w3id.org/bmontology#hasType`

Assigns a benchmark a benchmark type

has super-properties has data value

has domain Benchmark^{c}

has range { "Competitive Benchmark" , "Functional Benchmark" , "Generic Benchmark" , "Internal Benchmark" , "Process Benchmark" , "Product Benchmark" , "Strategic Benchmark" }

has Value^{dp}

IRI: `https://w3id.org/bmontology#hasValue`

Defines the value of an indicator declaration

has super-properties has region data value

has domain Indicator Declaration^{c}

has range booleanordecimalorstring

Annotation Properties

- creator
- description
- title

creator^{ap}

IRI: `http://purl.org/dc/elements/1.1/creator`

description^{ap}

IRI: `http://purl.org/dc/elements/1.1/description`

title^{ap}

IRI: `http://purl.org/dc/elements/1.1/title`

General Axioms

All Disjoint Classes

Backup^c , Basic data^c , Collaboration^c , Database^c , Dedicated server^c , File Service^c , IMAC^c , LAN^c , Mailbox^c , Mobile devices^c , Remote access service^c , SAP basis^c , SAP modules^c , Servicedesk^c , Storage^c , Telephony^c , Terminal server^c , Virtual server^c , WAN^c , Workplace^c

All Disjoint Classes

Indicator declaration of a boolean value^c , Indicator declaration of a decimal value^c , Indicator declaration of a string value^c

Namespace Declarations

default namespace https://w3id.org/bmontology#

dc http://purl.org/dc/elements/1.1/

dul http://www.ontologydesignpatterns.org/ont/dul/DUL.owl#

ontology http://download.fortiss.org/public/bm/ontology/

owl http://www.w3.org/2002/07/owl#

rdf http://www.w3.org/1999/02/22-rdf-syntax-ns#

rdfs http://www.w3.org/2000/01/rdf-schema#

w3id-org https://w3id.org/

xsd http://www.w3.org/2001/XMLSchema#

This document was obtained by processing the OWL ontology source code through LODE, *Live OWL Documentation Environment*, developed by Silvio Peroni.

Appendix: Published Version of Included Publications

Semantic Integration of Semi-Structured Distributed Data in the Domain of IT Benchmarking

Towards a Domain Specific Ontology

Matthias Pfaff[1] and Helmut Krcmar[2]

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Keywords: IT Benchmarking, Distributed Data Sources, Heterogeneous Data, Semantic Data Integration, Ontologies.

Abstract: In the domain of IT benchmarking a variety of data and information are collected. The collection of this heterogeneous data is usually done in the course of specific benchmarks (e.g. focusing on IT service management topics). This collected knowledge needs to be formalized previous to any data integration, in order to ensure interoperability of different and/or distributed data sources. Even though these data are the basis to identify potentials for IT cost reductions or IT service improvements, a semantic data integration is missing. Building on previous research in IT benchmarking we emphasise the importance of further research in data integration methods. Before we describe why the next step of research needs to focus on the semantic integration of data that typically resides in IT benchmarking, the evolution of IT benchmarking is outlined first. In particular, we motivate why an ontology is required for the domain of IT benchmarking.

1 INTRODUCTION

Benchmarking as a systematic process for improving organizational performance has gained great popularity worldwide since the 1980s. It is based on the insight that observing organizations and analyzing their acting and (measure) their performance is a powerful way to transform the own organization. This transformation is usually done by applying lessons learned form a benchmark (Camp, 1989; Peters, 1994). Moreover, benchmarking can help explaining value or cost aspects to stakeholders within the company while comparing for example their (IT) unit or only certain services of the IT with competitors (Spendolini, 1992).

Recent research in the Information Systems (IS) (e.g. (Slevin et al., 1991; Smith and McKeen, 1996; Myers et al., 1997; Gacenga et al., 2011)) focuses on the analysis and evaluation of performance measurement. Performance measurement in the IT context requires several prerequisites. Having a well-structured service oriented IT department and a consistent knowledge of IT services and their corresponding costs are, for example, important. Additionally these are basic requirements for circular comparisons and subsequently for improvements based on data analysis. Companies that are interested in benchmarking need to have valid definitions of the value and the costs for the objects selected to benchmark. (Rudolph and Krcmar, 2009) argues, that throughout increasing IT industrialization the standardization, documentation and definition of IT services are gaining more importance. They state, that IT service catalogues are an appropriate instrument to picture such a service structure. In addition, concepts for the identification of critical success factors for measuring the maturity level of service catalogues are developed by (Kütz, 2006) and (Rudolph and Krcmar, 2009). In detail, each IT service (object of IT benchmark) should encompass certain parts of deliverables and infrastructure components (Krcmar, 2010). Many of these studies omit facts such as data quality and data integration. Yet, in spite of this new interest, little work published in IS literature addresses the problem of data integration across different kind of IT benchmarks.

One difficulty in making data of different types of benchmarks comparable with each other is a result from the lack of an uniform description of any parameter that is measured. Moreover, a description of the relation in between two of such parameters is missing. This is not a particular issue in the domain of IT benchmarking. Other fields of research

Pfaff M. and Krcmar H..
Semantic Integration of Semi-Structured Distributed Data in the Domain of IT Benchmarking - Towards a Domain Specific Ontology.
DOI: 10.5220/0004969303200324
In *Proceedings of the 16th International Conference on Enterprise Information Systems* (ICEIS-2014), pages 320-324
ISBN: 978-989-758-027-7

are facing similar challenges in data integration, provided with some promising and practical approaches to solve them (Leser and Naumann, 2007). Thus, research on data integration methods for the specific field of IT benchmarking and its vocabulary should be intensified. Especially given the rising research in big data analysis, results from IT benchmarking should not be discarded because of an inadequate data management. A promising approach for data management lies in the use of a domain specific ontology, in order to make these kind of data meaningful (Uschold and Gruninger, 2004; Horkoff et al., 2012).

The next section gives an overview of benchmarking in general and data integration challenges in the domain of IT benchmarking in specific. Following Section 2 further research areas in semantic integration of IT benchmarking data are presented and discussed in Section 3. Furthermore, a first iterative approach for integrating data from different IT benchmarking initiatives is introduced in Section 3.

2 BACKGROUND

Most of the current research in IT benchmarking and the practical literature on this topic is only related to the implementation of IT benchmarks (e.g. (Dattakumar and Jagadeesh, 2003; Jakob et al., 2013)). All of these approaches have one thing in common: Neglecting the need for a sustainable semantic data integration and a unified structure for data management is left out of scope. Thereby most IT benchmarking initiatives are damned to exist side on side in siloed data storages. Consequently, they are incapable to be used a second time or in a different benchmarking context, except they have been collected for.

2.1 Benchmarking

In academic research benchmarking can be classified according to the nature of the object of study and according to the benchmarking type (e.g. process benchmarking, product benchmarking, and strategic benchmarking or generic benchmarking) (Carpinetti and Oiko, 2008). Benchmarking partners may include other units of the same organization, competitors in the same or different geographical markets and organizations in related or unrelated industries, in the same or different countries. So, a differentiation is made between internal and external comparisons of such a performance measurement.

Internal performance measurement focuses on the operations of a single company whereas external looks outside the firms industry. Nevertheless, both of them have a common foundation. An overview on the different types of benchmarks is given in Table 1.

Table 1: Types of benchmarks (Carpinetti and Oiko, 2008).

Type	Description
Process Benchmark	Compares operations, work practices or business processes
Product Benchmark	Compares products or services
Strategic Benchmark	Compares organisational structures, management practices and business strategies.
Internal Benchmark	Compares similar products or services of similar business units within one organization
Competitive Benchmark	Compares performance with a direct competitor. Objects under investigation can be: Products, services, technology, research and development, personnel policies, etc.
Functional Benchmark	Comparisons between one or more non-competitive organizations of particular business functions or processes.
Generic Benchmark	Compares an organization or business unit with the best performing organisation, irrespectively conducted of the type of industry.

An IT benchmark can be considered as passing through several phases. Starting with the initial conception by describing the object to investigate, up to optimizing and re-organizing internal (business) processes (cf. Figure 1). For each of these phases of a benchmark numerous data get collected in various data formats. The substance of these data are qualitative, as well as quantitative statements collected over the complete benchmarking cycle in every single benchmark. Furthermore these data get collected for every single participating company of a benchmark.

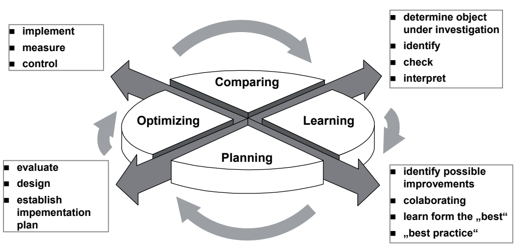

Figure 1: Phases of a benchmark (based on (Watson, 1993)).

2.2 Data Integration

As has already been presented by (Ziaie et al., 2012) and structural described by (Riempp et al., 2008) tool based data collecting is quiet common in the domain for IT benchmarking. Even if different benchmark types measure the same object from different perspectives a direct link in between these collected data is difficult to establish.

Next to various formats the data are stored no semantic information are machine readable persisted. But, in order to make the captured data comparable between different benchmarking approaches a semantic integration in a machine readable data format is crucial. Since concepts of such data integration methods are missing, most of the gathered data during a benchmark will stay only applicable for this specific one time performance measurement in its specific domain focus (e.g. cluster benchmarking by (Carpinetti and Oiko, 2008)). In other words, comparability of benchmarking data beyond the specific context of one specific benchmark is left out of research focus and actually impossible because of data separation.

Figure 2 shows the different scopes of data storing in benchmarking. Companies can participate on a specific benchmark (*Benchmark 1..n*) in a specific year. In other words, data storing is done yearly per participant. In addition, a benchmark itself can consist of several services (*Service A..n*) or specific strategic questions. Even if such benchmarks do have the same object of observation (f.i. same service or same product), no direct semantic information of these data are stored. Therefore, this kind of siloed storing information do inhibit further comprehensive analysis.

In the context of data integration particular requirements are demanded from the use of distributed context sensitive (i.e. heterogeneous) data. Since these are usually not solely for one field of research (e.g. IT benchmarking), approaches and methods to organize information are already applied in related fields of research. Ontologies which, by definition convey electronic or "semantic meaning" are already used to structure unstructured data (e.g. (Cambria et al., 2011)) in the medical or in the information management sector (Riedl et al., 2009; Müller, 2010; Cambria et al., 2011). Thus, representing semantic knowledge with formal ontologies, as proposed by (Guarino, 1995) and (Brewster and O'Hara, 2007), seem to provide promising approaches for data integration techniques in the domain of IT benchmarking.

In the academic literature of ontologies there exist several types of ontology development strategies. (Wache et al., 2001) distinguishes between three main types of ontologies (cf. Figure 3). A *single ontology*

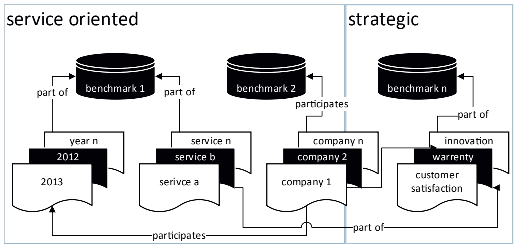

Figure 2: Data dispersion in benchmarking.

(Figure 3(a)) uses a shared vocabulary for describing the semantic information of data . The main advantages of this approach is its quick development process. Managing a single complex and large ontology is one of the main disadvantages, while every change is generating potentially sweeping ontology-wide inconsistencies. *Multiple ontologies* (Figure 3(b)) are based on several independently build ontologies for every source of information. The complexity of a single ontology is only dependant from its corresponding data source and therefore in general less complex. One major disadvantage is the lack of a shared vocabulary when comparing these ontologies. In order to achieve such comparisons *hybrid ontologies* (Figure 3(c)) are used. This kind of ontologies use a shared vocabulary with basic terms of the domain related information of its local ontologies.

On the basis of the existing data of IT benchmarking collected within the last four years, it has to be checked first which type of ontology being the most likely to leverage data integration. Particularly bearing in mind that most of the collected data during an IT benchmark were only meant to be used in their single case of measurement. Thus, existing data form questionnaires presented by (Ebner et al., 2012) and (Ziaie et al., 2012) are used to identify possible start-

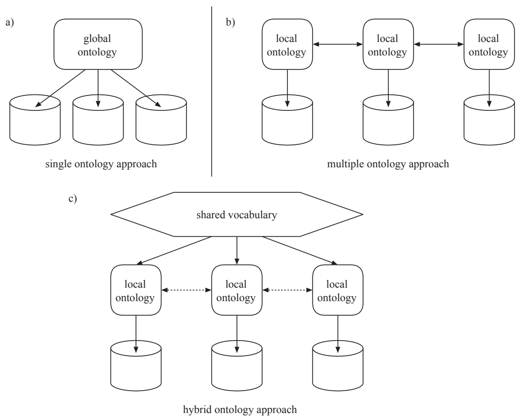

Figure 3: Types of ontologies (Wache et al., 2001).

ing points for a benchmarking ontology.

3 CONCLUSIONS

Identifying potential performance improvements within organisations by the use of IT benchmarks suffers from the quality of the collected data. This quality of data is strongly dependent on a precise specification of every single key performance indicator.

There is not only a demand of a precise description of these indicators on the questionnaires side, the underlying contextual connection should be taken into account for data management. This is especially important when trying to analyse benchmarking data beyond the specific scope they were collected for.

In order to achieve a comparison across different kinds of benchmarks a consistent semantic description of the collected data is essential. Consequently, future research on semantic data integration should be conducted for the domain of IT benchmarking.

For the development of a suitable solution for the data integration in IT benchmarking, already available data and service descriptions of different IT benchmarks serve as sources. These data were collected from 25 large and medium size companies during strategic and service oriented IT benchmarks over the last years. Previously implemented online IT benchmarking systems (c.f. (Ziaie et al., 2012)) and frameworks to structure and asses strategic IT/IS management (c.f. (Riempp et al., 2008)) are used for the data acquisition. Building up on these data the specific requirements that need to be met by a concept for data integration are identified.

Using a common vocabulary, such as based on (ITIL, 2013) might ensure broad acceptance of different domains of benchmarking or IT service management. Derived from this, a domain specific ontology for IT benchmarking will be developed iteratively according to (Noy and McGuinness, 2001).

In a next step, a concept of a system to re-integrate and organize benchmarking data needs to be developed and prototypically implemented. To this end, the previously used data and service descriptions of a strategic and service oriented benchmark can be restructured according to the previous elaborated ontology. This in turn allows a direct inclusion of the ontology and the restructured data into the existing capturing mechanisms for the data collection process during an IT benchmark. Therewith, not only an ontology for IT benchmarking is elaborated but also the seamlessly fit into the existing benchmarking tools is pointed out, with all its added value in terms of comparability of data collected.

Moreover, already existing benchmarking data become significantly enhanced by establishing a link across boards of different benchmarking initiatives.

At least the collected data become comparable and integrable across different benchmarking domains. This enables the development of new assistance system and further statistical analysis on such structured IT benchmarking data.

In addition, already existing data sets can be integrated into a uniform data representation structure and thus be used for further statistical analysis which is actually not possible.

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Information Need in Cloud Service Procurement – An Exploratory Case Study

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Abstract. Cloud computing enables the on-demand self-service procurement of standardized IT services over the internet. However, to efficiently use electronic markets and platforms for exchanging cloud services, a common understanding of the service to be exchanged is required between the organizations providing and the organizations in need of the service. Currently, only a few rather specific criteria catalogues are available to address this need, only focusing on certain types or specific aspects of cloud services. It remains unclear upon which general characteristics organizations require information when procuring cloud services. To identify this broad set of information, we conducted 16 interviews with small-to-large organizations. Combining the responses with literature-based findings, we identified a set of 39 items that form the essential set of characteristics required by an organization when procuring cloud services. This set provides a starting point for the development of a domain-specific vocabulary, service descriptions, and supports the decision-making process of procuring organizations.

Keywords: Cloud Service, Service Description, Case Study.

Traditionally, IT outsourcing providers try to engage in long-term relationships with their clients, providing them with customized IT services. Clients rely on the expertise and detailed solution descriptions offered by potential service providers to specify their individual service demand. Typically, an initial Request for Information (RFI) is sent out to providers describing an approximate demand while asking for a detailed solution specification. The client expects the service provider to present bite-sized information. Subsequently, the client may use this information as a blueprint for a more detailed demand specification, distributed among multiple vendors in a second step of the procurement process. In contrast to those iteratively and individually specified services, cloud computing services are rather standardized offerings. Cloud services, by definition, are designed to be purchased, integrated and used with minimal provider interaction [1], rendering individual requests, such as RFIs, inapplicable [2]. The industrialized IT-delivery model of cloud services is defined as "enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources that can be rapidly provisioned and released with minimal

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management effort or service provider interaction" [3]. Consequently, in the cloud computing market, prospective service customers must independently gather all relevant information regarding an offered service [4]. In turn, procuring organizations need to specify their service demand, and providers need to specify their service offerings, in every detail, to enable any matching of supply and demand. However, customers struggle to specify their demand, and providers struggle to identify the essential elements of cloud service descriptions - those service characteristics for which almost every customer will ask. First catalogues of cloud service characteristics emerged in academia and corporate practice, investigating specific aspects, but the following still remains unclear:

What is the essential set of service characteristics that describes the information needed by organizations when procuring cloud services?

To answer this research question, we first review the academic and practitioner-oriented literature, followed by an empirical analysis of requirements of small to large organizations towards cloud service descriptions, addressing the gaps identified in current literature.

1 Related Work

Academic research investigating the set of information important to organizations when in the process of procuring cloud services is scarce and addresses different foci [5]. Repschläger et al. [6] and Binz et al. [7] focus on rather specific, technical aspects such as the design and functionality of the interface used to manage and port software packages from one service provider to another. In corporate practice, first sets of such criteria focus on aspects such as security [8,9] or specific service functionalities [10]. As cloud services may be traded on electronic markets, ontologies provide a way to describe this type of IT service [11]. For example, the GoodRelations Ontology [12] could be of use to describe specific aspects, such as provider and payment details. To address and structure the full range of information demands of organizations, the quality models defined by the international standard "Systems and software Quality Requirements and Evaluation" (SQuaRE - ISO/IEC 25010) [13] can be used. This standard sets forth the following:

1. "A quality in use model composed of five characteristics […] that relate to the outcome of interaction when a product is used in a particular context of use." [13]
2. "A product quality model composed of eight characteristics […] that relate to static properties of software and dynamic properties of the computer system." [13]

The norm SQuaRE provides a list of quality characteristics that are important when determining quality needs throughout the procurement. Moreover, it provides a list of characteristics when measuring the quality of the service received throughout operations [13]. As the quality the customer will receive during service operations is rather unknown at the time of procurement, proxy values might be of use. As suggested by

Grönroos [14], characteristics of a provider's image could be used in this sense as a filter or proxy for unknown quality characteristics. Furthermore, as SQuaRE is designed for IT services, in general, some of the more cloud-specific aspects outlined in the research by Repschläger et al. [15] or Hoberg et al. [5] are not addressed in such detail. However, to enable a more efficient procurement process of cloud services for small and mid-sized organizations, sets of service properties are required that focus on the most important criteria while omitting security specifics or technical interfaces, which become more important in certain procurement settings only. Adding up all characteristics, vocabularies, ontologies, etc., means a high number of items to be considered when procuring. This high number of items would undermine one of the cloud service advantages - the ability to focus on the needs of agile organizations [16].

2 Research Approach

To answer the previously formulated research questions and to identify the essential set of information that small- and medium-sized companies need during the procurement process, the remainder of this paper has been organized as follows. We first introduce a case study we performed to gather the needed empirical data. Before analyzing the requirements of organizations with respect to cloud service descriptions, an overview of the research approach is provided. Subsequently, we present and discuss our empirical research results. Finally, we present the essential set of information organizations require when procuring cloud services. This set is derived from explorative group interviews with representatives of small-, medium- and large-sized organizations that have at least limited experience in procuring cloud services.

To gather the needed insights into this contemporary and complex sourcing model within a real-life context, we chose an exploratory case study approach [cf. 17] following the guidelines of Paré [18]. In general, the unit of analysis is the process executed by an organization when specifying a cloud service demand. Specifically, we aim at the identification of the particular set of characteristics an organization uses to characterize its cloud service demand. Within each organization investigated, the list of requirements, agreed upon by the procurement team, forms the cornerstone for all following processes within the procuring organization. At the same time, the list of requirements represents the essential set of information this organization requests when in search for cloud services, e.g., on electronic service markets. To gather insights on procurement processes in corporate practice, while accounting for extraneous variations regarding the set of information identified, we selected interview participants that met the following criteria: (i) represented a large-, medium or small-sized (ii) private sector organization that (iii) successfully executed a procurement process for at least one cloud service. As proposed by [cf. 19], we included organizations of varying sizes. Moreover, the focus on private sector organizations is driven by specific restrictions applying exclusively to public sector organizations (e.g., the Federal Information Security Management Act of 2002; Title 44 United States Code § 3541, et seq.). We identified 4 interview partners who were involved in the procurement of cloud services at large organizations, and 12 who were involved in the procurement at medium- or small-sized organizations. In addition to the interviews, additional feedback was collected by follow-up emails. For greater richness of detail and to increase the validity of our findings, each interview was attended by at least two researchers - one leading the interview and discussion and the second researcher taking notes and asking follow-up questions. In total, we completed three semi-structured group interviews with representatives of large organizations and two interviews with representatives of small- and medium-sized organizations. Table 1 provides an overview of our interview partners, the type of organization to which their answers refer and the position of the interviewee within the organization.

Table 1. Overview of interviewees

ID	Type of Company	Position of Interview Participant within Organization	
1	Large	Middle Management	Procurement
2	Large	Senior Corporate Counsel	Legal
3	Large	External	Consultant
4	Large	External	Senior Consultant
5	Medium	Team Lead	IT Department
6	Medium	Team Lead	IT Department
7	Small	Executive	Business Department
8	Medium	Founder	CEO
9	Small	External	Consultant
10	Medium	Team Lead	IT Department
11	Small	Staff	IT Department
12	Small	Founder	CEO
13	Small	External	Consultant
14	Medium	Team Lead	Business Department
15	Small	Staff	IT Department
16	Small	Founder	CEO

All four interviewees involved in cloud service procurement at large organizations were interviewed in 3 group-interview sessions, each lasting between 60 and 120 minutes. The 12 remaining interviewees were questioned in 2 sessions, each lasting 120 minutes. To provide a focused discussion on a specific and structured purpose, we chose group interviews as our interview technique as proposed in [20,21]. Moreover, this technique allowed us to collect the information an organization perceives when procuring cloud services. To structure the interviews and discussions, an interview guideline was used. First, the interview participants described themselves and briefly described their general experience with the procurement of cloud services. Next, the participants were asked to recall the set of information they used in their previous cloud sourcing activities and to report on single characteristics and lists of characteristics they used. Subsequently, lists of characteristics were presented based on the academic and practitioner-oriented literature review and the initial feedback from the group. Moreover, collected data were enriched with contextual information derived from the group discussions. Based on the responses and suggestions throughout the discussion, a catalogue of service properties representing the information need was collected at the end of each session. In a subsequent interview-session, this list of characteristics collected was presented to the participants for respondent validation [17], followed by a renewed discussion of the characteristics included and excluded. Based on notes taken in this subsequent discussion, a refined set of characteristics was collected and supplemented with a short summary of the researchers [18].

3 Information Needs of Cloud Service Buyers

Table 2a and 2b display the set of information gathered, structured according to the dimensions used in SQuaRE - ISO/IEC 25010 [13] and expanded by the image dimension being a proxy for unknown quality-in-use characteristics [14]. The SQuaRE dimensions cover functional suitability, performance, compatibility, usability, reliability, security, maintainability and portability. Functional suitability addresses a service's functional completeness, correctness and appropriateness [13]. Performance addresses a service's time behavior and capacity. Compatibility addresses the degree to which a service can exchange information with other products or services. A service's usability addresses aspects such as the learnability and operability of the service. Reliability addresses a service's maturity. Security addresses aspects such as confidentiality and data integrity. Maintainability addresses the degree of effectiveness and efficiency with which a product or system can be modified by the intended maintainers. Portability addresses the replace-ability of the service.

Table 2a. Information need when procuring a cloud service

Dimension	Information need
Func. suitability	Type of functionality the service is offering (IaaS & PaaS or SaaS)
Func. suitability	Support obligations (scope and response-times)
Func. suitability	Internationality of support
Func. suitability	Communication channels for customer queries
Performance	Guaranteed availability of service
Performance	Guaranteed throughput of service (parallel users supported)
Performance	Network bandwidth and redundancy
Performance	Initial provisioning time (hours until initial service use possible)
Performance	Elasticity supported (provisioning time (hours) after scaling-request)
Compatibility	Supported interfaces to application services
Compatibility	Supported interfaces to other platform- or infrastructure services
Compatibility	Supported Interfaces (interoperability to 3rd party applications).
Usability	Amount of factors determining a service's fee (cost transparency)
Usability	Possibilities to configure using options and rules
Usability	Supported techniques to authenticate users
Usability	Offered tutorials, demos and trainings for users and administrators
Reliability	Liability and compensation for SLA-violation
Reliability	Naming of (sub-)contractors involved

Table 2b. Information need when procuring a cloud service

Dimension	Information need
Security	Guaranteed data separation (Multi-tenancy)
Security	Security measures - Organization and Staff
Security	Security measures – Infrastructure and Technical
Security	Possibilities to audit provider/sub-contractors
Security	Degree of protection sufficient to process personal data (§9 BDSG)
Maintainability	Minimum contract duration and extensions
Maintainability	Self Service Possibilities to scale up/down
Maintainability	Backup and Recovery Possibilities
Maintainability	Update-Management Possibilities
Maintainability	SLA-Monitoring Possibilities
Maintainability	Handling of emergencies - Response times
Maintainability	Response times upon customer requests
Portability	Possibilities to export data stored with the service
Portability	Full data deletion upon contract termination
Image	Name and address of provider
Image	Stability of provider (years since foundation)
Image	Place of service provision (place where data are processed & stored)
Image	Duration provider offers a service (months)
Image	Reference customer(s), incl. phone numbers
Image	Service assessments by experts or customers

4 Conclusion

The diverse positions and departmental backgrounds of our interviewees within their organizations show that stakeholders of multiple departments engage in the procurement of cloud services. The interviewees reported that some of the departments involved emphasize distinct information needs and try to push specific lists of characteristics, either self-initiated or derived, from lists set up by associations of professionals or consultants. Summed up, the interviewees agreed upon the listed criteria shown in Table 2a/b as being a comprehensive set to be used at the start of the procurement process. Depending upon individual needs within the organization procuring cloud services, the importance of specific criteria might vary. This needs to be reflected when weighting criteria to personal needs in common decision support methods that help to solve multi-criteria decision problems, such as the analytic hierarchy process (AHP) or utility value analysis.

The need to potentially add more criteria during the procurement process was emphasized by those interviewees representing large organizations. All of the large organizations structure and classify their data and data sources existing within the organization according to a predefined set of protection classes. This protection class, in turn, defines the security measures to which a service storing or processing these data must comply (see [22] for the detailed approach). In addition to information needed to analyze and assess a service's characteristics, organizations require information on the quality they can expect when using the service. The interviewees would like to know whether they can expect a service to always be up and running and to be provided by a supportive and professional organization. Information provided by other organizations or the duration of a service that is already being offered are some of the proxy values organizations use to gather information on the quality they can expect. Furthermore, all of the interviewees state that the agile cloud market and its quickly emerging and vanishing service offers require agile and lean procurement processes, especially as the frequency of procurement and termination increases. However, the interviewees reported unclear formulated and incomplete service descriptions. This lack of clarity, in turn, requires manual requests for further information throughout the service procurement process. Reducing the current mismatch of information provided by service vendors and the set of information demanded by service-using organizations might not only enable automated searches for required services, it might be one of the next steps towards an agile and lean cloud service procurement.

Even if organizations need to comply with certain rules and regulations that require extending this set, the 39 items identified form the underlying basis. We, thereby, contribute to the sparse empirical research on cloud service procurement. Our findings form a starting point for further research and can be used by service providers to be able to develop meaningful and comprehensive service descriptions for prospective customers. Furthermore, this paper highlights the need for further research in service description languages and ontologies in the domain of cloud services. Thus, the outlined findings provide a conceptualizing overview of service properties to be covered by ontologies and vocabulary for the domain of cloud services.

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Natural Language Processing Techniques for Document Classification in IT Benchmarking

Automated Identification of Domain Specific Terms

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Keywords: IT Benchmarking, Natural Language Processing, Heterogeneous Data, Semantic Data Integration, Ontologies.

Abstract: In the domain of IT benchmarking collected data are often stored in natural language text and therefore intrinsically unstructured. To ease data analysis and data evaluations across different types of IT benchmarking approaches a semantic representation of this information is crucial. Thus, the identification of conceptual (semantical) similarities is the first step in the development of an integrative data management in this domain. As an ontology is a specification of such a conceptualization an association of terms, relations between terms and related instances must be developed. Building on previous research we present an approach for an automated term extraction by the use of natural language processing (NLP) techniques. Terms are automatically extracted out of existing IT benchmarking documents leading to a domain specific dictionary. These extracted terms are representative for each document and describe the purpose and content of each file and server as a basis for the ontology development process in the domain of IT benchmarking.

1 INTRODUCTION

Benchmarking as a systematic process for improving organizational performance has gained great popularity worldwide since the 1980s (Camp, 1989). It is based on the insight that analyzing the acting and performance of organizations is a powerful way to transform the own organization. This is done by applying lessons learned for the own organization derived by these observations (Peters, 1994; Camp, 1995). Moreover, this performance measurement (equiv. benchmarking) can help to explain value or cost aspects to stakeholders (Spendolini, 1992). Thus, the analysis and evaluation of such performance measurement approaches is subject of manifold studies (cf. Slevin et al., 1991; Smith and McKeen, 1996; Gacenga et al., 2011).

The research focus of attention is on structuring, standardize and generalize IT service catalogues (cf. Kütz, 2006; Rudolph, 2009; Nissen et al., 2014). Usually, in order to model internally provided (IT) services in a standardized manner. However, since (IT) service catalogues are commonly designed for internal or individual purposes only comparability is difficult to reach, especially across different (IT) organizations. At present, most of research in (IT) benchmarking is focusing on how benchmarking can be done or in how a successfully performed benchmark should be performed (Jakob et al., 2013). In other words, current research on (IT) benchmarking generally focuses on designing service catalogues or designing benchmarks on various kinds of subjects. Due to the nature of the subject, the information collected during a benchmark is generally done by the use of questionnaires. This leads to a variety of different kind of data getting collected withing a single benchmark (such as cost of employee, software licencing costs, quantities of hardware etc.). All of these approaches have one thing in common: A common concept for data management is left out of scope, even though it is strongly recommended (Pfaff and Krcmar, 2014; Wollersheim et al., 2014). Moreover, little work published in IS literature addresses the problem of data integration across different kind of IT benchmarks, yet. So, they omit facts of data quality and data integration.

Today, one difficulty in making data of different types of benchmarking comparable with each other is a result from the lack of a uniform description of any parameter measured. Their relation in between is not formalized too. Following Pfaff and Krcmar (2014) the conceptual level of the different benchmarking approaches needs to be analyzed, to iden-

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tify first similarities in a logical manner. To do so, already existing service description as well as questionnaires of different benchmarking approaches are used for examination. These data were collected over the last seven years within different benchmarking approaches supervised and evaluated. Encompassing data from strategic and consortial IT benchmarks, reflecting a broad range of numerous small to medium sized enterprises as well as large-scale enterprises.

By the identification of domain specific terms elaborating the specific structural characteristics from different benchmarking approaches, this work addresses the following question: How can the domain specific terms in IT benchmarking be automatically identified out of unstructured data? Subsequently, the results of this work are used to identify the requirements semi-structured and unstructured benchmarking data pose for the use of ontology.

To ensure maximum re-usability and to speed up the document classification process these benchmarking data are analyzed by the use of natural language techniques (NLP). Resulting in a domain specific dictionary as a basis for a domain specific ontology for IT benchmarking, in order to make these kind of data meaningful (Uschold and Gruninger, 2004; Horkoff et al., 2012).

First, an overview of benchmarking in general and data integration challenges in the domain of IT benchmarking in specific is given. Second, the used method and the quality of the previously mentioned approach is described in the following sections. Thus, in this paper the first step in the ontology engineering process is addressed by the use of NLP techniques.

2 RELATED WORK

Today, there exist a broad range of different approaches for structuring service catalogues (cf. Rudolph and Krcmar, 2009). A short overview of these approaches is given by Nissen et al. (2014). Next to IT service catalogues the structure of IT benchmarks follow the abstraction of IT departments proposed by Riempp et al. (2008). Thus, data management in IT benchmarking needs to cover a broad range of different characteristics (e.g. different views on supplier or provider of services, different level of abstraction of a service or various types of cost accounting). Especially where IT-based solutions become more and more used for the data collecting process in the domain for IT benchmarking, such as presented by Ziaie et al. (2012) and structural described by Riempp et al. (2008). Although such benchmarks do have the same object of observation (f.i. same service or same product), no direct semantic information are stored to identify this similarity, which is inhibiting further comprehensive analysis (Pfaff and Krcmar, 2014).

In related fields of research there already do exist several approaches to organise and integrate such kind of semantically identical information. Ontologies which, by definition, convey electronic or ”semantic meaning” are used to structure such kind of unstructured data in the medical sector (cf. Cambria et al., 2011) or in the sector of information management (cf. Riedl et al., 2009; Müller, 2010; Cambria et al., 2011). To address this lack of appropriate data management concept in the domain of IT benchmarking onotlogies are already proposed by Pfaff and Krcmar (2014), following Guarino (1995) and Brewster and O'Hara (2007).

There exist several types of ontology development strategies in academic literature (cf. Wache et al., 2001). A *single ontology* uses a shared vocabulary for describing the semantic information of data. *Multiple ontologies* are based on several independently build ontologies for every source of information. The lack of a shared vocabulary across these ontologies is one major disadvantage. *Hybrid ontologies* use a shared vocabulary with basic terms of the domain related information. But, to our knowledge no ontology exists for IT benchmarking or IT service management.

3 METHODS

Since NLP driven ontology development has become more and more common over the last years, (cf. Lame, 2005; Maynard et al., 2008; Witte et al., 2010; Ray and Chandra, 2012; Karanikolas and Skourlas, 2010; Alatrish et al., 2014) these techniques are used to develop a domain specific ontology for IT benchmarking. Focusing on the first phase of ontology development, such as term extrusion and dictionary development.

3.1 Ontology Development

Ontologies aim to capture static domain knowledge in a generic way and can be used and shared across applications and groups (Chandrasekaran et al., 1999). Thus, one can define an ontology as a shared specification of a conceptualization. Following Noy and McGuinness (2001) and Pinto and Martins (2004) Figure 1 shows the schematic procedure of the ontology creating an process.

First, already existing repositories of information, such as documents, are used to identify and ex-

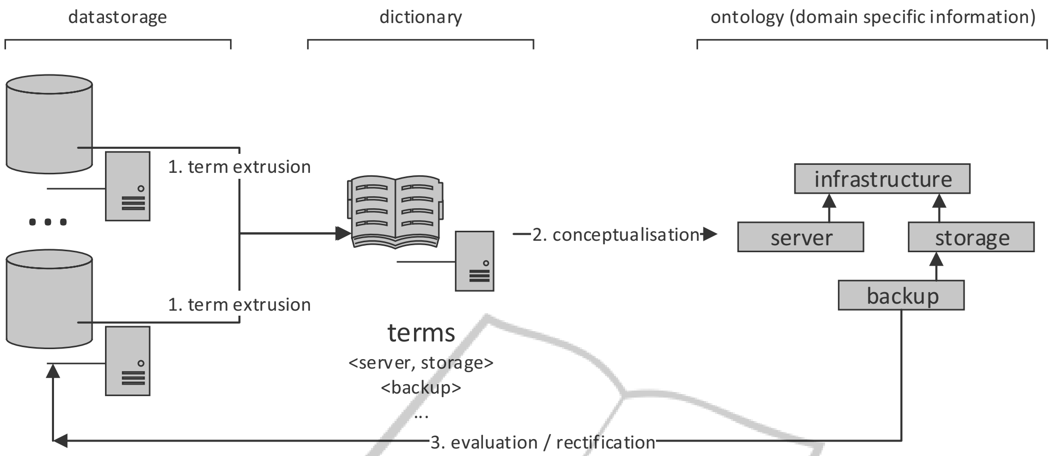

Figure 1: Ontology Engineering steps adapted from Sack (2008).

tract characteristic terms within the specific domain. Second, these terms are conceptualized according to Fernandez-Lopez et al. (1997). In a third step, the conceptualization is evaluated and revised to map the requirements previously identified. Supporting the construction of ontologies and populating them with instantiations of both concepts and relations, commonly referred to as ontology learning.

Next to a manual extraction of terms out of documents there exist several semi-automatic approaches. In general, these are natural language processing (NLP) or machine learning techniques (ML) which speed up the initial process of the ontology engineering.

3.2 Natural Language Processing

Based on already existing documents (i.e. service descriptions and benchmarking results of the last seven years) an automatic extraction of terms is performed. All of the documents stored in various data formats are converted into a new data format, commonly referred to as data stream (raw text). This raw text is the input for the NLP algorithm. Figure 2 illustrates the pipeline architecture for an information extraction system apart from technical details.

The complexity of the NLP analysis can be reduced since all documents are related to topics in the domain of IT benchmarking. It can therefore be assumed that these documents are based on a reduced set of vocabularies. Thus, a dictionary with commonly used terms in this domain supports the NLP process. Using this dictionary a pre classification of the documents can be made according to the initial set of terms. But, as it cannot be assumed that the initial generated dictionary is completely sound, this dictionary has to be iteratively adjusted or extended with the automatically identified terms of the analyzed the documents. As a result a representative set of terms for the domain of IT benchmarking is acquired.

On the pre-processing side of NLP the documents are parsed and transferred into a raw data format which is needed for *tokenization*, *division in sentences*, *lemmatization* and *lexical analysis*. As *tokenization* identifies each single term of a sentence *division in sentences* organizes these terms by grouping them into sentences. The reduction of each term to its basic form is called *lemmatization* (e.g. employees is reduced to employee). In a last step *lexical analysis* aims at the identification of grammatical classes for each term selected in the tokenization process.

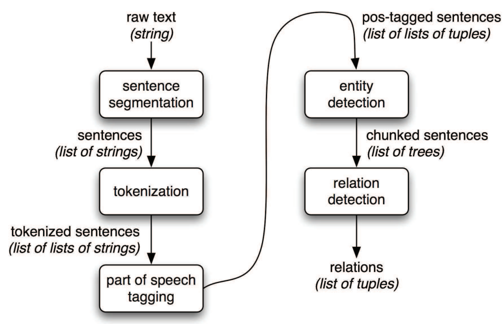

Figure 2: Pipeline Architecture for an Information Extraction System based on Bird et al. (2009).

Following Salton (1989) all words are analyzed and count according to their frequency of use within the existing documents first. The term frequency (t) within on single document (d) is brought into relation of all documents where (t) is used. This is called *inverse document frequency (IDF)*.

$$IDF(t) = \frac{FREQ_{td}}{DOCFREQ_t} \quad (1)$$

Thus, in a collection of (n) documents the significance (S_{ik}) for one term (t) in document (d) can be described by:

$$S_{ik} = C * \frac{n}{DOCFREQ_t} * FREQ_{td} \quad (2)$$

Where (C) is known as *Zipf's law* (Zipf, 1949), approximating the rank-frequency relationship where (r) is the rank of a term, (f) is the frequency of occurrence of the term, and (c) is a constant, dependent on the number of terms in a document.

$$C = r * f \quad (3)$$

This approach has its weaknesses in small to mid size documents with less different terms. In this case the documents get probably not identified by the most representative term if only the most weighted terms get saved. This will lead to an incomplete list of index terms an therefore inadequate for the building of a base dictionary for IT benchmarking. Consequently, terms of small an mid size documents are parsed last and compared with the dictionary entries created out of larger data sets. In case of new index terms, these terms are included into to dictionary. In case of a document with equivocal results concerning the representative term all terms are stored and associated with this document. This is done in order to prevent incomplete set of dictionary terms as well as incomplete result sets if searched for a specific term and its corresponding documents.

Before measuring the quality and effectiveness of the implemented automated document indexation it is necessary to specify the requirements the implementation has to full fill. In our case these are:

- All relevant information are extracted.
- Less irrelevant information are stored.

Thus, effectiveness reflects the amount of correct identified documents with less false positive results. Moreover, the list of documents identified correct should be nearly complete and the amount of documents not relevant for a specific search term should be small.

The four categories a document can be assigned to is shown in Figure 3. According to the definition of information retrieval systems, an information can be retrieved and be relevant (true positive) or retrieved

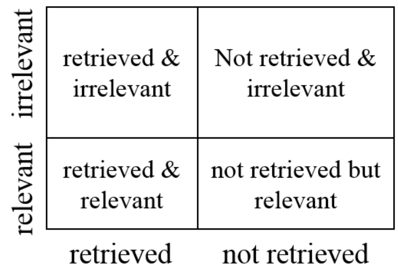

Figure 3: Segmentation of a collection of documents according to four types of classes of belonging (Nohr, 2003).

and irrelevant (false positive). In contrast, the information not received can be irrelevant (false negative) or relevant (true negative).

To measure the effectiveness, two key performance indicator are used, *recall* and *precision* Nohr (2003). *Recall* and *precision* are defined as follows:

$$Recall(r) = \frac{Number\ of\ relevant\ documents\ retrieved}{Total\ number\ of\ relevantdocuments} \quad (4)$$

$$Precision(p) = \frac{Number\ of\ relevant\ documents\ retrieved}{Total\ number\ of\ documents\ retrieved} \quad (5)$$

By definition, a high value of *recall* describes a set of documents where all relevant documents are identified, with its drawback, that this set may also contain irrelevant documents. Such high values of *recall* is desired if it is important to identify all documents related to a specific search term. In contrast, a high value of *precision* describes a set of documents with many relevant documents are identified correctly and the amount of irrelevant documents is comparatively low. Thus, a high value of *precision* is desired whenever relevant documents need to be identified only, at the expense of completeness.

4 METHODOLOGY

As already mentioned, it can be assumed, that most of the documents consist of a reduced set of vocabulary, as all of them are related to specific topics out of IT benchmarking. Thus, they describe technical and economic aspects such as IT costs or the number of employees. This constraint allows us to group data objects into subsets based on their relation, i.e. objects with similar information are grouped together.

The reduction to primary words is done by the help of LemmaGen (Juršic et al., 2010; LemmaGen, 2011), a lexical database that contains approximately

23385 natural language terms and about 10655 primary words.

4.1 Prototype

Figure 4 shows the schematic workflow of the implemented prototype. First a set of documents is analyzed according to the previously described NPL methods and transferred into raw data formats. Second, the shared terms of the different documents are identified, building the underlying dictionary of the domain. Therefore LemmaGen (Juršic et al., 2010) and the Stop Word (Savoy, 2014) identifier are used. This shared dictionary is used to identify each single document in a last step (e.g. by name, unit, year and representative tag).

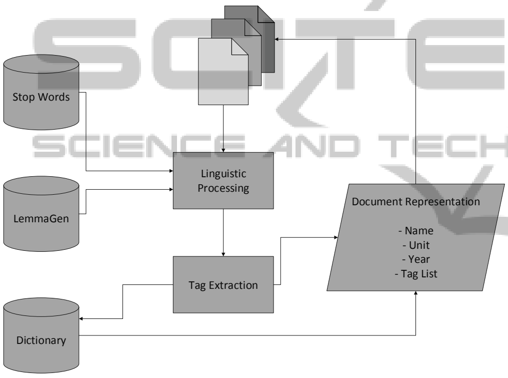

Figure 4: Schematic workflow of the prototype for document indexing.

The implementation of this prototype is done in Java. The documents are read in by the use of the Apache POI API (Foundation, 2014). This is to transform each document into a string-array, split into paragraphs for term identification. At last, each document gets tagged by its most representative term or list of terms.

4.2 Evaluation

According to this schematic workflow the prototype is tested on a set of documents out of different benchmarking approaches, mainly based on *.doc(x), *.xls as well as *.pdf documents, resulting in 1084 unique files. These files were previously categorized by hand, to identify relevant documents with potential terms for ontology building. Moreover, this is done to measure *recall* and *precision*, as the document distribution needs to be known (e.g. documents related to personal costs). This leads to a distribution of documents shown in Table 1.

Table 1: Documents under examination.

Total Number of Documents	1084
Number of relevant Documents	404

At first, the quality of document identification has been tested. Thus, it is evaluated if all relevant documents are found. The results are shown in Table 2.

Table 2: Accuracy of document identification.

Number of relevant documents	404
Number of identified documents	378
Accuracy	93.3%

26 documents could not be identified, as these missed some relevant information needed, such as the name of performance indicator that should be described by this document.

In a next step a subset of manually categorized documents were tested to measure the *precision* and *recall*, while focusing on a high *recall* value. This is due to the fact, that in case of IT benchmarking and especially for the development of an ontology nearly all relevant information/documents should be identified. This means, that false positive identified documents are allowed to occur in the result set. An overview on used search terms is given in Table 3.

Table 3: *Recall* and *precision* for the test data set.

Search term	Recall (%)	Precision (%)
Supported Devices	0.2	1.0
Personnel costs	0.57	0.8
Number of client devices	0.63	1.0
Total cost of IT	0.65	0.92

At last, it is tested whether all units of the indicators are identified correctly. The Result of this test is shown in Table 4. Five units could not be identified because of major typing errors within these documents.

Table 4: Identification of units.

Number of search documents	36
Identified Units	31
Accuracy	0.86%

5 DISCUSSION & FUTURE WORK

This work transfers NP and machine learning techniques into the domain of IT benchmarking, as basis for ontology creation processes in the future. It is its first step towards an ontology in this domain. By automating the term extrusion out of benchmarking documents the development of this ontology is accelerated. This acceleration is even more important on maintaining an ontology. As the initial development of such an ontology is only the first step, extension and maintenance processes are activities which also get supported by the automated term extrusion. This is especially useful if new domain specific terms need to be identified out of new documents, such as service descriptions (e.g. related to topics like cloud computing).

Future work will focus on step two/three, shown in Figure 1. As it is shown, the conceptualization of terms leads, in general, to a cyclically adjustment of the initial developed ontology. As this process needs to be supervised by a domain expert only a semi- automation of this step is possible yet. Nevertheless this semi-automation will be developed. To support the domain expert during this step, the differences between two ontology versions (before and after the automatic term extrusion) will be identified and presented to him. Moreover this kind of versioning helps to comprehend the development process of the whole ontology.

In a last step, already existing output data will be linked to the domain ontology, such as, cost or performance values collected from different companies since the last seven years and persisted in various databases (eg. MySQL or Access DB). Thus, the conceptualization of logical structures in this domain, is used to get access to benchmarking data. Without the need of the development of a unified database schema. Therefore new databases can be linked to already existing ones by the use of an abstraction layer, so called ontology.

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ORIGINAL ARTICLE

Ontology for Semantic Data Integration in the Domain of IT Benchmarking

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Abstract A domain-specific ontology for IT benchmarking has been developed to bridge the gap between a systematic characterization of IT services and their data-based valuation. Since information is generally collected during a benchmark exercise using questionnaires on a broad range of topics, such as employee costs, software licensing costs, and quantities of hardware, it is commonly stored as natural language text; thus, this information is stored in an intrinsically unstructured form. Although these data form the basis for identifying potentials for IT cost reductions, neither a uniform description of any measured parameters nor the relationship between such parameters exists. Hence, this work proposes an ontology for the domain of IT benchmarking, available at https://w3id.org/bmontology. The design of this ontology is based on requirements mainly elicited from a domain analysis, which considers analyzing documents and interviews with representatives from Small- and Medium-Sized Enterprises and Information and Communications Technology companies over the last eight years. The development of the ontology and its main concepts is described in detail (i.e., the conceptualization of benchmarking events, questionnaires, IT services, indicators and their values) together with its alignment with the DOLCE-UltraLite foundational ontology.

Keywords Ontology · Domain modeling · Information systems · IT benchmarking · Knowledge representation · Semantic data

1 Introduction

IT benchmarking is based on the insight that by observing organizations and analyzing their performance, an organization can transform the way it conducts business [4]. Such a transformation is usually achieved by applying lessons learned from benchmarking results to their own organization [5,40]. Information is generally collected during a benchmark exercise using questionnaires on a broad range of topics, such as employee costs, software licensing costs, and quantities of hardware or software. Moreover, there are different types of benchmarks that generally focus on the same subject from different points of view, especially in the domain of IT benchmarking. Although the different benchmark types measure the same object from different perspectives, a direct link is often difficult to establish between these collected data. Research in the field of IT benchmarking typically focuses on structuring, standardizing and generalizing IT service catalogs and their implementation within companies [11,32] to model internally provided IT services in a standardized manner. Because IT service catalogs are commonly designed for internal or individual purposes only, they are often not directly comparable, especially when attempting to compare the across organizational boundaries. This is because the concept of a uniform data description and data management is not considered even though it is strongly recommended for

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such measurement problems in the domain of IT benchmarking [41,54].

Currently, the number of studies in the IS literature addressing these data integration challenges across different types of IT benchmarks is limited and most literature sources omit facts related to the data quality, the data integration and the comparability of different types of benchmarks. This is because of the lack of a uniform description of any arbitrary performance parameter and key performance indicator (KPI) that is measured during a benchmark and because of the lack of a uniform description of the relationships between these parameters [42] relevant for comparability. However, a domain-specific ontology may represent a solution to ensure that the collected data are meaningful and to overcome these limitations of data comparability [28,51]. Similar ontology-based approaches for enhancing the data quality have been successfully implemented in related fields of research, for example, for linking IT infrastructure and business elements (cf. [2]).

Since there are numerous challenges related to data integration specific to not only the domain of IT benchmarking but also related fields, such as IT service management (ITSM), in this work, we describe an IT benchmarking ontology, an ontological formalization of all relevant elements, attributes, and properties in this domain, following the description logic fragment of the Web Ontology Language (OWL) 2 language [35]. Thus, this work contributes to the data comparability problem because of the lack of standardization by showing to which degree of abstraction the conceptualization of relevant concepts needs to be covered by an ontology in the domain of IT benchmarking and what basic relationships need to be modeled within the core IT benchmarking ontology (ITBM). While the ITBM ontology provides the common understanding of concepts and relations within the domain of IT benchmarking the semantic foundation is achieved by grounding the ITBM ontology in an upper ontology, a "foundational ontology." For this reason, the ITBM ontology is linked to Dolce UltraLite (DUL) [15]. Grounding in a foundational ontology ensures the semantic interoperability of distinct conceptualizations from different (domain) ontologies [24].

The paper is organized as follows: Sect. 2 provides an overview of the relevant literature on IT benchmarking/service management, foundational ontologies, and ontologies in related domains. The methodology for the development of the ITBM ontology is described in Sect. 3. Section 4 introduces the proposed ITBM ontology and gives an overview of the document structure used to build the domain ontology. Section 5 outlines the application and use case of the ITBM ontology. Finally, Sect. 6 provides the conclusion and perspectives for future in terms of ontology extension.

Table 1 Types of Benchmarks (based on [6])

Type	Description
Process Benchmark	Compares operations, work practices or business processes
Product Benchmark	Compares products or services
Strategic Benchmark	Compares organizational structures, management practices and business strategies
Internal Benchmark	Compares products or services of business units within a single organization
Competitive Benchmark	Compares performance with a direct competitor. The object of investigation may include products, services, personnel policies, etc.
Functional Benchmark	Compares one or more non-competitive organizations in terms of particular business functions or processes
Generic Benchmark	Compares an organization or business unit with the best-performing organization, irrespective of the type of industry

2 Background

2.1 The Domain of IT Benchmarking

As a systematic process for improving organizational performance, benchmarks can be classified according to the type of study (e.g., processes, products, strategies or generic objects) (cf. [6]). Benchmarking partners may be units of the same organization, competitors in the same or different geographical markets or organizations in related or unrelated industries. Thus, a distinction is drawn between internal and external comparisons of these performance measurements. Whereas an internal performance measurement focuses on the operation of a single company, an external performance measurement focuses on different companies. An overview of the different types of benchmarks is presented in Table 1.

A benchmark can be subdivided into several process phases, beginning with the initial conception which describes the object of investigation and ending with optimizing and re-organizing internal (business) processes. In each of these phases of a benchmark numerous data (KPIs) are collected in various data formats or data structures. These data consist of both qualitative and quantitative statements and are (recurrently) collected through the entire benchmarking cycle for every benchmark. Furthermore, they are collected for every benchmarking participant. In IT benchmarking, the scope of the collected data is generally limited to IT-related performance indicators, regardless of whether they were collected within a strategic or generic benchmark. Thus, these data (indicators) are similar in a semantic manner, as they are related to specific IT aspects, even if acquired within different

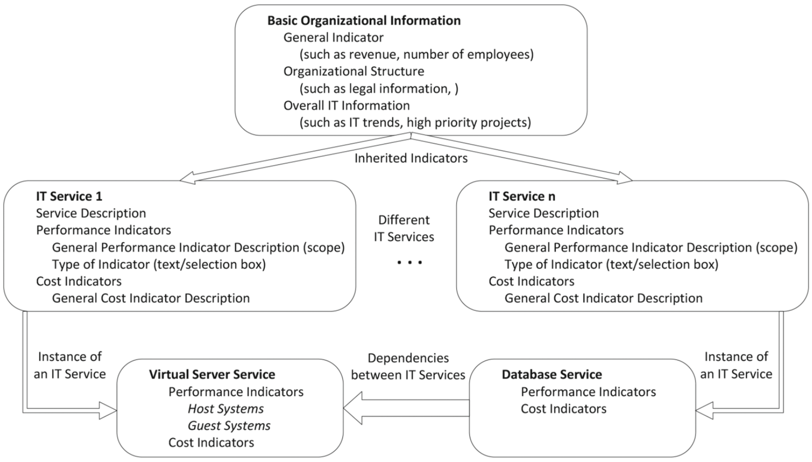

Fig. 1 Structural overview of the IT service catalogs used to build the ontology. Services are segmented first (e.g., cost or performance indicator) and optionally further split into indicator groups (e.g., host systems). Services may include the costs of other services (e.g., a database service includes the cost also specified in a virtual server service) (based on Pfaff and Krcmar [43])

types of benchmarks. More generally, different IT benchmarks often measure the same IT objectives from different vantage points. Therefore, such collected data are semantically related to each other for this specific objective which was measured within different benchmarks.

The structural layout of an IT service catalogs can be generalized to (i) basic organizational information (such as the number of employees or revenue), subsequently referred to as basic data services, and (ii) 20 additional IT services, describing more specific aspects of IT offerings (cf. Fig. 1). These IT services provide some general information about what the service offering is about (for example, providing a mailbox or a virtual machine/server) and detailed information about performance and cost indicators that are used to measure the performance of this service. Note that calculations of indicators may be dependent on different services. For example, a storage service contains all costs associated with disk storage in a data center; however, some of those storage-specific costs are also required within a more general IT service such as in the context of server costs (as disk storage is associated with servers in general). Additionally, costs originally related to the database service are based on both the general server costs as part of the infrastructure component and the more specific disk storage costs. Again, some cost indicators of the database service depend on the performance indicators of the server and data storage service. It is also possible that IT services could inherit indicators or values from the basic organizational information (such as the total number of employees of an organization) to perform further calculations within a specific service based on such a basic indicator. Figure 1 shows the structural layout of the IT service catalogs and IT service descriptions used to build the ontology.

In short, IT services are mono-hierarchically structured. Each top-level service consists of a set of subordinated service segments and, optionally, additional indicator groups. As shown in Fig. 1, the basic data service's segments correspond to general organizational information (e.g., organizational structure and IT costs), and the remaining IT services are segmented by whether they are cost or performance indicators and, optionally, grouped into smaller logical units (for example, the host or guest systems in the context of the virtual server service).

2.2 Foundational Ontologies and Ontologies in Related Domains of ITBM

To link data (bases), that are similar in a semantic manner, the use of ontologies has become popular in recent years, with a particular focus on the representation of business processes (cf. [17,50] or for the purpose of enterprise modeling (cf. [52]). By nature, when an ontology is built with a focus on business processes or enterprise modeling, it lacks the information needed to shift the focus to financial aspects, which are of crucial importance in the domain of IT benchmarking. Although such ontologies, such as the Edinburgh Enterprise Ontology (EEO) by Uschold [52], the TOronto Virtual Enterprise (TOVE) by Fox and Grüninger [12] and the Design and Engineering Methodology for Organizations (DEMO) by Dietz and Hoogervorst [9], are used for enterprise modeling, they differ in the meaning of key terms, as they are not grounded in a foundational ontology. Further, aside from the lack of a shared understanding of equal concepts in these ontologies, they do not address IT infrastructure and IT costs nor do they focus on IT-comparable IT services in general across company boundaries, which is crucial for the domain of IT benchmarking. This situation holds true for ontologies in the context of ITSM (cf. [13,53]), for ontologies and IT governance frameworks in the context of the Information Technology Infrastructure Library (ITIL) [38] and for related ontologies such as the GoodRelations ontology

[26] and the Financial Industry Business Ontology (FIBO) [8]. Whereas the business model ontology (BMO) [39] only focuses on the conceptualization of economic aspects within a single enterprise, the e^3-value ontology [21] only focuses on the conceptualization of economic aspects within a network of enterprises. Other, more domain-specific ontologies focus on the modeling of the aspects of an enterprise's accounting aspects, such as the resource-agent-event (REA) ontology [18], which is used to define the architecture of an accounting information system (AIS). Since the REA ontology is not grounded in a foundational ontology, it is unclear what is meant by an economic event.

One initial approach for measuring the impact of IT infrastructure changes on business processes and vice versa by an ontology was introduced by vom Brocke et al. [2]. The focus of this study is the linkage of (inner) organizational process levels to their IT-resource level. However, to (semi-) automatically compare IT-related and business-related performance indicators across organizational boundaries, a more fine-grained conceptualization of such information is needed. Especially if the ontology is directly used to link and access external data sources (i.e., directly map ontology concepts to IT business-related KPIs) to analyze the organizational performance of (IT) services, the conceptualization needs to be closer to the structure of IT service catalogs than to the abstract description of organizational processes or IT resources.

As previously stated, upper ontologies, or "foundational ontologies," are used to ensure the semantic interoperability of distinct conceptualizations from different domains [24]. Thus, several of these foundational ontologies have been recently developed. The Suggested Upper Merged Ontology (SUMO) [36], the Basic Formal Ontology (BFO) [48], the Descriptive Ontology for Linguistic and Cognitive Engineering (DOLCE) [16], the Unified Foundational Ontology (UFO) initially presented by Guizzardi and Wagner [25], and the General Formal Ontology (GFO) proposed by Herre [27] are some prominent examples of this type of ontology. The BFO was developed for the support of information retrieval, analysis and integration in scientific and other domains. It was developed to be very generic and to incorporate both three-dimensionalist and four-dimensionalist perspectives on reality. In contrast to BFO, DOLCE captures ontological categories underlying natural language and human commonsense [33]. As a descriptive ontology, DOLCE distinguishes between things and events, which correspond to organizations (things) and benchmarks (events) in the domain of ITBM. In DOLCE, the differences between these entities are related to their behavior in time, and they are linked by participation relations (similar to a participation within a benchmark), whereas in BFO (as a realist ontology) such branches are completely independent of each other. Thus, DOLCE offers a better support for representing temporal qualities (e.g., a benchmark as a time-specific event) and properties (e.g., a specific type of benchmark) and values (e.g., a particular benchmark of a specific type). Since a lightweight version of DOLCE is provided with DUL [15], being sufficient in terms of expressiveness and complexity, DUL was used for grounding the ITBM ontology. Note that for grounding the ITBM ontology in a foundational ontology, GFO and SUMO would also have been appropriate, as they also provide sufficient temporal conceptualizations. However, since no lightweight version of GFO exists and since the extensive and detailed taxonomy of SUMO is not needed, the ITBM ontology is grounded in DUL to provide a lightweight solution. In contrast to the previously mentioned foundational ontologies, which are based on OWL, UFO is based upon OntoUML [24]. As a result, and since the ITBM ontology was implemented in OWL, UFO and its extensions (UFO-A, UFO-B, UFO-C and UFO-S) were not considered further in the investigation. OWL was chosen for the development of the ITBM ontology to ensure further linkage possibilities to the previously mentioned domain ontologies (such as FIBO and BMO).

3 Methodology

For the development of the ITBM ontology, we implemented a customized process based on the NeOn framework for ontology engineering [49]. NeOn offers nine different scenarios consisting of 59 activities. The basic activities for each ontology development process are bundled in the NeOn core scenario. To perform a certain scenario, the scenario is mapped to the phases of an underlying life cycle model. Two life cycle models are supported; a waterfall model with a variable number of phases (depending on the scenario to be performed) and an iterative and incremental model. The iterative and incremental model is a sequence of subsequently performed waterfall models (i.e., iterations), each of which may be based on a different scenario; the chosen scenario defines the different phases to be performed during a specific iteration. Activities are described in a glossary of terms, aiming to give commonly accepted definitions for certain activities. Most activities come with a set of comprehensive descriptions consisting of functional descriptions (e.g., definition, goals, and input/output).

The IT benchmarking ontology as presented in this work is the result of a number of iterations of the overall ontology engineering process, which is based on an iterative and incremental life cycle model. So far, both the NeOn core scenario and the NeOn scenario for the reuse of ontological resources have been used. In addition to this customization, we further adapted some of the NeOn activities to fit our needs therein keeping the engineering process as lightweight as possible. In the following, subsequently performed activities are described in more detail in the order or their execution.

Knowledge Acquisition. According to the NeOn specification for the knowledge acquisition process, three different activities were performed: (i) ontology elicitation to acquire conceptual structures and their instances by domain experts; (ii) ontology learning to (semi-)automatically transform unstructured, semi-structured and structured data sources into conceptual structures; and (iii) ontology population to (semi-)automatically transform unstructured, semi-structured and structured data sources into instance data. Within the IT benchmarking ontology engineering process, the ontology population activity is not performed during the ontology design phase, as the IT benchmarking ontology solely contains conceptual knowledge. Analogously, knowledge elicitation is limited to gathering conceptual knowledge. Ontology learning was conducted to support the domain experts in performing the ontology elicitation activity; here, existing service catalogs and databases were analyzed using Natural Language Processing (NLP) techniques to extract the most important concepts, as described in detail in [42].

Ontology Requirements Specification. The main challenge during the specification activity was to identify a set of appropriate competency questions (CQs) to describe the requirements to be fulfilled by the final ontology as the ontology is used for accessing external data sources. Thus, the CQs are questions the ontology should be capable of answering, based on the results of the external attached data sources. Following the NeOn guidelines, Table 2 shows the categorized and prioritized CQs for the ITBM ontology and the corresponding query-style answers.

Ontology Conceptualization. To organize data and information according to the specified requirements in the domain of IT benchmarking, we created a conceptual domain representation as proposed by NeOn, which was stepwise refined. Starting with a list of terms obtained from the ontology requirements (i.e., extracted from the CQs) and deriving concepts from those terms, we enhanced this domain representation until reaching a semi-formal, graphical model of the intended ontology. Moreover, to enhance the general quality of the final model and to specify concepts in more detail, we used existing data sources (such as service catalogs and related databases (cf. Sect. 4) for the conceptualization, and additionally utilized the NeOn framework for ontology engineering [49]).

Ontology Reuse and Aligning. Existing (non-)ontological resources are used for the development of the ITBM ontology. These resources encompass ITBM data collected over the last eight years in the context of research activities on ITBM at the research institute fortiss and the Technische Universität München (TUM). Moreover, existing domain ontologies in related domains are identified and evaluated for their suitability in the context of ITBM (for additional details see Sect. 2.2). By grounding the ITBM ontology in the upper ontology DUL, the semantic foundation of the ITBM ontology is achieved. To achieve this, relevant concepts in DUL and the ITBM are identified and linked (see Sect. 4).

Ontology Implementation. Within the scope of ontology implementation, the conceptual model obtained during the conceptualization activity is implemented using OWL 2 DL [35]. Note that the expressiveness of OWL 2 entailment is required to formally represent more complex properties, especially property chains, that is, inferring a new property between two concepts based on a chain of existing properties already linking them (complex role inclusion) [22]. With regard to the huge number of indicators, the implementation process is supported by (semi-)automatic tools (i.e., a software script) that generate concepts of the ontology from previously extracted term lists derived from the existing databases.

Ontology Annotation. To keep the ontology readable for humans, we conduct an activity for annotating the ontology. In addition to general information (e.g., the ontology version), concepts and properties are annotated using *rdfs:label* and *rdfs:comment*. In the same way as the implementation activity, this activity is (semi-)automatically supported by the use of existing databases in this domain.

Ontology Evaluation. Before the ontology is published, ontology evaluation is performed. Here, the final ontology is first evaluated against the CQs listed during the specification activity. Then, different tools (i.e., the HermiT reasoner [19] and the OntOlogy Pitfall Scanner (OOPS) [44]) are applied to ensure both that the ontology is consistent as well as its general quality.

In addition to the subsequent activities as described above, the IT benchmarking ontology engineering process is supported by a number of side activities as also suggested by NeOn. Those activities are described as follows:

Ontology Quality Assurance and Control. The control activity refers to process monitoring and ensures that the subsequent activities described above are performed and completed correctly. The ontology quality assurance activity ensures the quality of the ontology implementation process and its artifacts. During the development of the IT benchmarking ontology, the process was monitored and controlled constantly using checklists.

Table 2 Extract of competency questions created during the *Specification* activity, grouped by pre-established categories as suggested by NeOn: (i) Indicator Structure, (ii) Individual Benchmarks and (iii) Participants and Values. Square brackets indicate lists of values

Group	Competency Question (CQ1-CQ20)	Exemplary Answer
Indicator	What performance indicators do exist?	[NumberOfUsers]
Structure (CQ1-CQ6)	What performance indicators are contained in the BENCHMARK_NAME in YEAR?	[NumberOfUsers]
	Regarding BENCHMARK_NAME of YEAR, how many cost indicators have been answered by all participants?	NUMBER
	What IT services are of interest (i.e., have had values provided for) for the ORGANIZATION_NAME ?	[BasicDataIndicator]
	How frequent is the revenue indicator queried within the existing benchmarks?	NUMBER
	How many values have been provided for the revenue indicator of the SERVICE_NAME in total?	NUMBER
Individual	How many benchmarks exist?	NUMBER
Benchmarks (CQ7-CQ11)	In which years was the BENCHMARK_NAME conducted?	[YEAR]
	Which indicators have been queried in at least two benchmarks?	[HardwareCost]
	How many values have been provided for the number of employees indicator in total?	NUMBER
	Which organizations have participated in which benchmarks?	[(ORGANIZATION_NAME, BENCHMARK_NAME, YEAR)]
Participants	How many organizations do exist?	NUMBER
and Values (CQ12-CQ20)	How many organizations have participated in at least one benchmark?	NUMBER
	Does ORGANIZATION_NAME participate in at least one benchmark called BENCHMARK_NAME ?	YES/NO
	What is the yearly revenue of ORGANIZATION_NAME ?	[(YEAR, NUMBER)]
	What was the average hardware costs for BlackBerry devices in YEAR?	NUMBER
	What was the greatest value of hardware costs for BlackBerry devices provided in YEAR?	NUMBER
	What are the hardware cost for BlackBerry devices in YEAR by ORGANIZATION_NAME?	[(ORGANIZATION_NAME, NUMBER)]
	Regarding YEAR, what was the average number of employees of all organizations having a revenue between $NUMBER_1 and $NUMBER_2 ?	NUMBER
	Regarding YEAR, what was the minimum number of employees of organizations having a revenue between $NUMBER_1 and $NUMBER_2 ?	NUMBER

Ontology Documentation. While developing the IT benchmarking ontology, the utilized and created documents and artifacts (e.g., including reasoning of design decisions and code fragments) were collected and ordered for documentation purposes.

As stated before, to allow the ITBM ontology to be machine-processable, it is implemented in OWL (more specifically, following the OWL 2 DL fragment [35]), a World Wide Web Consortium (W3C) standard [3,34]. Thus, the OWL ontology consists of the following: (i) classes as sets of individuals, (ii) individuals as instances of classes (i.e., real-world objects in the domain) and (iii) properties as binary relations between individuals. In addition to the implementation of the domain knowledge, it is possible to define cardinality ranges and other constructs (e.g., taxonomies) allowing inference within an ontology. Moreover, a reasoning engine was used during the development process to avoid inconsistencies in the specifications of the ontology classes and properties. The corresponding ITBM ontology was modeled using the open-source ontology editor Protégé [45], as it is one of the most common tools for ontology development [30].

4 IT Benchmarking Ontology

The IT benchmarking ontology was initially built based on already-existing IT service descriptions and catalogs of

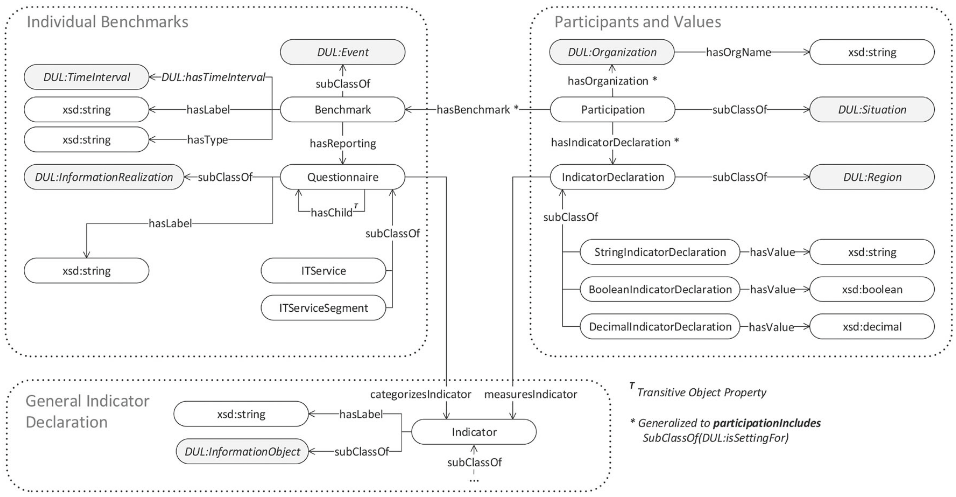

Fig. 2 IT benchmarking ontology consisting of three different sections: (i) Individual Benchmarks, (ii) Participants and Values and (iii) General Indicator Declaration. Solid arrows indicate data or object properties, with their direction being defined by *rdfs:domain* and *rdfs:range* [1]

numerous small- to medium-sized enterprises and several questionnaires from different IT benchmarking approaches. As previously stated, these data were collected over the last eight years in the context of research activities and were supervised and evaluated within different benchmarking approaches (cf. [42,47]). These data encompass results from strategic and consortial IT benchmarks. Subsequently, as a result of the different data acquisition channels of online web platforms, Excel questionnaires and other sources (cf. [10,55]), different distributed data sources were used to derive the concepts of the ITBM ontology. The database consists of 1007 unique descriptions of key performance indicators, which are composed of 25 service catalogs from individual companies. In addition, the underlying data for the ontology development consist of 708 data sets from consortial IT benchmarks. These data sets encompass questions on 15 IT services answered for 10 companies as an yearly average over the last six years. Furthermore, IT benchmarking results from 112 different companies were used to extend the database for the ontology development. These data were acquired over the last eight years within a strategic benchmark based on [46], and each data set consists of 1,612 quantitative and qualitative data points of a single organization. As previously stated, the existing service catalogs and databases were analyzed using NLP techniques to extract the most important concepts and terms relevant to building the ontology (for more details on NLP, see Pfaff and Krcmar [42]).

As described before, the ontology was implemented following the OWL 2 DL fragment [35] and using the common vocabularies based on ITIL [38]. Moreover, the alignment to DUL [15] was added to make the ontological commitments explicit and to specify the intended meaning of the introduced concepts [23].

4.1 Top-Level Description

Starting with the top-level description of the proposed benchmarking ontology, the ontology can be divided into the following three sections: *Individual Benchmarks* (equivalent to one specific benchmark), *Participants and Values* and the *General Indicator Declaration*. *Individual Benchmarks* section introduces concepts to describe, processes relying on different IT service descriptions or questionnaires, including a customizable structure of selectable indicators (measured within a benchmark). Participants (viz. organizations) and their values, which may be instantiated based on these concepts, are described in *Participants and Values* section. The indicators themselves and their hierarchical and intermediate relationships are organized in a three-layer taxonomy referred to as the *General Indicator Declaration* section. The *General Indicator Declaration* is described in more detail in Sect. 4.2 because of its complexity. Figure 2 provides a conceptual overview of the three ontology sections and the relations in between. Gray nodes indicate inheritances from DUL concepts and properties. The nodes of the graph illustrated in Fig. 2 refer to *concepts* (i.e., classes) or *datatypes* [35] of the ontology, whereas the edges refer to *properties* provided by the ontology.

4.1.1 Individual Benchmarks

An IT benchmark is identified by a specific name. As described in Sect. 2, a benchmark may be conducted once or several times within various time periods. In the following, an *individual benchmark* refers to a single conduction of a benchmark that a company is participating in (i.e., an instantiation of the Benchmark class), whereas the benchmarking specification in general refers to a concept of a benchmark that is performed numerous times in different capture or time periods. In other words, two individual benchmarks can be conducted based on two different indicator structures and indicators, or these individual benchmarks can differ in the year of being conducted. In both cases, these benchmarks are represented as a delimited instance within the ontology to uniquely identify individual benchmarks.

As already mentioned in Sect. 2, indicators may be captured in different contexts. For example, whereas an individual benchmark may be based on specific questionnaires (i.e., indicators are grouped in arbitrary categories), the indicator structure of another benchmark may be completely based on a traditional service catalog (i.e., indicators are grouped by the IT service that they belong to). To represent and distinguish the contexts a specific indicator is captured within individual benchmarks; different concepts have been introduced to represent an indicator structure (i.e., *Questionnaire*, *ITService* and *ITServiceSegment*).

In the following, the concepts that an *Individual Benchmark* consists of are described in more detail:

Benchmark. A benchmark can be seen as a time-specific event for the conduction of a benchmark. Thus, the Benchmark class is grounded in the *DUL:Event* concept. An instance must have at least one label, containing the benchmark's name, a type and its specific time interval of conduction. Such a *TimeInterval* is defined for events within DUL and may be freely specified by utilizing the *DUL:hasTimeInterval* property. The *hasType* property refers to the set of benchmark types as described in Table 1 and is therefore limited to those values. Each benchmark has to be assigned to one or two of these benchmarking types. The labels of a benchmark are represented by arbitrary strings, referring to benchmark names, for example expressed in one or multiple languages. For connecting to DOLCE, both *hasLabel* and *hasType* have been defined as a sub-property of *DUL:hasDataValue*.

Questionnaire. During a benchmark event, indicator values are reported by utilizing exactly one previously specified questionnaire that defines a structure for capturing these data of the KPIs. These questionnaires are connected to a benchmark instance using the *hasReporting* property. Within the ITBM ontology, a questionnaire refers to a physical object (e.g., paper sheets), is grounded in *DUL:InformationRealization* and is labeled by at least one headline (e.g., multiple headlines for multiple languages). Indicators are more abstract information objects and are linked to a questionnaire using the *categorizesIndicator* property, which is a sub-property of *DUL:realizes*. A questionnaire or a group of questionnaires consists of different indicators focusing on different aspects or activities within an IT department, such as general service offerings or more generic questions. For more details on the structure of a non-service-based ITBM see Riempp et al. [46]. A questionnaire can be further nested into sub-questionnaires coupling questions to a specific topic of interest to compare through the benchmark. This results in a mono-hierarchical structure that can be realized using the transitive *hasChild* property, which is a sub-property of *DUL:hasPart* and defines a questionnaire to be a part of another questionnaire.

ITService. An IT service consists of a set of different activities to be performed by an IT department to meet specific business or IT demands. Thus, as the structure of an individual benchmark is based on IT service catalogs, describing the parts of this service in natural language and based on indicators for the measurement of the service KPIs, this structural information is represented by the ITService concept. In other words, an ITService is a specialization of the more general questionnaire consisting of KPIs that are directly linked to IT service activities and their organizational resources (such as costs or human resource). Once an IT service is defined, it can also be further divided into sub-services.

ServiceSegment. It is also possible to structure an IT service in more fine-grained ways. Thus, an IT service can be divided into a set of smaller service segments. For example, an indicator set of a service could be divided into indicators referring to mobile and stationary IT systems in accordance with the description of the underlying IT service catalog structure. Moreover, a service segment may be further divided into smaller segments if necessary to maintain the structural information of this service.

4.1.2 Participants and Values

In the domain of IT benchmarking, a participant represents an organization contributing values of benchmarking indicators (answering questions) specific to an individual benchmark. In the ontology, this organization is represented as a class (i.e., Organization) and connected to an individual benchmark (i.e., Benchmark). The contributed values are indicated by the use of the Participation and IndicatorDeclaration classes. The description of these classes is as follows:

Organization. A participant represents an organization participating in specific benchmarks (minimum of one) and is identified by its name. To foster reuse, it refers to the *DUL:Organization* concept provided by the DUL ontology.

Participation. According to the IT benchmarking process an organization contributes its KPIs (alues) while participating in a specific benchmark. In DUL, such participations are usually represented by *DUL:involvesAgent* and the *DUL:isAgentInvolvedIn* properties, established between an event and its participants. However, this approach is insufficient, as a single property cannot represent the ternary relation of a benchmark and the participant in combination with the contributed values (cf. [37]). Therefore, the participation has been implemented based on the Nary Participation ontology design pattern [14], which specifies a reified participation concept and a *participationIncludes* property to link participation with (i) at least one event (e.g., the benchmark), (ii) at least one object (e.g., the participant and its values) and (iii) at least one time interval to describe when the participation in the event occurred. Regarding the ITBM ontology, however, the time index of the participation (iii) was removed as we are only interested in the time span for which collected values are valid (i.e., given by the benchmark event) rather than the time span in which values were collected. Moreover, to further specify the role of a certain entity during one participation, additional properties (i.e., *hasBenchmark*, *hasOrganization* and *hasIndicatorDeclaration*) inheriting from *participationIncludes* have been introduced.

IndicatorDeclaration. For each indicator value, provided by a specific organization, an *IndicatorDeclaration* (grounded in the *DUL:Region* concept) is instantiated. This is included in one participation and represents the measures of exactly one specific indicator. An IndicatorDeclaration has one or multiple values attached to it. Currently, these values can be in the format of strings, Booleans or decimals, represented by the corresponding subclasses. For each pair consisting of a participation and an indicator, only one IndicatorDeclaration is instantiated. Thus, using a subclass referring to a specific unit type, instead of the more abstract IndicatorDeclaration, an indicator can only be described by a single type of unit at one time, even if more values are attached to it (e.g., a list of values).

StringIndicatorDeclaration. A *StringIndicatorDeclaration* refers to indicator values that are described in string format. Suitable indicators include qualitative indicators such as descriptions of service level agreements.

BooleanIndicatorDeclaration. A *BooleanIndicatorDeclaration* refers to indicator values that are described in Boolean format, that is, indicators having binary values assigned (e.g., yes/no). For example, such indicators refer to the question of whether a certain technology is used within an organization.

DecimalIndicatorDeclaration. A *DecimalIndicatorDeclaration* refers to indicator values that are described in decimal format. It represents, for example, quantitative performance indicators, such as the number of workplaces, as well as cost indicators.

One of the most important relations within the concepts described above is the relation between the Benchmark and its associated participation and the involved organizations. The Participation concept is only required to model the ternary relation between a benchmark, its participants and their provided values. This, however, comes at the cost of a more complicated ontology usage, as this intermediate concept has to be considered for related queries. Moreover, using DUL, one would usually expect that for participation relations, a *DUL:involvesAgent* and/or its inverse *DUL:isAgentInvolvedIn* is specified. Unfortunately, the Nary Participation pattern does not include statements to establish such a relation. This issue is addressed by utilizing complex role inclusion [29]. Thus, to define the original *DUL:involvesAgent* property (which also implies its inverse), a property chain consisting of the inverse of *hasBenchmark* ($hasBM^{-1}$) and the *hasOrganization* ($hasOrg$) property has been specified to imply the *DUL:involvesAgent* property and is formally represented as

$$hasBM^{-1} \circ hasOrg \sqsubseteq involvesAgent.$$

As mentioned before, indicators of a specific benchmark (i.e., their instantiation) are linked to a single category using the *categorizesIndicator* object property. If, for example, category *A* nests category *B*, which already nests category *(*C), category *(*A) also nests category *(*C) and is referred to as a transitive relation of categories. This transitiveness does not apply to indicators linked by *categorizesIndicator*. To ensure that category *A* also includes all indicators that are categorized by one of its sub-categories, the following needs to be introduced:

$$hasChild \circ categorizesIndicator \sqsubseteq categorizesIndictor$$

4.2 General Indicator Declaration

General Indicator Declaration section (cf. Fig. 3) introduces a taxonomic description of the indicators used in IT benchmarks. This starts from the top level with the general Indicator class and moves on to the more specific concept of an indicator (for example, the MobileDevicesIndicator in Fig. 3) that refers to indicators that are instantiated by an individual benchmark. In other words, instances of indicators form the

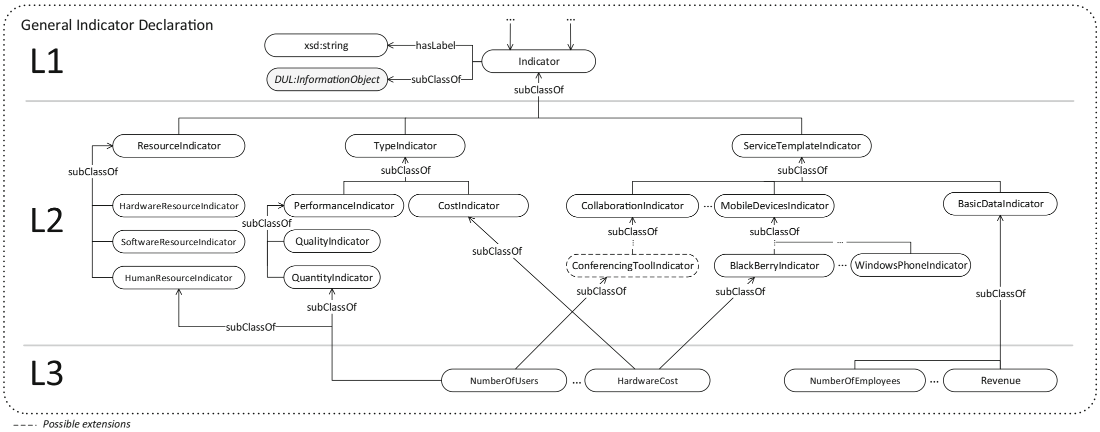

Fig. 3 General Indicator Declaration including exemplary indicators. Solid arrows indicate taxonomic relationships, and concepts with dashed borders indicate examples of more fine-grained extensions of the service template. Statements of disjoint classes are omitted to improve readability

entities that are linked to a benchmark structure described in Sect. 4.1.1. The most specific classes, which contain the subset of indicator instances, refer to the same (specific) indicator, as they are included in different individual benchmarks.

The taxonomy is implemented in three different layers (L1 to L3). Except for the first layer, layers 2 and 3 consist of a large set of classes partitioning the set of available indicators by different characteristics using *subClassOf* definitions. Due to the large number of indicators, in the following, we refer to a complete layer, rather than to a single concept, to provide a more coarse-grained description instead of describing each concept individually.

L1: General Concept. The top layer of the taxonomy only consists of the root concept of the taxonomy: the *Indicator* class. This class constitutes the set of all instantiated indicators and is grounded in the *DUL:InformationObject* class to describe more abstract pieces of information to be realized by a questionnaire. Furthermore, the elementary data property *hasLabel* is defined and used by indicator instances to specify at least one label used as an indicator name within a specific benchmark (equivalent to an individual benchmark).

L2: Indicator Dimensions. Indicators may be classified using different dimensions. In the current ontology version, we introduced dimensions for (i) the (IT) service that is measured according to a service template for the structure of an IT service based on recent research activities [46,47], (ii) the specific type of questions to which an indicator is assigned (i.e., whether it is a cost or performance indicator) and (iii) the type of resource (i.e., hardware, software, or human resource) to which the indicator refers.

There is no natural order for performing hierarchical splits among the different dimensions; thus, all possible splits are performed in parallel in the intermediate layer of the taxonomy. One dimension subdivides the set of all indicators into smaller (sub-)sets. These subsets of indicators belong to a certain service or a certain type of indicator.

Concepts within the same dimension and the same hierarchical level are pairwise disjoint. Specifically, an indicator (L3) may only be of one type for each dimension. Moreover, except for the service template dimension, a dimension does not necessarily need to cover all indicators. Thus, it is possible to specify indicators that are neither cost nor performance indicators and/or do not imply a resource type.

Indicators belonging to the basic data service template (represented by the BasicDataIndicator class) describe the core data of participating organizations (e.g., the yearly revenue), the number of employees, and structural information about the organization among others. Most indicators are neither performance nor cost indicators and therefore are separated in this basic data service. The remaining services refer to more specific IT services, such as those regarding user collaboration or IT infrastructure.

The resource dimension refers to the resources described by a specific indicator. Possible resources include hardware, software and human resources. Performance indicators may be further split into quality (e.g., referring to service level agreements) and quantity indicators. There are, however, performance indicators that are neither quality nor quantity indicators.

Dimensions can have their own intrinsic hierarchy, describing the different concepts they consist of in different granularities. For example, as shown in Fig. 3, the collaboration indicators are additionally specified by the ConferencingToolIndicator class in the service template dimension. Another example at a more specific level includes indicators to be further split according to different quality or hardware standards that they describe, such as BlackBerry or WindowsPhones within the MobileDevices service template.

In contrast to the introduced intermediate abstraction levels shown in Fig. 3, the current implementation of the ontology contains two levels of abstraction within the service template dimension. (Additional splits are marked as possible extensions.) The first abstraction refers to the service name, and the second abstraction refers to an additional sub-classification, for example as, currently implemented for the MobileDevices service. In contrast to the service template dimension, descriptions of other dimensions are expected to remain more constant.

L3: Indicators and Relationships. The bottom layer of the indicator taxonomy consists of the most specific indicator descriptions, referring to a single indicator instantiated by individual benchmarks rather than to an indicator categorization. As explained above, such indicators are classified in one or multiple dimensions (using *subClassOf* definitions) but are only covered completely within the service template dimension.

4.3 Ontology Summary

At present, the IT benchmarking ontology consists of a number of statements, which are summarized in Table 3. The number of classes corresponds to the concepts described in the previous sections, including the 20 top-level service classes (one of which is the basic data service), corresponding to IT services that are commonly measured within an IT benchmark, and the 1064 L3 indicator classes, corresponding to key performance indicators that are measured during an IT benchmark. Entities of the indicator taxonomy do not have their own properties defined but rather inherit the *hasLabel* property from their *Indicator* base class. Therefore, only a small set of object and data properties need to be additionally defined, and they are shown in Fig. 2. Currently, the majority of axioms refer to the number of *SubClassOf* definitions. However, axioms on the domain and range of object properties and statements relevant to the characterization of disjoint classes also exist. The number of annotations includes bilingual (viz. English and German) *rdfs:label* and *rdfs:comment* for all classes. The description logic expressiveness for the benchmarking ontology is $\mathcal{SRIQ}(\mathcal{D})$.

Table 3 Number of classes, properties, axioms and annotations in the ITBM ontology

Ontology Metric	#	Ontology Metric	#
Classes	1192	Logical Axioms	3287
Object Properties	123	Annotations	5264
Data Properties	9		

5 Application and Use Case of the ITBM Ontology

5.1 System Architecture

Because the ITBM ontology is built for the purpose of data access in the domain of IT benchmarking and is based on research activities on strategic and service-oriented IT benchmarking initiatives, the application of the ITBM ontology within a web-based system architecture for data access will be described as follows. The main focus of the presented prototype is on (i) accessing data from external databases through the use of natural language queries and (ii) supporting the (semi-)automatic mapping of concepts of the ontology with data points of the attached databases. The complete system architecture is described in more detail in [43]. Figure 4 illustrates the complete system architecture. A black border highlights the implementation of the ontology within the system.

The connection of external data sources is configured through the use of the data source manager. The data source manager ensures the correct mapping of the relational structure of the attached databases to the corresponding ontology by detecting changes in the relational scheme. These changes are reflected in a new version number for the data source.

The Extract Transform Load (ETL) module is implemented for the data integration task (see below). This process is based on a twofold mapping of the metadata stored in the metadata repository. The first part (part 1) specifies a set of transformation rules to transform external data models (i.e., a database scheme) into a virtual model, where each virtual table (i.e., SQL queries, referred to as *Generators*) corresponds to an ontological concept. The specification in the second part (part 2) utilizes this virtual model to map table instances (i.e., rows) to instances of the corresponding concepts. Examples of those metadata are provided in Listing 1. A *generator* created on top of the organization table of an external database is specified (part 1) and mapped to the *DUL:Organization* concept of the ontology (part 2). To keep the example simple, both further transformations (e.g., filters) and specifications of links to other generators (i.e., foreign keys) have been omitted.

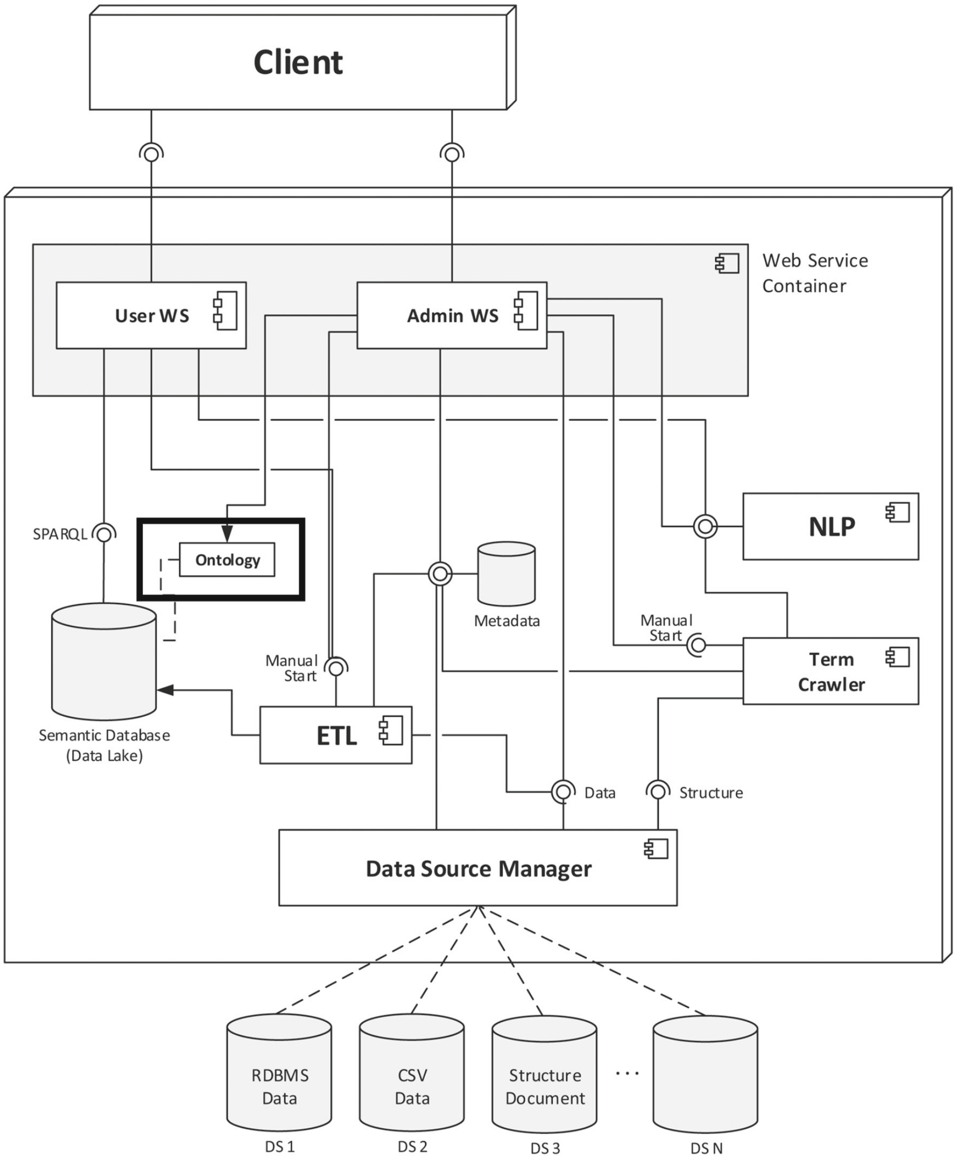

Fig. 4 System architecture for ontology-based data integration [43]

```
<generator name="gen_organization"
   baseTable="organization">
   <primary-keys>
      <column>id</column>
   </primary-keys>
</generator>

<mapping class="DUL:Organization"
   generator="gen_organization">
   <data-property name="bm:hasOrgName
      " value="#{name}" />
</mapping>
```

Listing 1 Exemplary mapping metadata.

Creating such mappings for all tables/concepts is a tedious process; thus, to support the mapping of database contents to ontology concepts (i.e., creating the second part of metadata), a (semi-)automatic mapping recommender is implemented. Here, "(semi-)automatic" refers to the fact that mappings are initially recommended by the system but not applied automatically so that human interaction is needed to confirm recommended mappings for the purpose of quality assurance. The system supports two different types of mapping recommendations. The first type of recommendation assumes that a whole database table corresponds to an existing ontology concept and the second type of recommendation that each database table record is mapped to a different ontology concept. Additional details are provided as follows:

– *Mapping (virtual) tables to ontology concepts:* Often, a (physical) table from the original database schema directly corresponds to a concept defined in the ontology. In this case, all records of this table are converted to instances of this concept. Note that if concepts in the ontology are specified on a more fine- or coarse-grained level of abstraction, such a table may still be constructed virtually using appropriate SQL statements (e.g., JOINs); within the scope of the system, this type of table has been referred to as *Generators*. For example, consider the database table *"organization"*, which contains all the organization names of the participants for a specific benchmark. Thus, the rows of this table directly reflect the instances of the *DUL:Organization* concept that need to be integrated. The matching of database table names to the concepts of the ontology is based on different similarity metrics. This mapping is realized by the mapping recommender. For quality assurance, the mapping candidates are presented to the user for confirmation. An example of such a mapping is given in Listing 1. In this example, the mapping process for two organizations, named *Organization 1* and *Organization 2* (cf. the name column of the organization table), results in the corresponding triples, which are shown in the following Listing 2.

```
:org1    rdf:type        DUL:
   Organization;
         bm:hasOrgName   "Organization
            1"^^xsd:string.
:org2    rdf:type        DUL:
   Organization;
         bm:hasOrgName   "Organization
            2"^^xsd:string.
```

Listing 2 Result of an exemplary table-concept mapping.

– *Mapping (virtual) table records to ontology concepts:* Sometimes records are not meant to be converted to instances of the same concept but rather are partitioned to different concepts. In this case, a specific table is chosen, and each of its records is converted to one instance of a specific concept of the ontology.
For example, a database table of *indicators* may consist of the different indicators that are captured during the benchmark. In this case, however, each row of the table corresponds to an individual concept within the ontology. Consequently, the mapping recommender searches for a corresponding concept for each row of the table within the ontology by applying similarity metrics to each of these rows/concepts. As a result, a mapping entry is generated for every table row. Listing 3 shows the mapping results for the *NumberOfEmployees* table and the *Revenue* table (cf. Fig. 3) labeled with *Number of employees* and *Yearly revenue* to their corresponding ontology concepts.

```
:ind1    rdf:type        bm:
   NumberOfEmployees;
         bm:hasLabel     "Number of
            employees"^^xsd:string.
:ind2    rdf:type        bm:Revenue;
         bm:hasLabel     "Yearly
            revenue"^^xsd:string.
```

Listing 3 Result of an exemplary row-concept mapping.

Both of these mapping cases are implemented through the use of the same underlying bipartite matching algorithm (based on Kuhn and Yaw [31]) differing from its run-time configuration. In the first case (i.e., mapping (virtual) tables to ontology concepts), the total set of virtual and physical table names and the names of the ontology concepts are used as input configuration. In the second case (i.e., mapping (virtual) table records to ontology concepts), the total set of rows of a specified table and the names of ontology concepts are used as the input configuration for the mapping algorithm.

These mappings represent the assignment between the entities and attributes from the data sources and their corresponding concepts and properties of the ontology. According to these mappings, the data integration process is stepwise performed as follows (executed by the extract, transform, load (ETL) module):

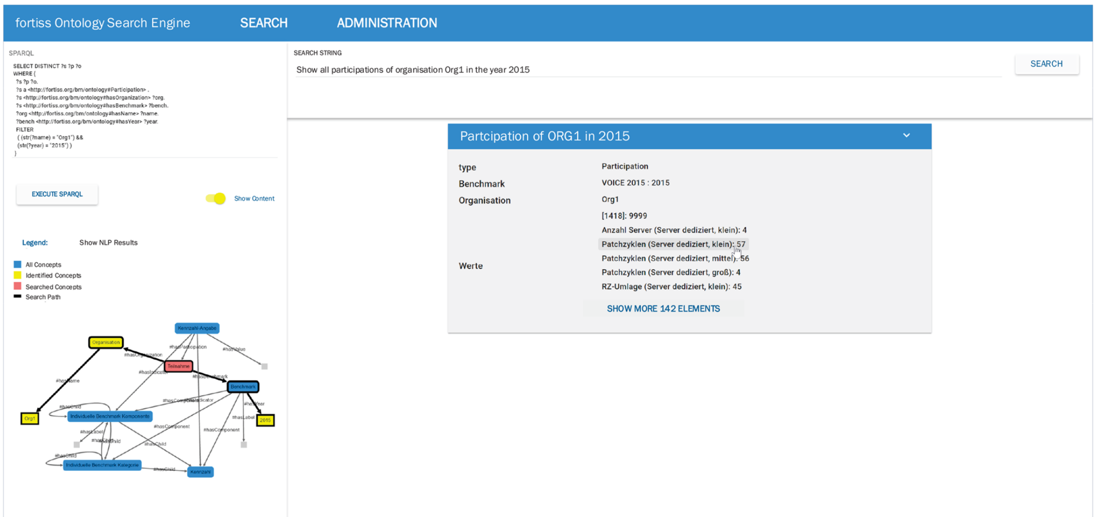

Fig. 5 Client-side search mask for ontology-based data access in ITBM (based on Pfaff and Krcmar [43])

– Load the mapping entries in accordance with the selected versions of both the ontology and the connected databases.
– Apply transformation rules to the relational models of the connected databases to create an intermediate model with bidirectional links between tables; this is realized by creating a set of SQL statements wrapped around the original tables.
– Load data from attached databases via the data source manager using the generated SQL statements.
– According to the second part of the mapping specifications, map tables to concepts by converting their rows into instances of the ontology using the triple-store format.
– Load the data into the semantic database as a new graph within the semantic database; old data are kept in the old graph.
– Check whether the new graph differs from the data loaded in previous ETL iterations and log changes.

A web interface can be used to access the attached data sources via natural language text (text-to-sparql). This client-side user interface is implemented using AngularJS [20] and is shown in Fig. 5. As a result of most of the data sets being in German, the output of the user query ("Show all participations of organisation Org1 in the year 2015") is presented in the German language. Directly underneath the automatically generated SPARQL query, the search tree within the ontology is presented. Blue nodes represent the corresponding concepts in the ontology when the user searches for data sets. In addition, the automatically generated SPARQL queries can be directly edited or reformulated using the web interface.

5.2 Competency Questions and SPARQL Queries

Because data access is generally performed through the use of natural language queries (see Sect. 5) and can also be performed by executing SPARQL queries, the correspondence between the CQs and the resulting SPARQL queries is outlined in the following, focusing on the most complex or interesting queries (see Tables 4 and 5).

CQ2 asks for all performance indicators that have been collected in a specific benchmark of a specific year. In SPARQL, these performance indicators are queried by filtering the set of all benchmarks in accordance with the defined benchmark name and year. As previously stated, all indicators of a specific benchmark are linked to a specific questionnaire (see Sect. 4.1.1). Thus, all performance indicators that are linked to this questionnaire are queried. Please note that the root questionnaire directly categorizes all indicators linked to a benchmark due to the *bm:categorizesIndicator* property chain (see Sect. 4.1.2).

CQ4 asks for the existence of all IT services to which an organization responded within a specific benchmark (i.e., values for indicators are provided by the organization). An organization can participate within various benchmarks; therefore, all its participations, the corresponding indicator declarations and its indicators are queried. As a result of this CQ the result set of this query only contains indicators that have been specified within a specific IT service.

CQ10 asks for the total number of responses provided by an organization for the specific indicator *bm:NumberOf Employees*. The resulting SPARQL counts the number of indicator declaration instances referring to this indicator.

Table 4 Excerpt of competency questions and corresponding SPARQL queries for indicator structure and individual benchmarks

Group	CQ	SPARQL Query

Indicator Structure	CQ2	SELECT * WHERE {
		  ?bm a bm:Benchmark ;
		      bm:hasLabel "<BENCHMARK_NAME>" ;
		      dul:hasTimeInterval <YEAR> ;
		      bm:hasReporting ?qn .
		  ?qn bm:categorizesIndicator ?ind .
		  ?ind a bm:PerformanceIndicator .
		}

	CQ4	SELECT DISTINCT ?service WHERE {
		  ?org a dul:Organization ;
		      bm:hasOrgName "<ORGANIZATION_NAME>" ;
		      bm:isIncludedInParticipation ?part .
		  ?dec a bm:IndicatorDeclaration ;
		      bm:isIncludedInParticipation ?part ;
		      bm:measuresIndicator ?indicator .
		  ?service a bm:ITService ;
		      bm:categorizesIndicator ?indicator .
		}

Individual Benchmarks	CQ10	SELECT (COUNT(?dec) AS ?count) WHERE {
		  ?dec a bm:IndicatorDeclaration ;
		      bm:measuresIndicator ?indicator .
		  ?indicator a bm:NumberOfEmployees .
		}

	CQ11	SELECT ?org ?bm WHERE {
		  ?org a dul:Organization .
		  ?bm a bm:Benchmark ;
		      dul:involvesAgent ?org .
		}

Next, CQ11 queries all participations of all organizations and the benchmarks they participated in using the introduced object property chain, which infers the *dul:involvesAgent* property for all benchmarks and organizations.

CQ13 queries the number of organizations that participated in at least one benchmark. Similar to CQ11, this is achieved using the inverse of *dul:involvesAgent*, that is, *dul:isAgentInvolvedIn*, and then by counting over the distinct result set. Note that without using the DISTINCT command, organizations that have participated in more than one benchmark would be counted multiple times.

By CQ15, the yearly revenue of a specific organization is queried. Using the abstract property *bm:isIncludedIn Participation*, the organization is identified by its name, the years are queried using the specific benchmarks that the organization participated in, and the corresponding values of the revenues are returned.

By CQ19, the average number of employees of all organizations in a specified year with a revenue within a specified range is calculated. Again, the abstract *bm:isIncludedIn Participation* property is used to query the participation pattern. Thus, the organizations, the benchmarks, the indicator declaration of the revenue, and the indicator declaration of the number of employees are queried. The resulting set of values is filtered to match the specified revenue range and the number of employees is averaged and returned.

6 Conclusion and Outlook

This work introduces a domain-specific ontology for the domain of IT benchmarking to bridge the gap between a systematic characterization of IT services, which is closely related to ITSM, and their data-based valuation in the context of IT benchmarking. This ontology will serve as a universal link for the semantic integration of different types of different benchmarking data. It is based on ITBM data and IT service catalogs collected over the last eight years in the context of research activities at fortiss and TUM. The ontology is implemented in an evaluation and reporting tool for ITBM as a core concept for the data access and connection of different ITBM data sources.

The layered indicator structure addresses two major aspects that have to be considered when developing an ontology for IT benchmarking. First, it provides the flexibility needed when assembling a new service based on individual indicators, as it separates the service structure from the indicator structure. Second, new indicators can be introduced or modified apart from the service structure. This eases the maintenance of the ontology for future improvements and customizations on both sides; the indicators and the service structure.

At present, the ontology is divided into three sections: (i) Individual Benchmarks, (ii) Participants and Values, and (iii) General Indicator Declaration. Therefore, a separation of the general time-related information of a benchmark and the

Table 5 Excerpt of competency questions and corresponding SPARQL queries for participants and values

Group	CQ	SPARQL Query

Participants and Values	CQ13	SELECT (COUNT(DISTINCT ?org) AS ?count) WHERE {
		  ?bm a bm:Benchmark .
		  ?org a dul:Organization ;
		        dul:isAgentInvolvedIn ?bm
		}

	CQ15	SELECT ?org ?year ?value WHERE {
		  ?org a dul:Organization ;
		        bm:hasOrgName "<ORGANIZATION_NAME>" ;
		        bm:isIncludedInParticipation ?part .
		  ?dec a bm:IndicatorDeclaration ;
		        bm:isIncludedInParticipation ?part ;
		        bm:measuresIndicator ?ind ;
		        bm:hasValue ?value .
		  ?ind a bm:Revenue .
		  ?bm a bm:Benchmark ;
		       bm:isIncludedInParticipation ?part ;
		       dul:hasTimeInterval ?year .
		}

	CQ19	SELECT (AVG(?value) AS ?avg) WHERE {
		  ?org a dul:Organization ;
		        bm:isIncludedInParticipation ?part .
		  ?bm a bm:Benchmark ;
		       dul:hasTimeInterval <YEAR> ;
		       bm:isIncludedInParticipation ?part .
		  ?dec a bm:IndicatorDeclaration ;
		        bm:isIncludedInParticipation ?part ;
		        bm:measuresIndicator ?ind ;
		        bm:hasValue ?value .
		  ?revDec a bm:IndicatorDeclaration ;
		         bm:isIncludedInParticipation ?part ;
		         bm:measuresIndicator ?revenueInd ;
		         bm:hasValue ?revenue .
		  ?ind a bm:NumberOfEmployees .
		  ?revenueInd a bm:Revenue .
		  FILTER (?revenue > <NUMBER_1> && ?revenue <
		     <NUMBER_2>)
		}

structural information of the utilized questionnaires from the corresponding data that are connected to a specific indicator is achieved. For future work, *General Indicator Declaration* section, which is implemented in a three-layer (L1 to L3) architecture that considers the relevant relations and dependencies of all indicators within a benchmark could be extended by introducing further categorization within the service template dimension as well as by introducing a new dimension, therein consisting of a set of several disjoint L2 classes in the L2 layer referring to different unit types. It could be the case that various indicators share their unit or may be of different indicator unit types within different IT services. For example, one performance indicator can be represented by a single number (e.g., number of physical hosts), whereas another indicator can be indicated by textual values (e.g., the name of a specific software product). The same holds true for cost indicators, which might be expressed in different currencies (e.g., Euros or Dollars) or other units (e.g., full time equivalents (FTEs)). In addition, some indicators that are neither cost nor performance indicators (i.e., that are not classified within this dimension) could also share their type of unit with cost or performance indicators. For example, the yearly revenue, which is part of the basic data service, could be seen as a shared cost indicator, and the number of employees of an organization can be an example of a shared performance indicator. To overcome this fragmentation of different indicator types, the dimension of the *General Indicator Declaration* could facilitate defining a set of restrictions across different dimensions, i.e., classes referring to unit types could be declared pairwise disjoint from classes belonging to different dimensions (e.g., CostIndicators could be defined disjoint from any type of textual unit types). By directly assigning the unit type to an indicator, a more fine-grained indicator categorization would be achieved.

The ITBM ontology is already implemented as bilingual (viz. English and German) using annotation properties, and the application that the ontology is part of handles terminological transformations through the NLP module, which is sufficient for the current use case, as all concepts of the ontology are already lemmatized. In the future, this linguistic information could be further improved through the use of an ontology lexicon such as the lexicon model for ontologies (lemon) as introduced by Cimian et al.

[7]. In this manner, it could be possible to improve the results of the NLP module, especially if the ITBM ontology is continuously expanding and if multiple languages and vocabularies need to be associated with the ontology.

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A web-based system architecture for ontology-based data integration in the domain of IT benchmarking

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ABSTRACT

In the domain of IT benchmarking (ITBM), a variety of data and information are collected. Although these data serve as the basis for business analyses, no unified semantic representation of such data yet exists. Consequently, data analysis across different distributed data sets and different benchmarks is almost impossible. This paper presents a system architecture and prototypical implementation for an integrated data management of distributed databases based on a domain-specific ontology. To preserve the semantic meaning of the data, the ITBM ontology is linked to data sources and functions as the central concept for database access. Thus, additional databases can be integrated by linking them to this domain-specific ontology and are directly available for further business analyses. Moreover, the web-based system supports the process of mapping ontology concepts to external databases by introducing a semi-automatic mapping recommender and by visualizing possible mapping candidates. The system also provides a natural language interface to easily query linked databases. The expected result of this ontology-based approach of knowledge representation and data access is an increase in knowledge and data sharing in this domain, which will enhance existing business analysis methods.

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1. Introduction

Benchmarking, as a systematic process for improving organizational performance, has considerably increased in popularity worldwide since the 1980s. This process is based on the insight that by observing organizations and analyzing their performance, an organization can transform the way that it conducts business. In the context of benchmarking, such a transformation is generally achieved by applying the lessons learned from benchmarking results to one's own organization (Camp 1989; Peters 1994). Moreover, such performance measurements (or benchmarking) can often assist in explaining value or cost aspects to stakeholders (Spendolini 1992). Thus, the analysis and evaluation of this type of performance measurement approach have been the subject of various studies (e.g., Smith and McKeen 1996; Gacenga et al. 2011).

In fact, research in the field of IT benchmarking (ITBM) is typically focused on the structuring, standardizing and generalizing of IT service catalogs and on their implementation within companies (e.g., Dattakumar and Jagadeesh 2003; Kütz 2006; Nissen et al. 2014) to model internally provided IT services in a standardized manner. Since IT service catalogs are commonly

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designed for internal or individual purposes only, they are often not directly comparable, particularly across different organizations. The information collected in a benchmark exercise is generally obtained using questionnaires on a broad range of topics, such as employee costs, software licensing costs, quantities of hardware and so forth. All of these approaches have one commonality: a concept for a uniform data management is not considered although it is strongly recommended (Wollersheim, Pfaff, and Krcmar 2014; Pfaff and Krcmar 2015). Moreover, little work published to date in the IS literature addresses this challenge of data integration across different types of IT benchmarks. Thus, most literature sources omit facts related to data quality and data integration. The lack of a uniform description of any arbitrary parameter that is measured and the relationships between parameters, limit the comparability of different types of benchmarks. In general, a domain-specific ontology may be a solution to ensure that the collected data are meaningful and to overcome these limitations of data comparability (Horkoff et al. 2012; Pfaff and Krcmar 2014).

An ontology can either be constructed with assistance from domain experts or be discovered from domain-specific data. The first approach in ontology construction is performed manually and has high time and energy demands. If the ontology is to be developed for a more complex application area, then it tends to become increasingly subjective. An ontology may differ in numerous aspects depending on the recipient of the ontology, even when the ontology is constructed by domain experts. This is in contrast to the idea of a universal, common description of domain-specific knowledge. The second method of developing an ontology using the support of automated or semi-automated methods reduces the manual effort required for ontology construction and enhances the quality of the obtained ontology. Therefore, this paper is based on the results of the development of a domain-specific ontology in the ITBM domain supported by the use of natural language processing (NLP) techniques, as presented in (Pfaff and Krcmar 2014). This ontology was initially constructed based on already existing IT service descriptions and catalogs of numerous small- to medium-sized enterprises and on several questionnaires from different ITBM approaches. The data presented here were collected over the past seven years; they were supervised and evaluated within different benchmarking approaches and they encompass data from strategic and consortial IT benchmarks. Subsequently, as a result of the different acquisition channels through which the data were collected (i.e., on-line web platforms, Excel questionnaires and other sources), various different distributed data sources could be integrated using this domain ontology. In this paper, this ontology is used as the basis for a uniform data description in the domain of IT service management (ITSM) in general and ITBM in particular. To foster reuse of the benchmarking ontology the linkage to concepts provided by the DOLCE UltraLite (DUL) ontology (2010) is also implemented. The benchmarking ontology in version 1.1 is available at https://w3id.org/bmontology. In addition to this domain ontology, a system architecture for the integration of existing distributed data sources is presented in this paper. Thus, this work addresses the following questions: How can a system be designed to integrate existing distributed data sources using a domain-specific ontology? How can the administrator be supported to keep all the system components (mappings) up to date? To provide users with simple access to these distributed data sources NLP techniques are used to translate natural language requests into SPARQL (W3C 2008) queries. The system architecture follows a service-oriented design, encapsulating client (user)-side functionalities in a browser application and server-side funcionalities in replaceable (service) components. Because ontologies are not static entities but evolve over time, the system is able to handle version changes of the ontology to safeguard data accessibility to the attached data sources.

The remainder of this paper is organized as follows: Section 2 provides an overview of the relevant literature on the domain of ITBM, the ITBM ontology and on ontology-based applications. Section 3 addresses methods for data integration in ITBM and describes the proposed system architecture for the ontology-based data integration of various distributed data sources in this domain. Section 4 summarizes the results and metrics used for the data integration and presents the prototypical implementation of the proposed system architecture. Finally, Section 5 offers conclusions and perspectives for future work and extension possibilities of the proposed system.

2. Background

2.1. *The domain of IT benchmarking*

As a systematic process for improving organizational performance, benchmarks can be classified according to the type of study (e.g., processes, products, strategies or generic objects) (Carpinetti and Oiko 2008). Benchmarking partners may be units of the same organization, competitors in the same or different geographical markets, or organizations in related or unrelated industries. Thus, a distinction is drawn between internal and external comparisons of these performance measurements. Whereas an internal performance measurement focuses on the operation of a single company, an external performance measurement focuses on different companies. A benchmark can be subdivided into several process phases, beginning that the initial conception which describes the object of investigation and ending with optimizing and re-organizing internal (business) processes. In each of these phases of a benchmark, numerous data are collected in various data formats. These data consists of both qualitative and quantitative statements and are collected throughout the entire benchmarking cycle for every benchmark. Furthermore, these data are collected for every benchmarking participant. As previously stated by Ziaie et al. (2012) and described in a structural form by Riempp, Müller, and Ahlemann (2008), tool-based data collection is quite common in the ITBM domain.

The representation of business knowledge using ontologies has become popular in recent years, with a particular focus on the representation of business processes (Thomas and Fellmann 2009; Garcia-Crespo et al. 2011; Aldin and Cesare 2011; Jung et al. 2015; Hachicha et al. 2016). By nature, when an ontology is constructed with a focus on business processes, it lacks the information needed to shift the focus to financial aspects, which are of crucial importance in the ITBM domain. The same holds true for ontologies used for business modelling, system configuration and execution management systems, as presented by Cai et al. 2016), as well as for typologies in the context of business process management (BPM), as introduced by Müller et al. (2016). On the one hand, this also applies for ontologies in the context of ITSM (Freitas, Correia, and E Abreu 2008; Valiente, Garcia-Barriocanal, and Sicilia 2012), IT governance frameworks in the context of the Information Technology Infrastructure Library (ITIL) (Office 2011) and for related ontologies, such as the GoodRelations ontology (Hepp 2008) or the Financial Industry Business Ontology (FIBO) (Council 2016). On the other hand, ontologies such as the Business Model Ontology (BMO) (Osterwald, Pigneur, and Tucci 2005) and the e3-value ontology (Gordijn and Akkermans 2001) only focus on the conceptualization of economic aspects within a single enterprise or economic aspects within a network of enterprises. To the best of our knowledge, the only existing approach for measuring the impact of IT infrastructure changes on business processes and vice versa by an ontology was introduced by Vom Brocke et al. (2014). However, the focus of this study is in linking (inner) organizational processes to their corresponding IT resources. However, (semi) automatically compare IT-related and business-related performance indicators across company boundaries, a more fine-grained conceptualization of such information is needed, especially if linking external data sources (i.e., map ontology concepts to IT business-related KPIs) to concepts within an ontology.

2.2. *The IT benchmarking ontology*

The basis for the development of the ITBM ontology is IT service descriptions in the form of IT service catalogs from different (IT) companies. Moreover, ITBM questionnaires (based on Riempp, Müller, and Ahlemann (2008); Rudolph and Krcmar (2009)) are used to construct the ontology. The structural layout of an IT service catalog can be generalized to (i) basic organizational information (such as the number of employees and revenue), subsequently referred to as basic data service, and (ii) 19 additional IT services, describing more specific aspects of IT offerings (see Figure 1). These IT services provide some general information about the purpose of the service offering (for example providing a mailbox or a virtual machine/server) and detailed information about the performance and cost indicators that are used to measure the performance of this service. Note that calculations of indicators may be dependent on different services. For example, the storage service contains all costs associated with disk storage in a data center; however, some of these storage-specific costs are also required within a more general IT service, such as in the context of server costs (as disk storage is associated with servers in general). Additionally, costs originally related to the database service are based on both the general server costs as part of the infrastructure component and the more specific disk storage costs. Again, some cost indicators of the database service depend on the performance indicators of the server and data storage service. It is also possible that IT services inherit indicators or values from the basic organizational information (such as the total number of employees of an organization) to perform further calculations within a specific service based on such a basic indicator.

The structural layout of the IT service catalogs and IT service descriptions used to construct the ontology is presented in Figure 1. In short, IT services are mono-hierarchically structured. Each top-level service consists of a set of subordinated service segments and optionally additional indicator groups. As shown in Figure 1, the basic data service's segments correspond to general organizational information (i.e., organizational structure, IT costs, and so forth), and the remaining IT services are segmented based on whether they are cost or performance indicators and optionally grouped into smaller logical units (for example, the host or guest systems in the context of the virtual server service). Services may also include the costs of other services (e.g., a database service also includes the cost specified in a virtual server service). The core concepts of the benchmarking ontology are described in Section 3.1.2.

To allow ontologies to be machine processable, their modeling is often implemented in the Web Ontology Language (OWL) because it is part of the World Wide Web Consortium (W3C) languages (Calvanese, De Giacomo, and Lenzerini 2001; McGuinness and Van Harmelen 2004). Technically, OWL is an extension of the *Resource Description Framework* (RDF) and the *RDF Schema* (RDF-S), which are based on XML as an interchange syntax. As an extension of RDF and RDF-S, OWL ensures the smooth technical exchange of information among applications within the context of the Semantic Web and business

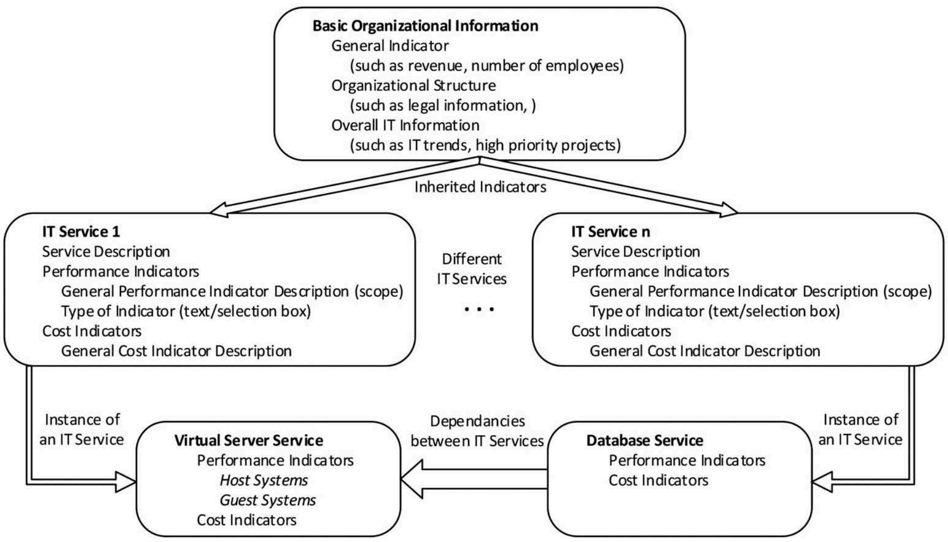

Figure 1. Structural overview of the IT service catalogs used to construct the ontology.

modeling frameworks (e.g., BPMN framework), which are also based on XML as their interchange syntax. An OWL ontology consists of: (i) classes as sets of individuals, (ii) individuals as instances of classes (i.e., real-world objects in the domain), and (iii) properties as binary relations between individuals. In addition to the implementation of domain knowledge, it is possible to define cardinality ranges and reasoning rules within an ontology. Several reasoning engines (e.g., Pellet 2015) exist that can be used to infer additional knowledge explicitly included in an OWL ontology (e.g., class equivalence checks). An OWL ontology can be modeled using open-source ontology editors such as Protégé (2014), which is one of the most common tools for ontology development (Khondoker and Mueller 2010).

To develop the ITBM ontology, we implemented a customized process based on the NeOn framework for ontology engineering Suárez-Figueroa, Gómez-Pérez, and Fernández-López (2012). The ITBM ontology is the result of a number of iterations of the overall ontology engineering process, which is based on an iterative-incremental life cycle model. Thus far, both the NeOn core scenario and the NeOn scenario for the reuse of ontological resources have been used. In addition, some of the NeOn activities were adapted to keep the engineering process as lightweight as possible. According to the NeOn specification for *knowledge acquisition* ontology learning was conducted to support the domain experts in performing the ontology elicitation activity; here, existing service catalogs and databases were analyzed using NLP techniques to extract the most important concepts, as described in detail in (Pfaff and Krcmar 2015). Following the NeOn guidelines for the specification activity, competency questions were formulated, categorized and prioritized (see Table 1). Moreover, the ITBM ontology is grounded in the upper ontology DUL to set the semantic foundation of the ITBM ontology (for details on the relevant concepts that are linked in DUL and the ITBM, see Section 3.1.2). The ITBM ontology was modeled using the open-source ontology editor Protégé.

2.3. *Ontology-based applications*

Storing information in ontology-based knowledge bases or systems is becoming increasingly popular across various areas of research. Lehmann et al. (2015) introduced an approach to extract knowledge from Wikipedia using the Semantic Web and linked data technologies, called DBpedia.

Table 1. Extract of competency questions created during the *specification* activity grouped by pre-established categories as suggested by NeOn: (i) indicator structure, (ii) individual benchmarks, and (iii) participants and values. The square brackets indicate lists of values (Pfaff, Neubig, and Krcmar 2017).

Group	Competency Question	Exemplary Answer
Indicator Structure	What performance indicators exist?	[NumberOfUsersIndicator]
	What performance indicators are contained in the BENCHMARK_NAME in YEAR?	[NumberOfUsersIndicator]
	Regarding BENCHMARK_NAME of YEAR, how many cost indicators exist?	NUMBER
	What IT services are of interest (i.e., values have been provided for) for the ORGANIZATION_NAME ?	[BasicDataIndicator]
	How many values have been provided for the revenue indicator of the SERVICE_NAME in total?	NUMBER
Individual Benchmarks	How many benchmarks exist?	NUMBER
	In which years was the BENCHMARK_NAME conducted?	[YEAR]
	Which indicators have been queried in at least two benchmarks?	[DesktopInstallCostIndicator]
Participants and Values	How many organizations exist?	NUMBER
	How many organizations have participated in at least one benchmark?	NUMBER
	Does ORGANIZATION_NAME participate in at least one benchmark called BENCHMARK_NAME ?	YES/NO
	What is the yearly revenue of ORGANIZATION_NAME ?	[(YEAR, NUMBER)]
	Regarding YEAR, what is the minimum number of employees of organizations having a revenue between $NUMBER and $NUMBER ?	NUMBER

DBpedia serves as a linked data source on the Web since it covers RDF links pointing to various external data sources and vice versa. This linkage (mapping) is performed manually by the community. For DBpedia, Paredes-Valverde et al. (2015) developed ONLI (ontology-based natural language interface) for querying DBpedia using natural language techniques. Rodríguez-García et al. (2014) proposed a semantically enhanced platform based on an ontology for annotating cloud services to assist in the process of discovering the cloud services. This annotation for the cloud services semantic repository is generated automatically, but no further external data sources are directly attached by the semantic structure of an ontology. Ong et al. (2017) introduced Ontobee as a linked ontology data server that stores ontology information using RDF triple-store technology that supports the query, visualization and linkage of ontology terms in the biomedical and biological domains. Ontobee primarily used for ontology term querying and result visualization, and it allows the execution manually written SPARQL code. In the healthcare domain, Lasierra et al. (2014) introduced an ontology-based system to capture knowledge regarding item management and usage for hospitals and medical centers. The focus of this system is to align and unify dispersed health catalog modeling items and the structure of the organization related to their management rather than in data access of external sources by an ontology. Using Ontop, Calvanese et al. (2016) presented an open-source ontology-based data access (OBDA) system that is used for querying relational data sources in terms of executing manually written end-users SPARQL queries. The mapping is of mappings to an existing ontology and by executing end-users SPARQL queries. The mapping of ontology concepts to data sources is performed manually using traditional mapping languages, such as the W3C RDB2RDF mapping-language (R2RML) (Souripriya, Seema, and Cyganiak 2012). The advantages of an ontology-based data management approach were evaluated by Daraio et al. (2016). Keeping all components of the system up to date, particularly the ontology and the mapping, is still the responsibility of the administrators of the system and is performed manually. Tatu et al. (2016) presented an approach for converting users natural language questions into SPARQL for querying and retrieving answers from an RDF store. Because the focus of their research is in transforming semantic structures identified in unstructured data sources (documents) to an RDF store that is accessible via natural language questions, the mapping of ontological concepts to (external) data sources is beyond the scope of their proposed framework. The same constraint holds true for OntoNLQA (Asiaee et al. 2015), which was introduced to query RDF data annotated using ontologies to allow posing questions in natural language. In the clinical and clinical research contexts, Mate et al. (2015) introduced a system for linking information of different systems using declarative transformation rules for ontologies of the source system and the target system. Here, the mapping of the target ontology to the source ontology is also created manually. Focusing on specific technologies for the translation of RDB to RDF, Michel, Montagnat, and Faron-Zucker (2014) and Sahoo et al. (2009) provided a brief overview on the individual technologies. As a symmetrization of the work, at present, domain-specific mappings for data semantics that lies outside an RDB schema are commonly performed manually.

3. Benchmarking data and knowledge integration

A system for integrating various distributed data sources and documents must be able to not only handle various data sources but also integrate various data formats to serve as an effective tool for knowledge processing and knowledge representation (Nalepa 2010; Pfaff and Krcmar 2015). Therefore, this paper presents an ontology-based knowledge support system with a domain-specific ontology as a pivotal methodology for representing domain-specific conceptual knowledge, as proposed by Guo and Zhang (2009) and Pfaff and Krcmar (2014, 2015). Because ontologies offer certain advantages over regular database schema, for example, they are highly flexible and enable modifications and extensions (Zhang, Hu, and Xu 2010) in a straightforward manner, the presented system architecture addresses this unique capability through the use of a separate metadata repository. This repository is used to map the distributed data sources to the ontology (and its possible version changes over time) in a continuous update/integration interval.

3.1. *System architecture*

The basic service-oriented architecture of the web-based system for ontology-based data integration is illustrated in Figure 2. The web application is implemented using the Play Framework (Play 2016), offering stateless representational state transfer (REST) services (Fielding and Taylor 2000) for (client-side) interactions and encapsulating application logic in services with a uniformly defined interface (server-side). In this figure, *Client* represents the web browser-based user interface, allowing the user to interact with the server-side implementation. On the server side, the *Web*

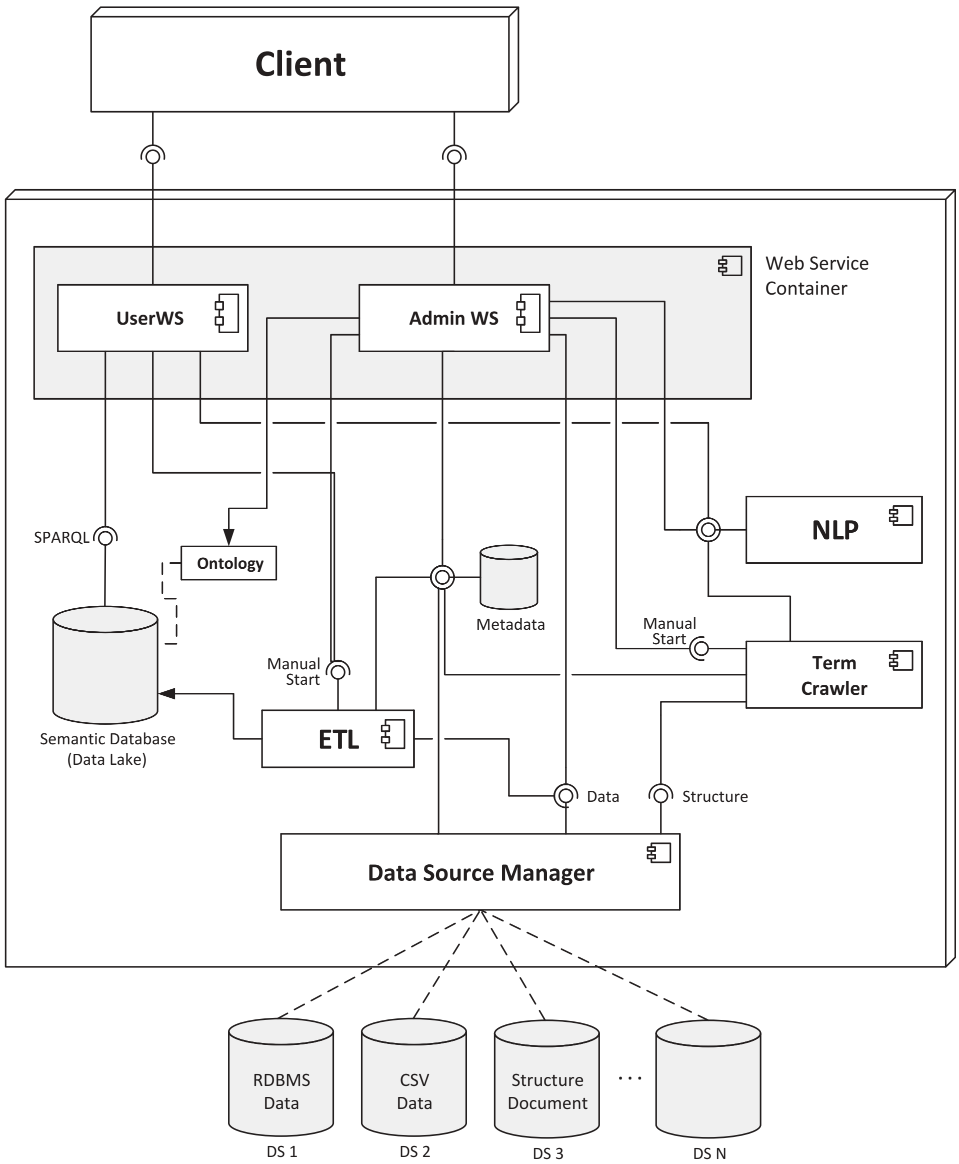

Figure 2. System architecture for ontology-based data integration.

Service Container encapsulates web services (WS) for both user roles: the general user (User WS) and the administration user (Admin WS). The general user has only limited rights to modify the links between the attached data sources and the ontology: thus he is only allowed to formulate natural language requests, which are automatically translated into SPARQL queries using NLP techniques and the extract, transform, load (ETL) module. Conversely, the administration user is allowed to reconfigure the complete system, including the mapping configuration. At present, this type of user and access management is sufficient because all individuals using the system have the right to access all data attached to the system. For future implementation possibilities in terms of more finde-graind user management and access controls, see Section 5.

3.1.1. *Web service container*

As previously mentioned, the system is implemented in the REST paradigm and is therefore accessible via the Web, and the web service container provides functionalities for two different user roles. The *user web service* (User WS) processes user requests in natural language form. These requests are analyzed using NLP techniques and are transformed and forwarded to the semantic database using SPARQL. By design, the NLP module, which can be executed by any user, focuses on a high rate of accuracy in its first iteration with the purpose of identifying as many domain-specific terms as possible within the data sets to be analyzed. In its second iteration, a high rate of *precision* is desired, identifying only results relevant to the (user or administration) queries (Pfaff and Krcmar 2015). In addition to these search requests, users may also trigger the ETL module to reload the linkage between the ontology and the attached data sources. Note that through the user role, only the existing linkage between the attached database and the ontology can be reloaded. It is not possible for the user to update or modify links between concepts of the ontology and database objects.

The *admin web service* (admin WS) performs the following operations:

– *Ontology Update*: Through this operation, it is possible to either upload a new ontology or update an existing one. This ontology is stored in the semantic database. At this point, the new ontology is versioned, and the metadata repository is flagged as no longer valid due to possible mismatches between the data sources and the new ontology (see Section 3.1.3 for details). Moreover, the dictionary that is part of the NLP module may be updated with new terms introduced by concepts or synonyms contained within the new version of the ontology.
– *Data Source Management*: The attached data sources can be configured using the data source manager. It is also possible to connect structured and unstructured data sources. All necessary configurations for access to the data sources, such as internal database names or source folders, are stored in the metadata repository. Moreover, all attached sources (ontology and databases) are versioned to ensure that later mapping activities are linked with the correct version (for details see Section 3.1.3).
– *Structure Mapping*: For a user with the administrator role, it is possible to specify the mapping of the attached databases to concepts contained within the ontology. Thus, this role possesses the right to read from the attached data sources and the right to write the mappings into the metadata repository. Using the NLP module, similar terms contained in the ontology and the attached data sources are first recommended as mapping candidates.
– *Term Crawler Configuration*: It is possible to configure the term crawler to run periodically in addition to its manual execution by a user with the administrator role. The term crawler, which uses NLP techniques was previously introduced Pfaff and Krcmar (2015).
– *Manual ETL Start*: In addition to the periodic execution of the ETL process, it is possible for this event to be triggered manually by a user or administrator.

All operations are performed through a graphical user interface (GUI) with which administrators and users are able to trigger the previously mentioned operations stepwise guided by an operation wizard.

3.1.2. *SemDB and ontology*

The semantic database (SemDB) is implemented with Virtuoso Universal Server as a triple store (Erling and Mikhailov 2010; OpenLink 2015). Because the database represents a SPARQL endpoint, it can be accessed through SPARQL queries. In addition to the semantically processed data provided by the attached external databases, SemDB also stores the ontology used for the mapping process.

The ontology can be divided into the three following sections: *individual benchmarks* (equivalent to one specific benchmark), *participants and values* and the *general indicator declaration*. Three concepts are used to describe the *individual benchmarks*, including a customizable structure of selectable indicators (measured within a benchmark), participants (viz., organizations) and the values that may be instantiated based on the concepts described in the *participants and values* section. The indicators themselves and their hierarchical and intermediate relationships are organized in the *general indicator declaration* section. An *indicator* itself is either a *PerformanceIndicator* or a *CostIndicator*. Indicators at the *PerformanceIndicator* level are non-cost indicators, such as quantity details or performance details. As indicated by the name, *CostIndicator* subsumes all indicators related to financial aspects that are compared in a benchmark. Because each indicator is included in at least one benchmark, this information is represented through by the indicator label. In this manner, it is possible to associate an indicator of one benchmark with an indicator of a different benchmark that has a different name but is identical from a semantic perspective (i.e., measure the same objective). A specific benchmark is specified by its label, represented by an arbitrary string and the year is represented by the standardized *gYear* literal type according to (Peterson et al. 2012) within the concept of *individual benchmarks*. Here, the type property refers to the set of benchmark types (such as a process, product, strategic or generic benchmark (cf. Carpinetti and Oiko 2008) and is limited to those values. For the connection to DOLCE, the *benchmark* class has been defined as a sub class of the *DUL:Event* class of the DUL ontology.

The components property facilitates the assignment of multiple *BMComponents*. Each BMComponent is either an instance of an indicator or a collection *(BMCategory)* of indicators. Consequently, it is possible to instantiate any arbitrary hierarchical structure of *BMCategories* and indicators. A *participation* in a benchmark is represented for each participating *organization* and its associated responses to an indicator by the intermediate concept *IndicatorDeclaration*. Thus, it is possible to associate an organization with a benchmark even without the existence of any specific indicator values (e.g., no responses have yet been given but the organization is participating in the benchmark) using the concept of *participants and values*. To foster reuse, an *organization* refers to the *DUL:Organization* concept provided by the DUL ontology Gangemi (2010).

Figure 3 provides a conceptual overview of these three ontology sections and the relations in between. Grey nodes indicate DUL concepts and properties. The nodes of the graph illustrated in Figure 3 refer to *concepts* (i.e., classes) or *datatypes* (cf. Motik, Patel-Schneider, and Parsia 2012) of the ontology, whereas the edges refer to *properties* provided by the ontology. A class can also be considered as a set of instances, and a subclass can be considered as a subset of those instances (Motik, Patel-Schneider, and Parsia 2012). A property can either establish a direct link between instances of two classes or link an instance to a literal (i.e., a value of a certain data type).

3.1.3. *Extract, transform, load module and metadata repository*

The ETL module is implemented as an independent single thread with a continuous execution interval in addition to being a triggered event (executed on demand by the user). The main tasks of the ETL process are (i) loading the external data into the semantic database by generating a virtual table based on the database structure of the external data base, and (ii) resolving redundancies that may occur during the loading process by the entity resolution (ER) step (see Section 3.1.4 for details on ER).

Prior to the execution of the ETL module, the versions of the currently used ontology and its attached databases are identified. The versioning of the ontology is assured because an uploaded ontology is always annotated with its version number (using the OWL *versionInfo* tag). The data source manager is used to ensure the correct mapping of the relational structure of the attached databases to the

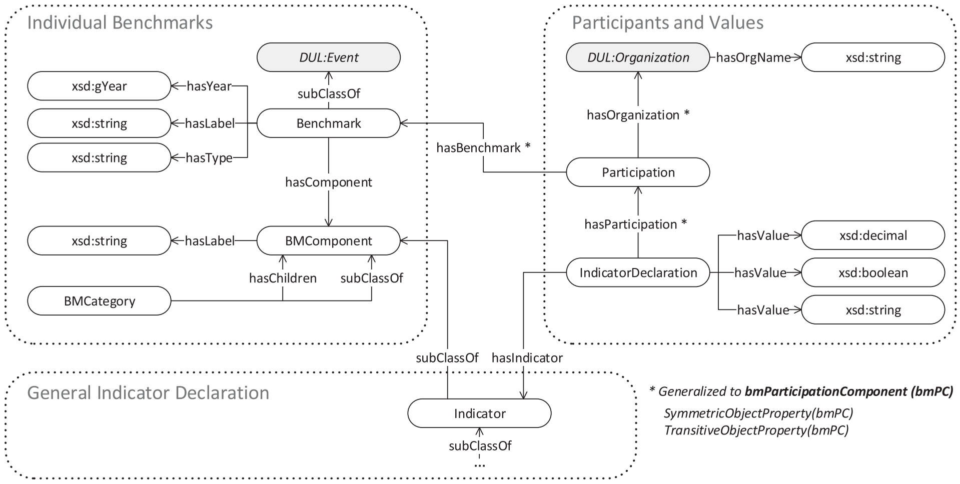

Figure 3. Benchmarking ontology. Source: Pfaff, Neubig, and Krcmar (2017).

corresponding ontology version. These steps are crucial to ensuring compatibility between the metadata and the ontology/databases and thus to guarantee that the mapping is performed on a sound basis.

The mapping of metadata that are stored in the metadata repository is two-fold. The first part specifies a set of transformation rules that transform the relational models of the connected databases into virtual models (i.e., nested SQL queries rather than physically transformed tables) and where each table of a connected database corresponds to a concept within the ontology. The second part specifies mappings from this virtual model to the target ontology itself. These mappings consist of the assignment between the entities and attributes from the data sources and their corresponding concepts and properties of the ontology. According to these mappings, the data integration process is performed stepwise as follows:

(i) Load the mapping entries from the metadata repository in accordance with the selected versions of both the ontology and the connected databases.
(ii) Apply transformation rules to the relational models of the connected databases to create an intermediate model with bidirectional links between tables; this is realized creating a set of SQL statements wrapped around the original tables.
(iii) Load data from the attached databases via the data source manager using the generated SQL statements.
(iv) According to the second part of the mapping specifications, map tables to concepts by converting their rows into instances of the ontology using the triple-store format.
(v) Use the Virtuoso bulk loader to load the data into a new graph within the semantic database; old data are retained in the old graph.
(vi) Check whether the new graph differs from the data loaded in previous ETL iterations and log changes.

The following example illustrates the result of the ETL process (i.e., the *mapping* between the ontology) based on Figure 3 and two external data sources. The name space used for the uniform resource identifiers (URIs) for the concepts and properties of the ontology is represented in shortened form by the prefix *bm*. The instances of benchmarking values depending on which data source is mapped are indicated by the prefixes *v* and (i). In this example, two indicators (Indicator1a and Indicator2a) of a data set *a* from the first data source *v* and one indicator (Indicator 2b) of a different data set *b* from the second data source *v* are linked to each other using the benchmarking ontology. As previously noted and shown in Figure 3, a data set is always linked to an organization that is a participant in a specific benchmark. Thus, these three indicators are associated with two organizations (organizations A and B, where organization A is a participant in two benchmarks). The linkage between these three indicators and the ontology is shown below. In this example, *OrganizationA* is a participant in *benchmarkA*, providing *indicator1* and *indicator2*, and it is also a participant in *benchmarkB*, providing only *indicator2*. *OrganizationB* is a participant only in *benchmarkB*, providing *indicator1*.

```
# Instances of indicators with labels for each benchmark.
v:indicator1            rdf:type bm:Iindicator1;
                        bm:label "Indicator_1a"^^xsd:string.
v:indicator2            rdf:type bm:Indicator2;
                        bm:label "Indicator_2a"^^xsd:string.
i:indicator1            rdf:type bm:Indicator2;
                        bm:label "Indicator_2b"^^xsd:string.
```

```
# Definitions of benchmarks.
v:benchmarkA            rdf:type bm:Benchmark;
                        bm:year 2015;
                        bm:label "Benchmark_A"^^xsd:string;
                        bm:components v:indicator1;
                        bm:components v:indicator2.
i:benchmarkB            rdf:type bm:Benchmark;
                        bm:year 2015;
                        bm:label "Benchmark_B"^^xsd:string;
                        bm:components i:indicator2.
```

```
# Definitions of the organizations for each benchmark.
v:OrganizationA         rdf:type bm:Organization;
                        bm:organizationName "Name_of_Org_A"^^xsd:string.
v:OrganizationB         rdf:type bm:Organization;
                        bm:organizationName "Name_of_Org_B"^^xsd:string.
i:OrganizationA         rdf:type bm:Organization;
                        bm:organizationName "Name_of_Org_A"^^xsd:string.
```

```
# Definitions of participation.
v:OrganizationA_part    rdf:type bm:Participation;
                        bm:benchmark v:benchmarkA;
                        bm:organization v:OrganizationA
v:OrganizationB_part    rdf:type bm:Participation;
                        bm:benchmark v:benchmarkA;
                        bm:organization v:OrganizationB
i:OrganizationA_part    rdf:type bm:Participation;
                        bm:benchmark i:benchmarkB;
                        bm:organization i:OrganizationA
```

```
# Values of indicators.
v:OrganizationA_ind1    rdf:type bm:IndicatorDeclaration;
                        bm:indicator v:indicator1;
                        bm:participation v:OrganizationA_part;
                        bm:indicatorValue 100
v:OrganizationA_ind2    rdf:type bm:IndicatorDeclaration;
                        bm:indicator v:indicator2;
                        bm:participation v:OrganizationA_part;
                        bm:indicatorValue 200.
i:OrganizationA_ind1    rdf:type bm:IndicatorDeclaration;
                        bm:indicator i:indicator1;
                        bm:participation i:OrganizationA_part;
                        bm:indicatorValue 100.
v:OrganizationB_ind1    rdf:type bm:IndicatorDeclaration;
                        bm:indicator v:indicator1;
                        bm:participation v:OrganizationB_part;
                        bm:indicatorValue 500.
```

3.1.4. *Entity resolution*

After data from multiple databases have been loaded using the ETL module, multiple instances resolved from different data sources may exist that actually refer to the same thing; in the above example, *organization A* exists in both connected databases (i.e., *v* and *i*). Thus, from the SemDB's point of view, they are considered as two distinct instances; consequently, associated properties are not considered as belonging to the same organization (e.g., organization *v:OrganizationA* participates in benchmark A, and a different organization *i:OrganizationA* with the same name participates in benchmark B).

To consider both instances equally and thus integrate all associated data sets, ER has to be performed. In contrast to the mapping metadata, the ER metadata are only bound to the ontology's version. For all concepts with instances to be resolved, the ER metadata specify criteria on how to compare such instances, i.e., (i) transformations to be conducted to ease comparison and (ii) criteria about the comparison itself. Considering organizations, transformations involve crossing out common suffixes (e.g., *Inc*), and comparison criteria may include the calculation of string distance metrics (e.g., Levenshtein distance). If two instances are considered equal with respect to the specified comparison criteria, then they are resolved by adding an *owl:sameAs* definition. In the current version of the system, only organizations are considered for ER. Data contributions within a benchmark are not integrated, even if the same indicator is requested within the scope of two different benchmarks running at the same time period. This is because each contribution refers to a distinct benchmark instance and we want to keep that knowledge.

3.2. *Semi-automatic mapping recommender*

To support the mapping of database contents to ontology concepts, a semi-automatic mapping recommender is developed. Here, 'semi-automatic' refers to the fact that mappings are recommended in the first place and not applied automatically; thus, human interaction is needed to confirm recommended mappings for the purpose of quality assurance. The system supports two different types of mapping recommendations. The first type assumes that an entire database table corresponds to an existing ontology concept, and the second type assumes that each database table record is mapped to a different ontology concept. In both cases, mappings are only recommended if a certain level of confidence is reached (see also Section 4.2).

Mapping (virtual) tables to ontology concepts: Often, a (physical) table from the original database schema directly corresponds to a concept defined in the ontology. In this case, all records of this table are converted into instances of this concept. Note that if concepts in the ontology are specified on a more fine- or coarse-grained level of abstraction, such a table may still be constructed virtually using appropriate SQL statements (e.g., JOINs); within the scope of the system, these types of tables have been referred to as *generators*. For this type of mapping, the implementation in pseudocode is shown in Listing 2.

Listing 1 Type-1-Generator-Mapping in pseudo-code

```
generateMappingsFromGeneratorLayer():

    // Create concept list and generator list
    conceptList = getConceptNamesUsingSparql()
    generatorList = getGeneratorNamesFromMetadata()

    // Clean generators by deleting unnecessary prefixes
    for (i, name) in generatorList:
            generatorList[i] = clean(name)
```

```

    // Execute bipartit matching
    matchings = bipartiteMatching(getLevenshteinMetric(),
        threshold = 0.6, conceptList, generatorList)

    // Create empty set of mapping meta data
    // and add identified matchings
    mappingMetadata = createEmptyMappingMetadata()
    for (concept, generator) in matchings:
        mappingMetadata.push(createMappingMetadata(
            from = generator, to = concept))

return mappingMetadata
```

Mapping (virtual) table records to ontology concepts: Occasionally records are not meant to be converted to instances of the same concept but are rather partitioned to different concepts. In this case, a specific table is chosen, and each of its records is converted into one instance of a specific concept of the ontology. For this second type of mapping, the implementation in pseudocode is shown in Listing 2.

Listing 2 = Type-2-Generator-Mapping in pseudo-code

```
// Parameters are (i) the name of the generator,
// which instances shall be mapped to concepts
// and (ii) the pivotal columne name pivotal used fot the mapping,
generateMappingsFromGeneratorInstances(generator, column):

    // Create empty concept list and an empty list of instances
    conceptList = getConceptNamesUsingSparql()
    instanceList = []

    // Load instances (single row) of the generator form the external
    // data source and add the corresponding value to the list of instances
    result = executeSQL(generatorManager[generator].sql)
    for row in result:
            instanceList.push(row[column])

    // Execute bipartit matching
    matchings = bipartiteMatching(getFuzzyJaccardJaroWinklerMetric(),
        threshold = 0.2, conceptList, generatorList)

    // Create empty set of meta data for the mappings
    // and populate this set by the calculated best matches
    // of the FuzzyJaccardJaroWinklerMetric
    mappingMetadata = createEmptyMappingMetadata()
    for (concept, instance) in matchings:

        // A row of the generator (from) and a concept (to)
        // is only mapped if the generator row is a match
            mappingMetadata.push(createMappingMetadata(
                from = generator, to = concept,
                require = (column, instance)))

return mappingMetadata
```

Both of these mapping cases are implemented using the same underlying bipartite matching algorithm (based on (Kuhn and Yaw 1955)) while differing in terms of its run-time configuration. In the first case (i.e., mapping (virtual) tables to ontology concepts), the total set of virtual and physical table names and the names of the ontology concepts are used as the input configuration. In the second case (i.e., mapping (virtual) table records to ontology concepts), the total set of rows of a specified table and the names of ontology concepts are used as the input configuration for the mapping algorithm. The respective configurations of the algorithms are described in the following.

3.2.1. *Bipartite matching algorithm*

Both of the scenarios explained above are based on a highly configurable bipartite matching algorithm. Starting with two sets of items, this algorithm assigns each item of the first set to an item of the other set such that the total difference of pairwise matched items is as minimal as possible. Moreover, items are only matched if a certain confidence threshold of confidence is exceeded, meaning that the resulting set of matched items is not necessarily complete. As input, the bipartite matching algorithm requires two parameters, namely, a metric to be used to calculate the distance between two items and a minimum confidence threshold.

The implementation of the bipartite matching algorithm is based on an execution of the Hungarian method (Kuhn and Yaw 1955). In the first step, a cost metric is calculated by assigning each pair of items from the two different sets a specific distance, which is expressed as a floating point number between 0 and 1. Here, 0 refers to the equality of items, and 1 refers to a maximum difference. The derived cost matrix is passed to the Hungarian method, which assigns each item of the first set an item of the second set. After the Hungarian method has completed, the similarity of the items within each matched item pair is derived by subtracting the beforehand calculated cost from 1. If the resulting similarity is below the specified minimum (i.e., the passed confidence threshold), then this match is removed from the result set.

Two different groups of metrics are used within the mapping recommendation system based on the metric class of the SimMetrics[1] Java library. The first group of metrics compares strings and consists of the Levenshtein distance (Levenshtein 1966), and the Jaro-Winkler distance (Winkler 1990) is used to compare single words. The second is more coarse grained and compares complete groups of words. It is based on the Jaccard index (Jaccard 1901) (i.e., comparing two sets by dividing the number of common items by the number of (distinct) total items), which additionally makes use of the previously calculated distances of the first group of metrics. Assuming equality between items, even if they slightly differ, these metrics are denoted as fuzzy Jaccard metrics. Thus, in our case, this *FuzzyJaccardJaroWinkler metric* calculates the Jaccard index while assuming equality between two items if their Jaro-Winkler similarity is greater than 0.94. For further details see Section 4.2 .

4. Results and evaluation

4.1. *Ontology*

At present, the ITBM ontology (version 1.1) consists of a number of statements which are summarized in Table 2.

The number of classes corresponds to the concepts described in the previous sections, including the 20 top-level service classes (one of which is the basic data service), corresponding to IT services that are commonly measured within an IT benchmark. The 1,250 indicator classes correspond to key performance indicators that are measured during an IT benchmark. Entities of the indicator taxonomy do not have their own properties defined because they only inherit them from the BMComponent class. Therefore, only a small set of object and data properties need to be additionally defined, and they are shown in Figure 3. Currently, the majority of axioms refer to

Table 2. Number of classes, properties, axioms and annotations in the ITBM ontology.

Ontology Metric	#	Ontology Metric	#
Classes	1,250	Logical Axioms	2,927
Object Properties	113	Annotations	5,362
Data Properties	10		

the number of *SubClassOf* definitions. However, axioms on the domain and range of object properties and statements relevant to the characterization of disjoint classes also exist. The number of annotations includes bilingual (viz., English and German) *rdfs:label* for all classes. The description logic expressiveness for the benchmarking ontology itself is $\mathcal{SHI}(\mathcal{D})$, and in combination with the DUL ontology the logic expressiveness is $\mathcal{SHIN}(\mathcal{D})$.

4.2. *Metrics and minimum confidences of the mapping recommender*

Both the previously described metrics (see Section 3.2.1) and the best minimum matching confidences have been derived and proven in various experiments. Regarding the mapping within the *virtual* table layer (case one in Section 3.2), a simple Levenshtein metric with a minimum confidence of 0.6 is applied; in the instance mapping scenario (case two in Section 3.2), a fuzzy Jaccard metric using the Jaro-Winkler metric is used. The internal threshold of equality has been set to 0.94 as already mentioned; the minimum confidence threshold necessary for accepting a match resulting from the Jaccard index has been set to 0.2. The computational complexity is of square, for calculating the cost matrix and calculating the distances for each pair of items. If the fuzzy Jaccard metric is used for the similarity check, then the computational complexity increases to mn^2, where m is the (largest) number of words contained in each item. Regarding to the Hungarian method, we utalize its optimized version, reducing its complexity from $O(n^4)$ to $O(n^3)$. Removing the items with a distance that is worse than the minimum confidence threshold is performed linearly. Thus, the overall computational complexity of the bipartite matching algorithm is $O(n^3)$ (Edmonds and Karp 1972).

4.3. *Prototypical implementation*

4.3.1. *User interface for natural language text to SPARQL queries*

A web interface can be used to access the attached data sources via natural language text (text-to-sparql). This client-side user interface is implemented using AngularJS (Google 2016) and is shown in Figure 4. As a result of the German data sets, the outputs of the user search ('Show all participations of organisation ORG1 in year 2016') are presented in the German language.The search tree within the ontology is presented directly underneath the automatically generated

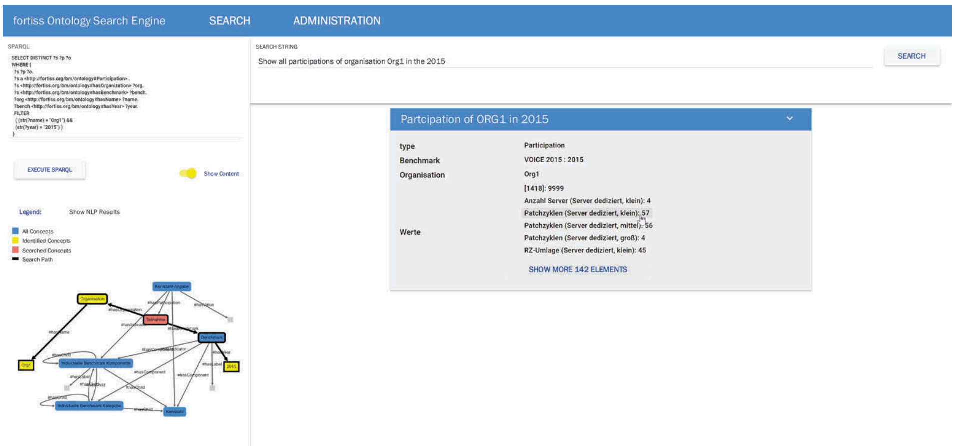

Figure 4. Client-side user interface for ontology-based data access.

SPARQL query. Blue nodes represent the corresponding concepts in the ontology that the user was searching for data sets.

In this previous example, the search string 'Show all participations of organisation ORG1 in year 2016' is parsed and processed by the NLP module. In the first step, concepts that the user searched for are identified by comparing all words within the search string with the *label* description of all concepts. Note that all already specified concepts of the system are already lemmatized within a *CachingDictionary* as lemmatization of all concepts for every single user search would be very time consuming.

Figure 5. Stepwise identification and assignment of identified tokens.

As shown in Figure 5, the Levinshtein distance of each lemmatized word within the search string and the implemented concepts is calculated. In the next step, these distances are evaluated against the operations needed to transform the lemmatized word into a concept. Only if this is possible by less than three NLP operations is the entered word identified as a concept. In Figure 5 all identified concepts are highlighted using yellow background color. Analogous to the concept identification, the remaining words are analyzed to identify literals that are specified within the ontology. Consequently, the identified literals are transformed into filter parameters such as *subject, predicate, and object*. The *subject* specifies the concept for which the filter is set, the *predicate* specifies the *rdfs:type*, and the *object* is set by the literal itself. The following example shows the filter results for

```
Filter
    Type URI:         ,,http://fortiss.org/bm/ontology#Organization''
    Predicate URI:    ,,http://fortiss.org/bm/ontology#hasName''
    Value:            ,,ORG1 GmbH''
Filter
    Type URI:         ,,http://fortiss.org/bm/ontology#Organization''
    Predicate URI:    ,,http://fortiss.org/bm/ontology#hasName''
    Value:            ,,ORG1''
```

the identified literal 'ORG1'. In the last step, all identified literals are marked as 'processed' (indicated by the green background color in figure 4.3.1).

4.3.2. *Data source configuration and mapping recommender*

The configuration of the mapping between an ontology and corresponding data sources is supported by an administrator user interface (see Figure 6). For each data source this configuration needs to be performed before the mapping of concepts to generators can be conducted. For consistency and data loss prevention reasons, all changes of the mapping between data sources and the ontology are stored temporarily and need to be confirmed separately after the configuration procedure. The mapping is performed stepwise, following the workflow shown in Figure 7.

(A) An external data source needs to be selected first. In this step, all already configured data connections are available for selection

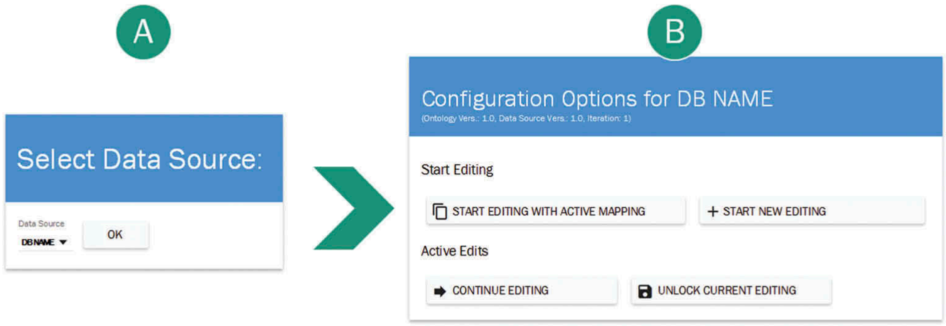

Figure 6. Admin: mapping configuration.

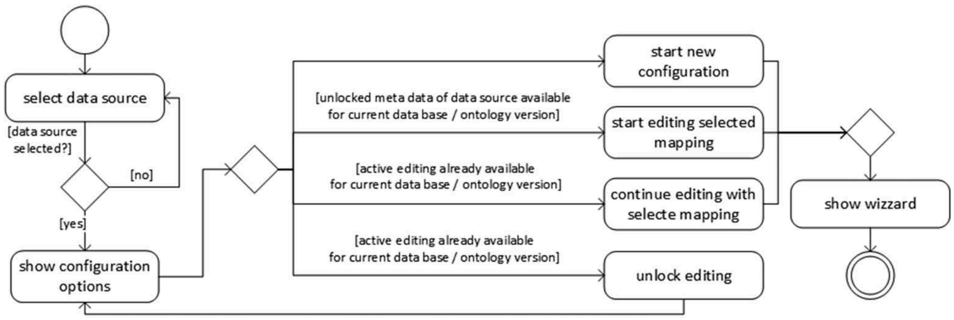

Figure 7. Workflow of the administration wizard.

(B) Based on the selected data source, different editing options for the mapping are available, depending on the different work-flow states.

- A new mapping can be started by 'Start Editing', or an active mapping can by modified by 'Start Editing With Active Mapping'. In both of these cases, the active mappings between ontology concepts and generators are overwritten by a new configuration.
- If not already finished and stored, an existing mapping configuration can be edited and locked or unlocked to prevent data loss.

Once the configuration of the mapping is finished, the user is forwarded to the actual mapping web interface (see Figure 8. This interface can basically be divided into four sections.

- The first section (1) contains all of the actions that are available, such as saving the manually generated mappings; replotting the graph, which is shown in (2); and starting the semi-automatic mapping recommender (see Section 3.2).
- The second section (2) shows the graph and all connections of the generators for the previously selected data source.
- The third section (3) shows all concepts within the ontology that can be mapped to generators.
- The fourth section (4) provides the details for a selected entity (concept, connection or generator) and configuration options to implement the mapping.

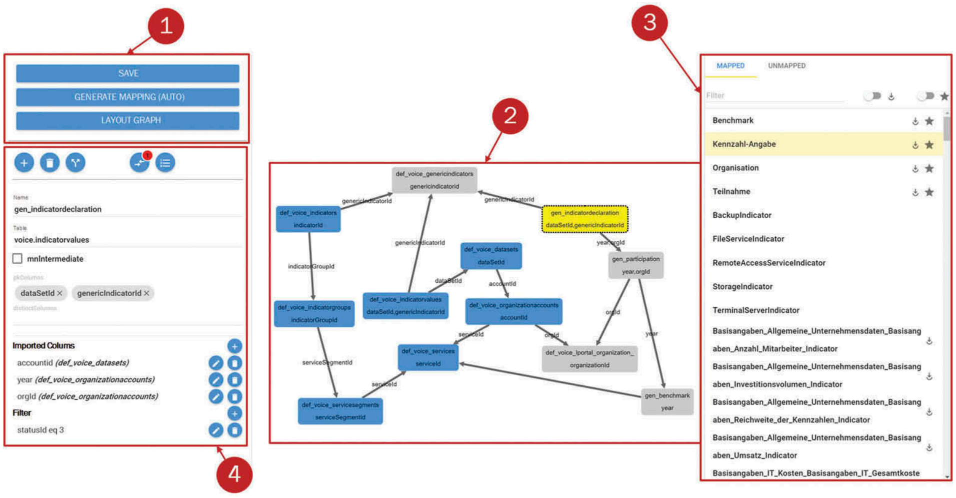

Figure 8. Client-side administration wizard for the configuration of mappings.

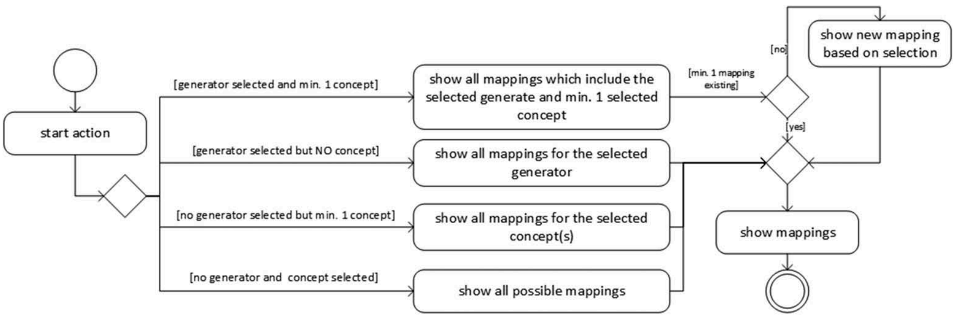

Figure 9. Mapping options based on different pairing possibilities.

The mapping of a selected entity can be displayed and configured using the linkage button (highlighted by a red 'one' in Figure 8. The number represents how many mappings already exist for this selected entity. If a generator and one or more concepts are selected in combination, the number indicates all mappings that exist for the selected pairings. Because various possibilities exist for mapping configurations depending on the selected concepts or generators, Figure 9 shows the different mapping options based on different pairing possibilities.

After an entity is mapped manually or as a result from the mapping recommender, Figure 10 shows the user interface for a detailed overview on the mapping parameters. In this assignment interface for each mapping, the header (A) and the detailed mapping configuration (B) for this entity are shown. In this example, the header consists of the generator name and its mapped ontology concept. In the scope of this header interface, it is also possible to show/hide the details for the mapping; to copy the current mapping, which is use full if only 'Required Attributes' differ for a selected entity; and to mark this mapping for deletion. The deleting process is performed during the save operation of the entire mapping process. Within the detailed view, attributes are separated according to their allocation. On the left side, the generator is shown together with its 'Required Attributes'. On the right side of the detailed view, all mapped concepts are shown, together with their associated properties. The red overlay (1) indicates a previously performed

Figure 10. Admin: interface for the mapping configuration of entities.

deletion operation on this generator. Note that for all 'Required Attributes', only one value can be specified, whereas for the 'DataTypeProperties' (2), columns of the linked data sources can be specified (using,"#{..}" notation) as well as a free text. For 'ObjectProperties' (3), only the specification of corresponding generators is possible. Note that although it might be possible that a very large number of nearly similar mappings need to be configured for a concept, it is possible to copy 'Data- and ObjectProperties' to reduce the configuration effort.

5. Conclusion and future work

Because there are numerous challenges related to data integration in the domain of ITBM and the related field of ITSM, this paper introduced an architecture for the (semi-)automatic and ontology-based integration of data from distributed data sources. To the best of our knowledge, the proposed system architecture and software prototype constitute the first approach to bridge the gap between a systematic characterization of IT services and their data-based valuation based on an ontology. Moreover, because the mapping of databases to ontology concepts is a very complex and time-consuming task, a semi-automatic mapping recommender was developed to support the user in this process. This recommender semi-automatically identifies similarities of possible mapping candidates and visualizes them in a graph to reduce the complexity of the mapping process for the system administrators. On the user side, the complexity for the use of such a system could also be reduced as it provides an easy way of to access data by using NLP techniques to translate natural language questions into SPARQL queries. This translation process is also implemented in a transparent manner by showing the generated SPARQL query and by visualizing the resulting search graph.

The proposed web-based system architecture for data integration allows numerous external data sources to be linked through the use of the domain ontology, which is a flexible way to link data sources without knowing the structures of already attached data sources. The separation of structural information provided by the ontology on the one hand and the data sources on the other hand addresses the need for flexibility in the case that the linkage must adapt to changes on both sides. In this way, already existing data sets from various data sources, such as MySQL databases, could be interlinked in terms of their semantic equivalence. At present, all non-administrator users are allowed to access all attached data sources. By using this client-/server-side implementation, based on web technologies, a more fine-grained access control could be implemented in the future. This would address possible security needs that could occur if the system is used beyond company boundaries. Moreover, it is conceivable that restrictions for the use of specific data sources and specific data points within a single data source could also be implemented to ensure that the attached data sources are only allowed to be used within a special context (benchmark) or by special users/organizations.

The ITBM ontology was developed on a large collection of ITBM documents and data set and covers various types of IT benchmarks and (IT) service descriptions from numerous organizations. Thus the developed ontology covers all aspects relevant for using it as universal link for the integration of different types of external benchmarking data. Because the quality of an ontology, in terms of its expressiveness and consistency, is highly dependent on domain knowledge, a broad range of different data are needed as a basis for the development process. Thus, the analysis of such an enormous amount of data, is generally extremely time consuming. This issue in the ontology construction process was already addressed by Pfaff and Krcmar (2015) using NLP techniques to populate the domain ontology and in this paper re-used to identify similar indicators in data sets across different IT benchmarks. In addition, the use of NLP also grounds the development process of an ontology and reduces the variations of an ontology that may occur if it is constructed manually by different domain experts. However, since an ontology is generally discontinuously changing over time, a periodic consistency check of the ontology and the linked data sources was also implemented. In the future, this already implemented consistency check could be developed further to automatically recognize changes upon their occurrence. Additionally, the mapping process for the ontology could also be extended to support and automatically resolve relations across different indicators that characterize the same concept. For now, the structural description of a benchmark within the ontology is limited to a hierarchical structure; this limitation could also be addressed in future research to enable the modeling of more complex coherence. Developing the capability of (semi-)automatic linkage with additional ontologies will be the next step in this research for the purpose of propagating a uniform description of domain knowledge in ITBM.

Note

1 https://github.com/Simmetrics/simmetrics.

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Disclosure statement

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