Chair of Communication Networks
TUM School of Computation, Information and Technology
Technical University of Munich

SDR-MDNet: A tool for Survivable Demand Routing in Multi-Domain Networks

Maria Samonaki[1], Mehmet Emre Çiçek[1], Cristian Bermudez Serna[2], Wolfgang Kellerer[1], and Carmen Mas-Machuca[2]

Motivation & Background

Multi-domain networks consist of several interconnected single-domain networks which have their own control and management policies. Each domain has two types of nodes, as shown in Fig. 1:

- **internal nodes**: connected with intra-domain links and can view only local network information,
- **border nodes**: can view both local and global network information and connect the different domains with inter-domain links.

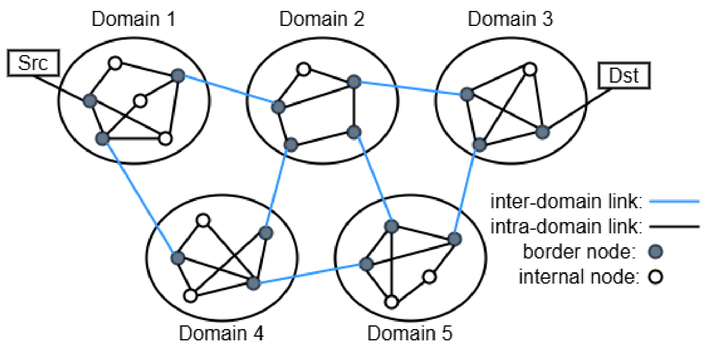

Fig. 1 Physical multi-domain network.

Challenge: Confidentiality vs. Survivability

- **Confidentiality**: Topology Aggregation (Fig. 2).

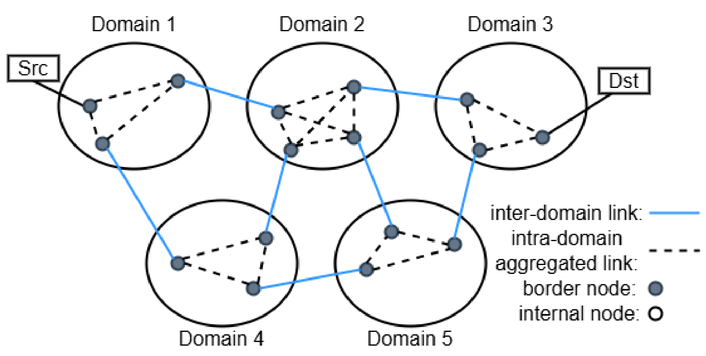

Fig. 2 Full-mesh aggregated multi-domain network.

- **Survivability**: Minimum-cost **link-** and **node-disjoint** path pairs based on [1] and [2] respectively.

Intra- & Inter-Domain Routing

Two-Step over Two-Step (ToT) from [1] and [2] for link-disjoint and node-disjoint routing respectively.

- **Intra-domain routing:** Disjointness information matrix with a **Two-Step** approach:

Fig. 3 Intra-domain disjointness information matrix.

- **Inter-domain routing:** Utilizing the disjointness information matrix of every domain, the **Two-Step** approach is applied on the inter-domain aggregated topology for the computation of the end-to-end disjoint path pair for every demand.

The Tool

SDR-MDNet is a tool designed as a web application with an interactive Graphical User Interface (GUI) which shows how disjoint paths are configured for every demand in multi-domain networks.

Goal:

- **Link-disjoint vs. node-disjoint routing**.
- **Privacy vs. demand protection blocking**.

Multi-domain network setup:

- **Inter-domain aggregated topology:** Cost266 European network [3] with 21 countries-domains.
- **Intra-domain topologies:** 6 countries with > 1 border node [3, 4]: Germany, France, Spain, Italy, UK and Poland.

Technical Implementation

Front-end: leaflet.js used for the interactive map.

Back-end: Flask framework for the web application, Python and NetworkX for the end-to-end routing.

Functionality:

1. Click the source and destination of the demand.
2. Click the routing scheme and the **"Send"** button.
3. **Intra-** and **inter-domain** routing can be different for a demand within a domain.
4. Click a country to see the intra-domain routing, and then click **"Back"** to go to the inter-domain topology again.
5. Click **"Cancel"** or **"Reset"** for a demand.

SDR-MDNet: Visualization & Examples

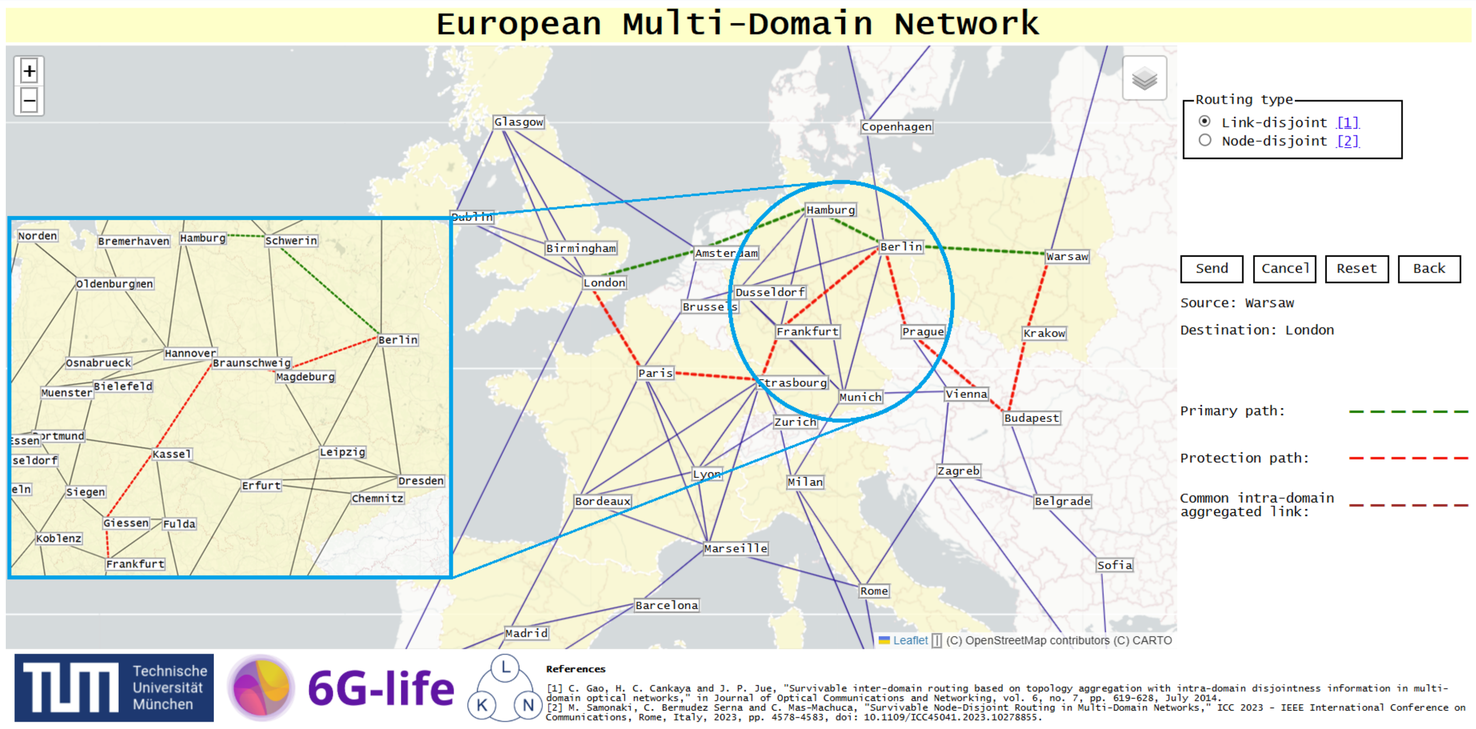

Fig. 4 The optimal link-disjoint path pair for the demand from Warsaw to London as it is configured from SDR-MDNet.

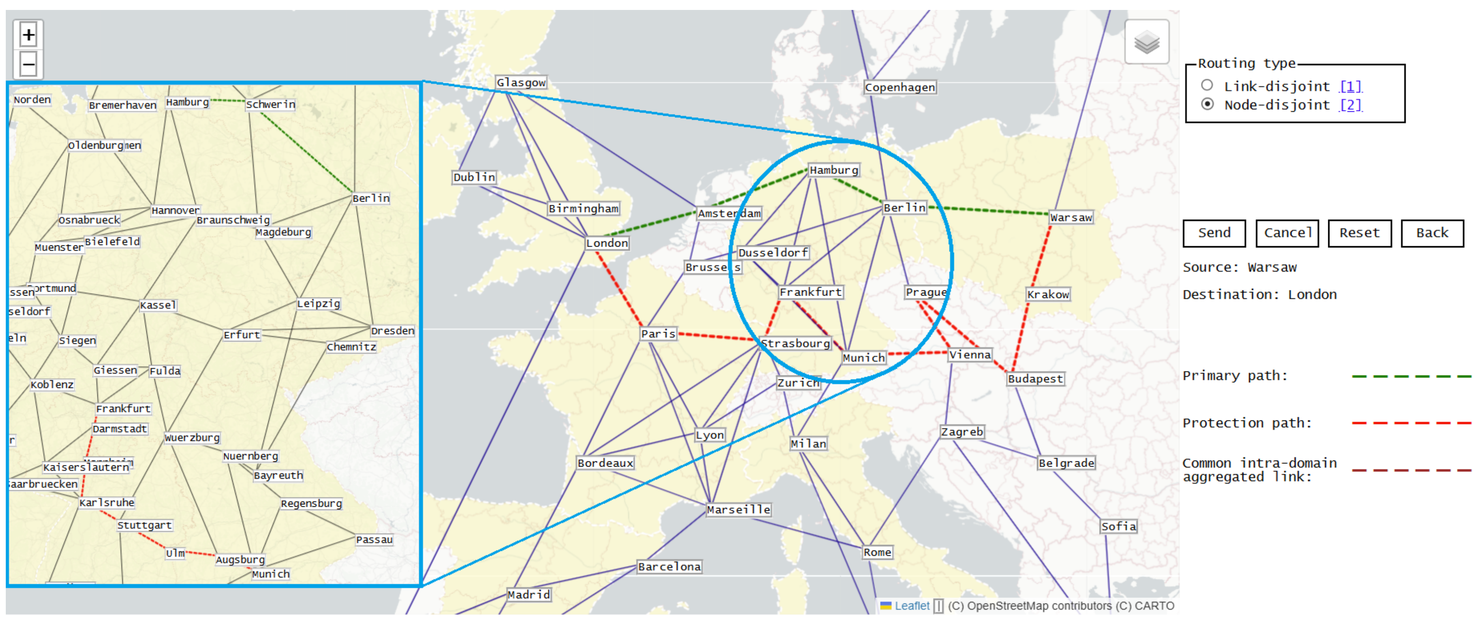

Fig. 5 The optimal node-disjoint path pair for the demand from Warsaw to London as it is configured from SDR-MDNet.

References

[1] C. Gao et al., “Survivable inter-domain routing based on topology aggregation with intra-domain disjointness information in multi-domain optical networks,” Journal of Communications and Networking, 2014.
[2] M. Samonaki et al., "Survivable Node-Disjoint Routing in Multi-Domain Networks," IEEE ICC, Rome, Italy, 2023.
[3] S. Orlowski et al., “SNDlib 1.0-survivable network design library,” Netw.: An Int. J., 2010.
[4] S. Knight et al., “The internet topology zoo,” IEEE J. Sel. Areas Commun., 2011.

[1]Chair of Communication Networks, Technical University of Munich.
[2]Chair of Communication Networks, University of the Bundeswehr Munich.
Contact: maria.samonaki@tum.de

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