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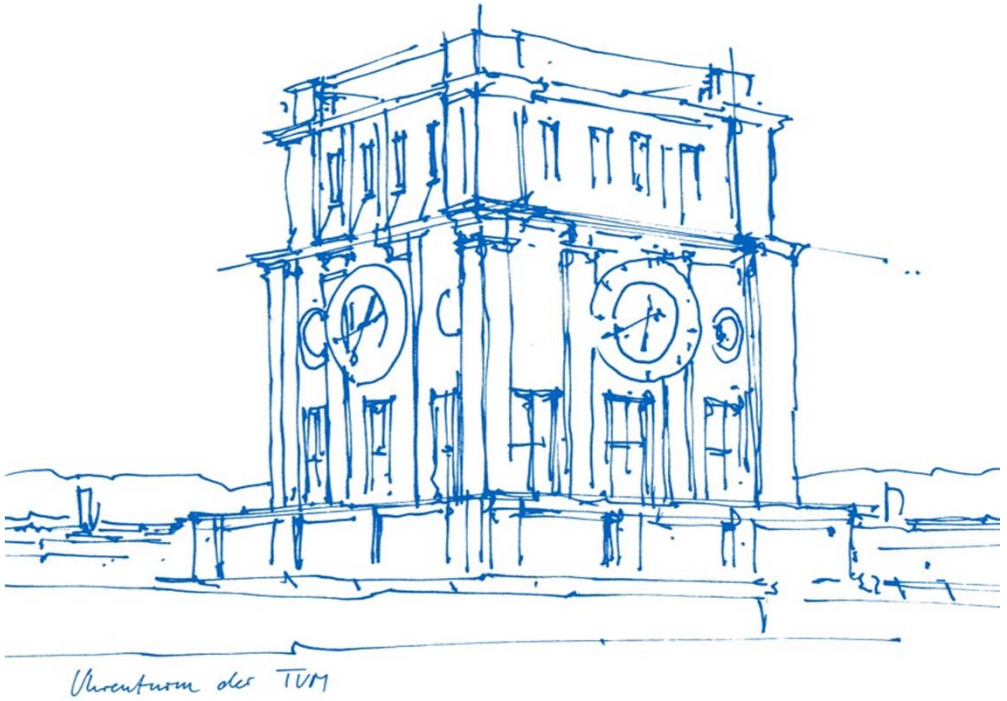
5G Research Hub Munich

Prof. Dr.-Ing. Wolfgang Kellerer
Technische Universität München

LWL Symposium,
Olching 22.10.2019



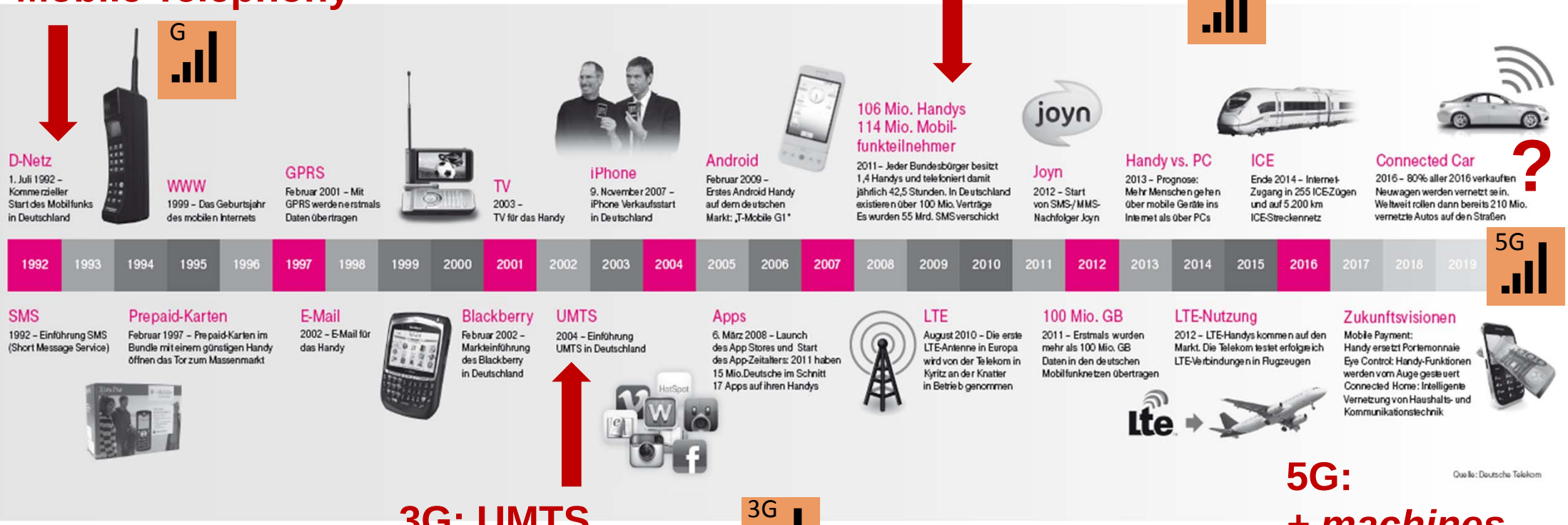
Short Introduction to 5G

5G – a (very special) new generation mobile communication?

- So far every 10 years a new generation

2G: GSM/GPRS
Mobile Telephony

4G: LTE
+ data communication (Apps for users)

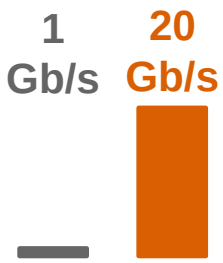


3G: UMTS
Mobile Telephony

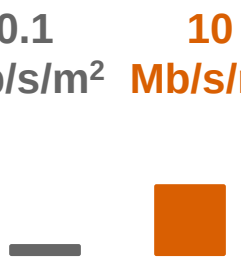
5G:
+ machines communicate

Was ist neu? - Systemparameter von 5G im Vergleich zu 4G

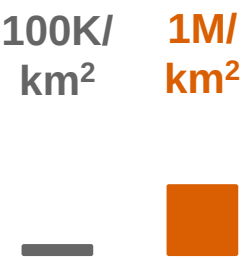
4G – 5G Vergleich



Datenrate



Datenverarbeitung



Dichte der Geräte

Mobilität

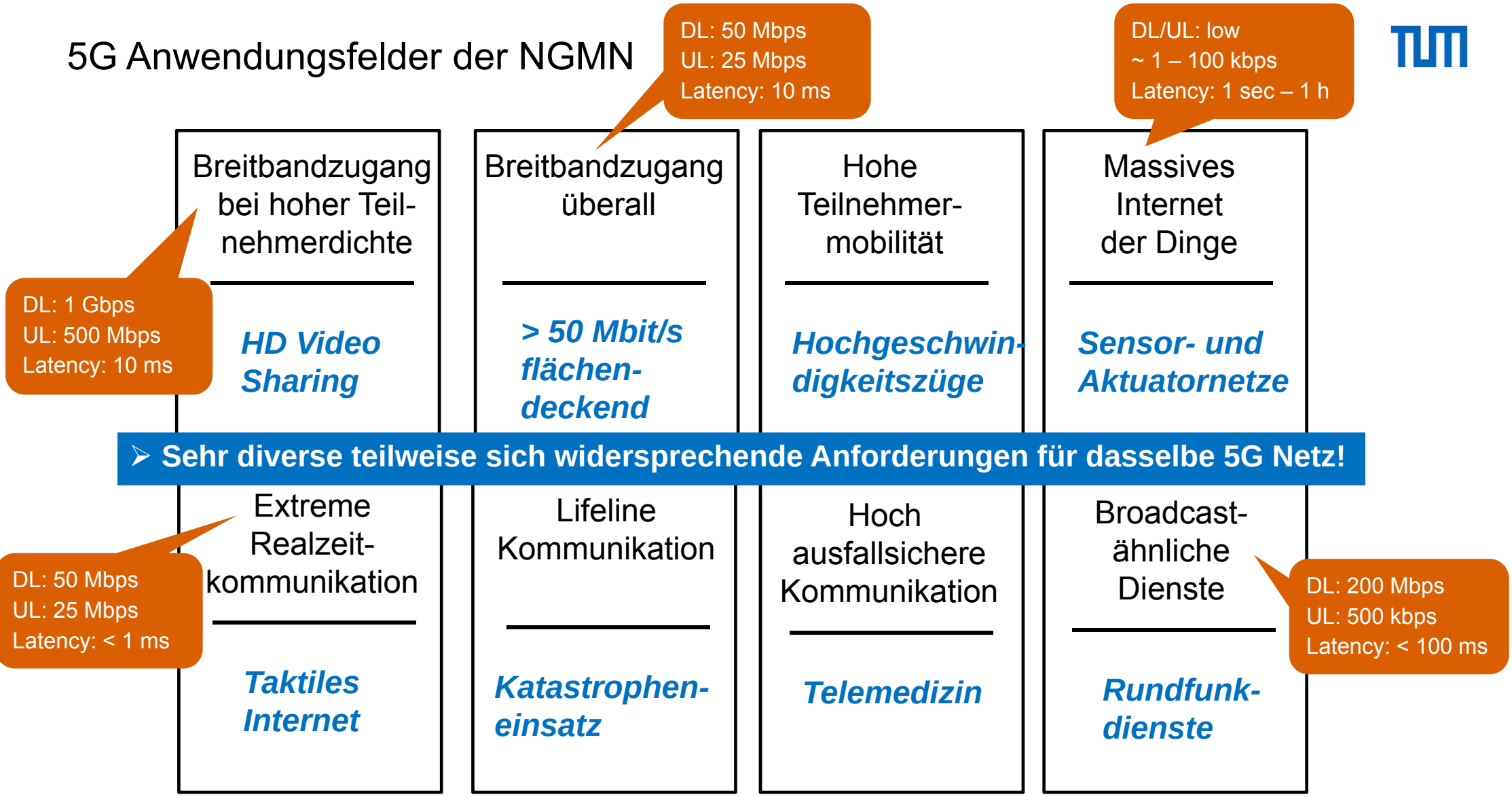
10-fach niedrigere
Verzögerungen (Millisekunden)

Verzögerung

Energieverbrauch

Quelle: Young, L. J. (2015): *Telecom Experts Plot a Path to 5G*. IEEE Spectrum, Vol. 52, no 10 (INT), Oct. 2015

5G Anwendungsfelder der NGMN



Note: UL/DL is user experience

Quelle: NGMN 5G white paper

Experimental Platform:
5G Research Hub Munich

Overview

The 5G Research Hub Munich targets the

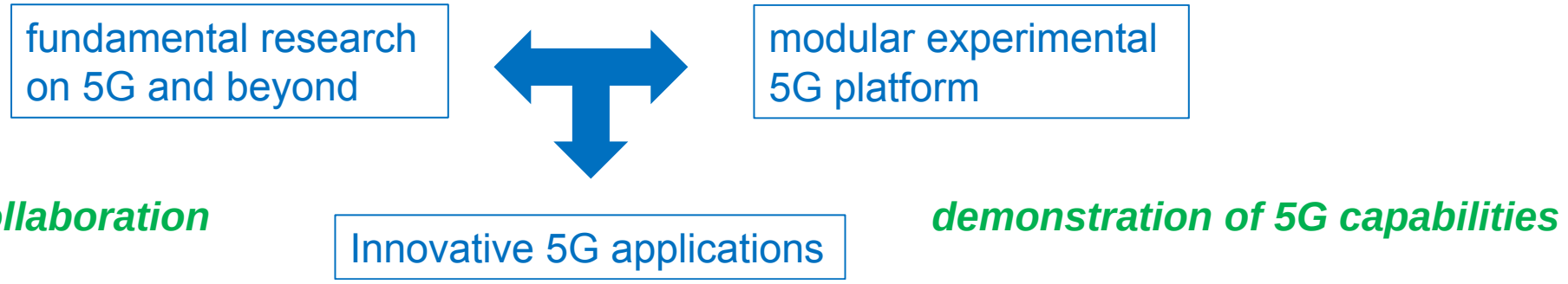
development of an experimental 5G platform at the Technical University of Munich

based on a **joint research project** started in 2019 between the
Chair of Communication Networks (Prof. Wolfgang Kellerer) and the
Chair of Media Technology (Prof. Eckehard Steinbach)
funded by the Bavarian Ministry of Economic Affairs, Regional Development and Energy.

The experimental platform is open for collaboration.

Objectives

- **Realization of a 5G experimental lab platform** and its continuous advancement according to latest 5G standard releases and related research
- **Fundamental research** to significantly shape the state of the art for selected areas in 5G technologies and applications
- **Realization of a methods and technologies platform** as a modular framework being open for emerging applications



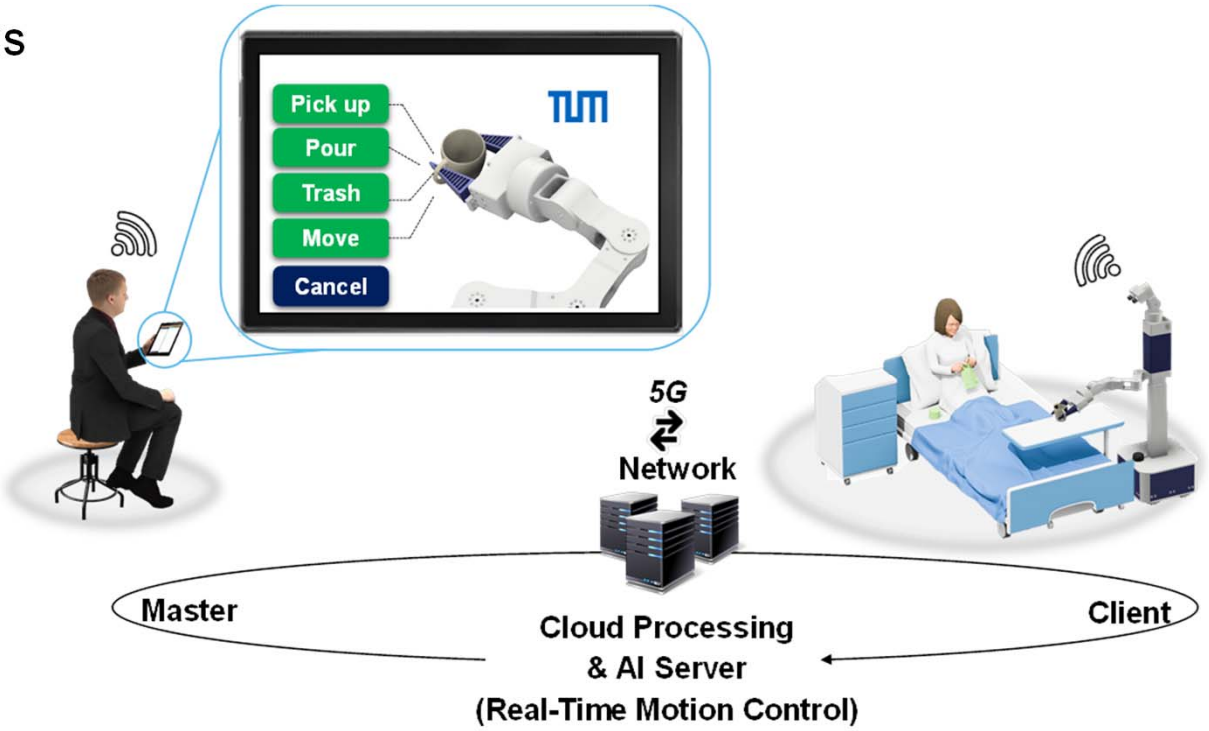
Focus application area: eHealth

Scenario: Telepresence and Teleservice

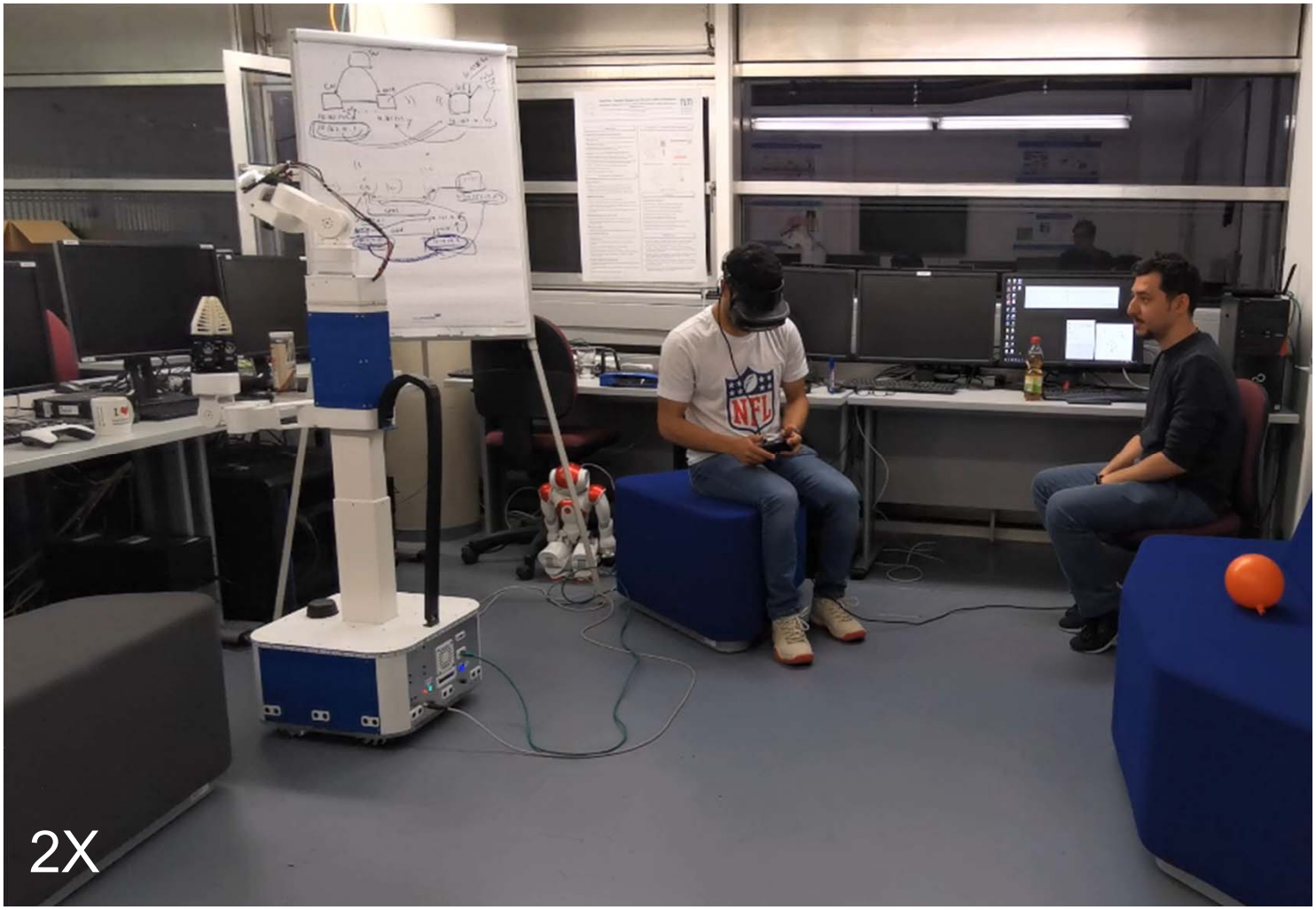
- Teleoperation and semi-autonomous task execution
- Visual immersion: 3D 360° video
- Object recognition
- Localization and mapping

5G requirements

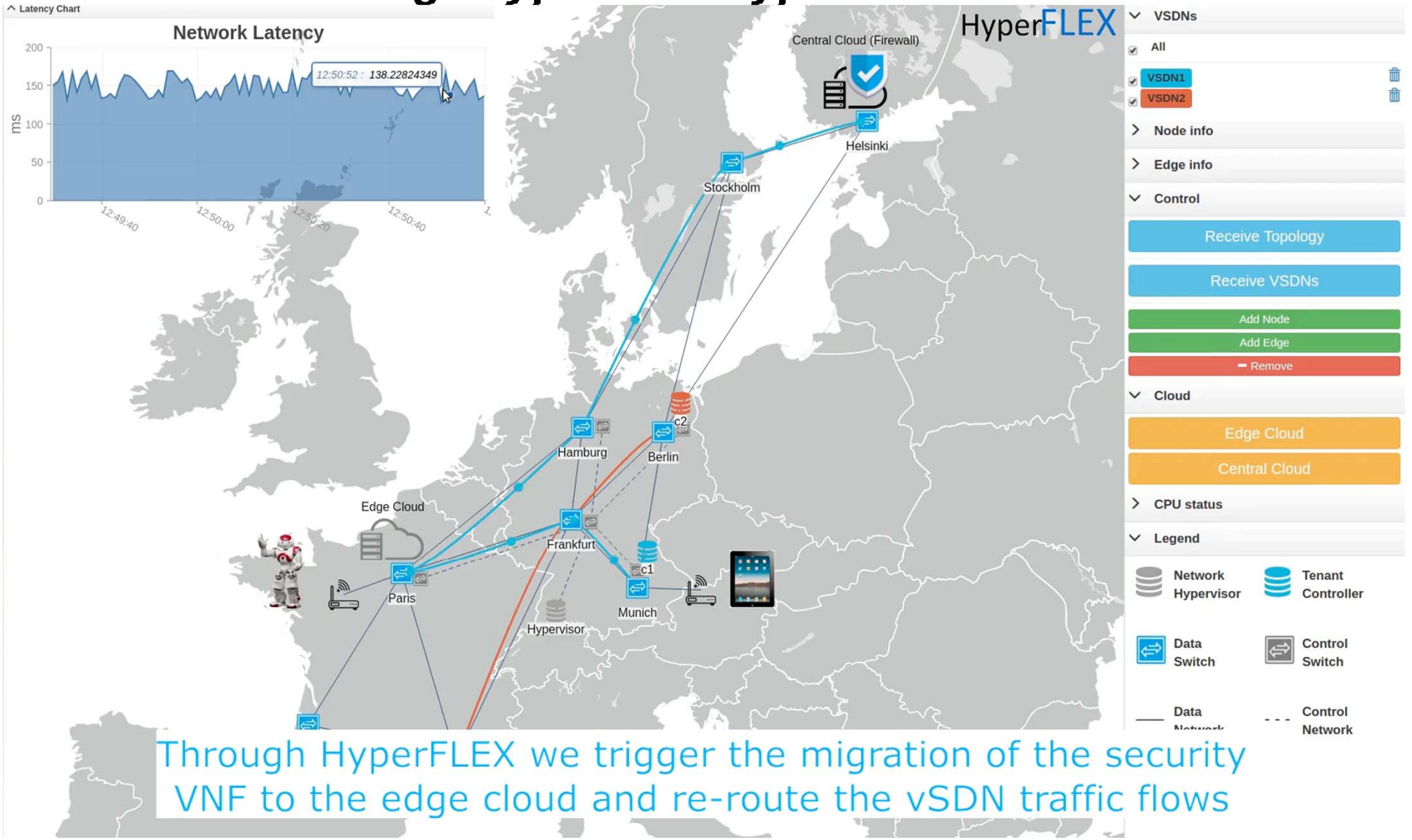
- Ultra low delay
- Network-based processing
- High reliability
- High data rates (video)
- QoS differentiation → Slicing



Teleoperation robot demo

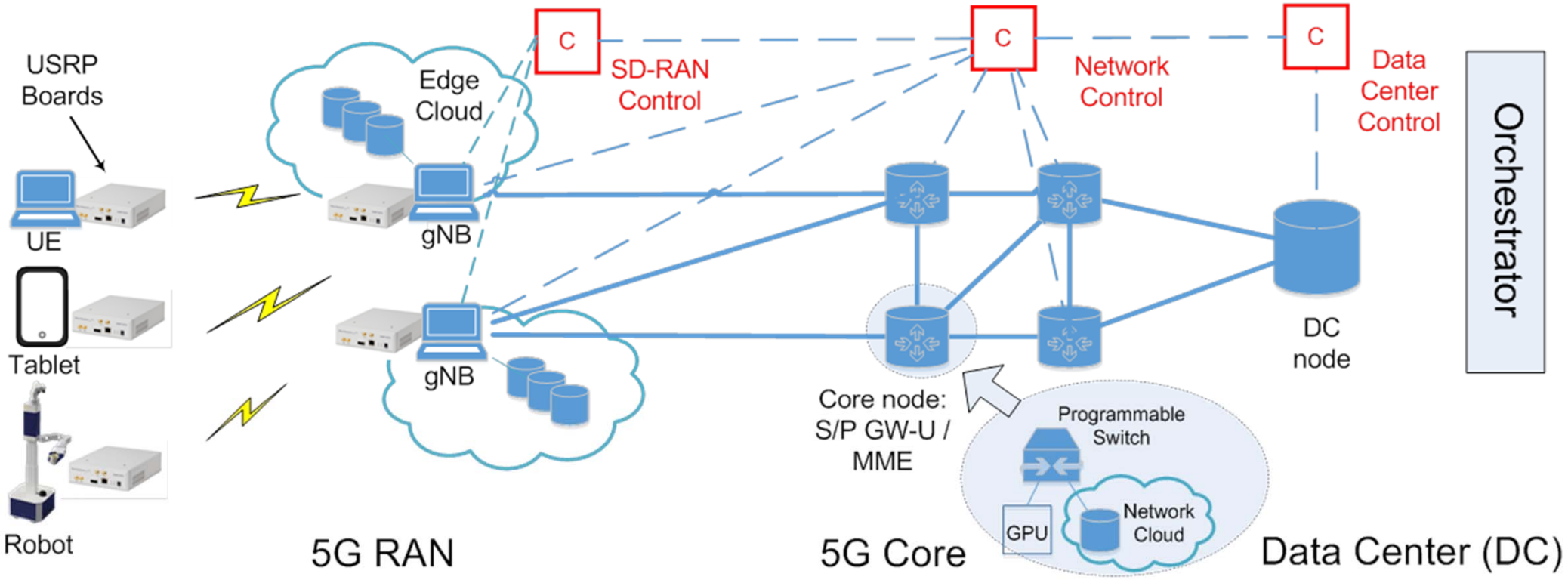


Core network slicing: HyperFlex Hypervisor



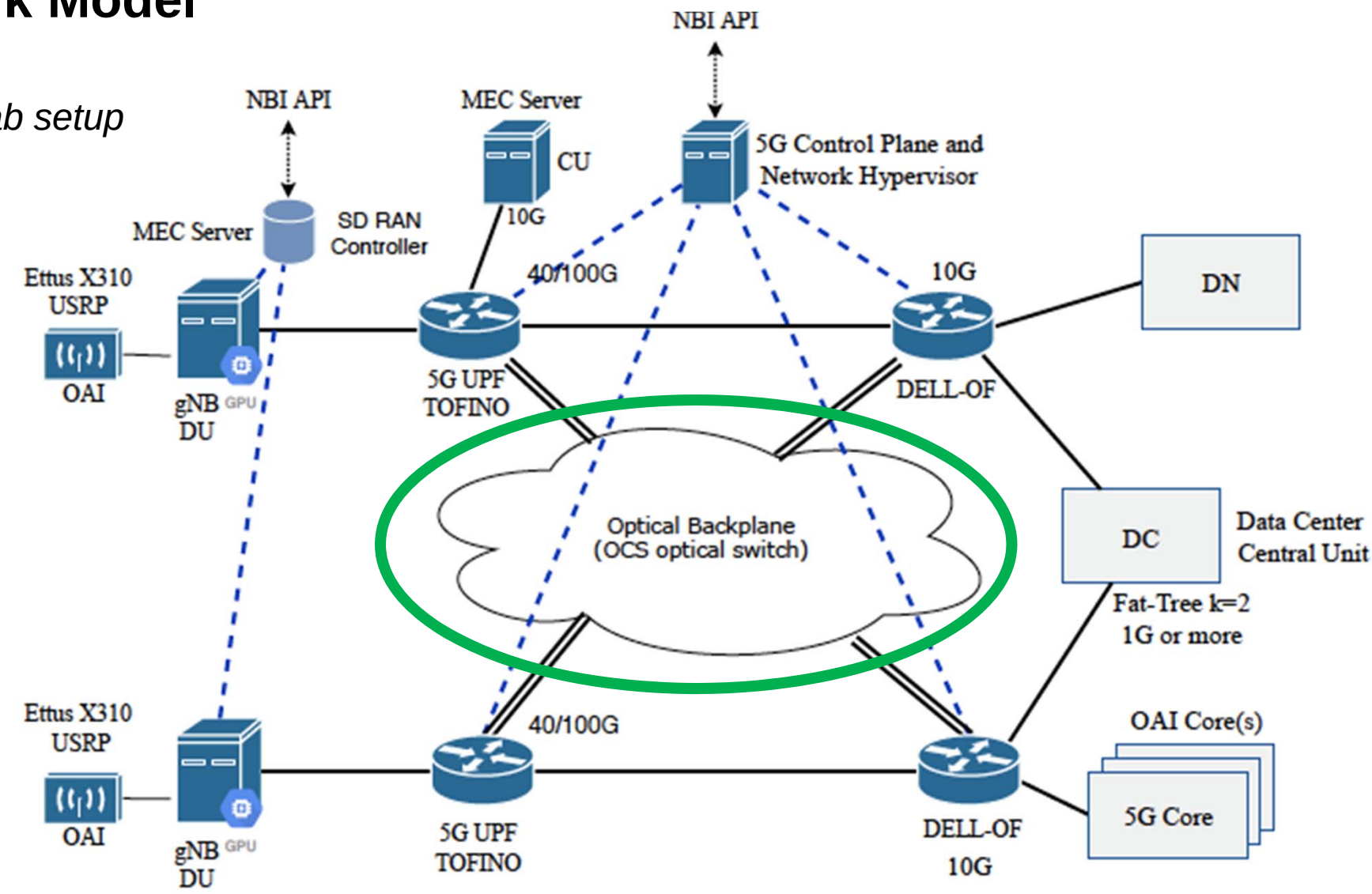
Network Model

Planned lab setup



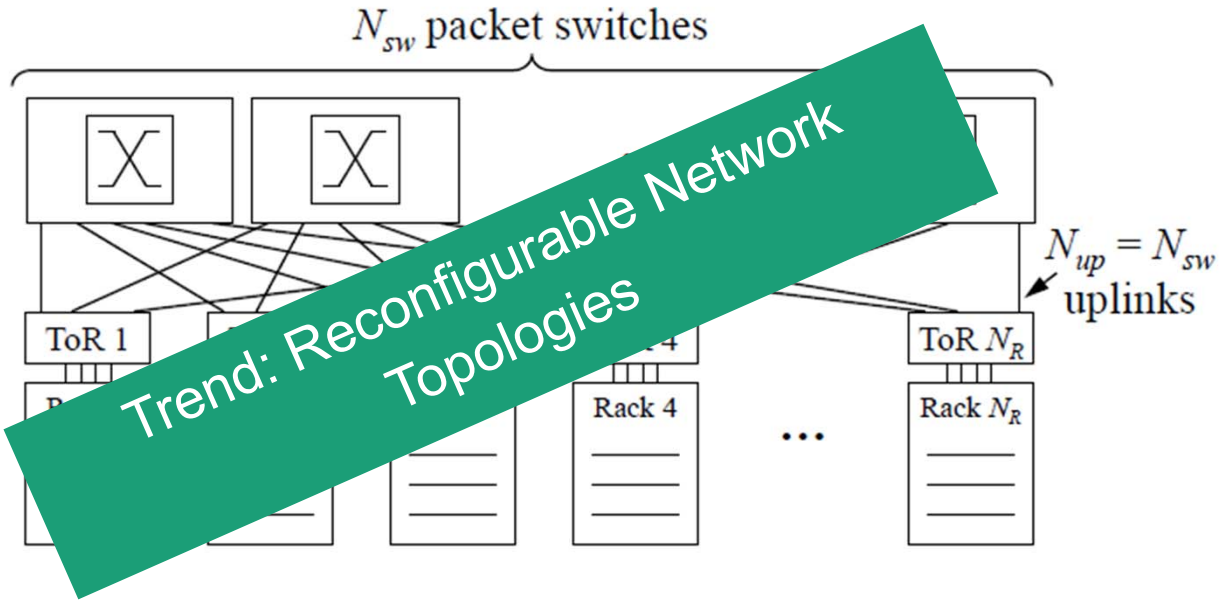
Network Model

Planned lab setup (detail)



Trends of Optical Communication in modern Data Communication

Recent Approaches in Data Centers



A typical Clos-base data center network topology [1]

Existing problems:

- Designers must decide in advance how much capacity to provision on ToRs
- Demands exceeding capacity lead to congestion
- Extending with optical-electrical-optical conversion too expensive

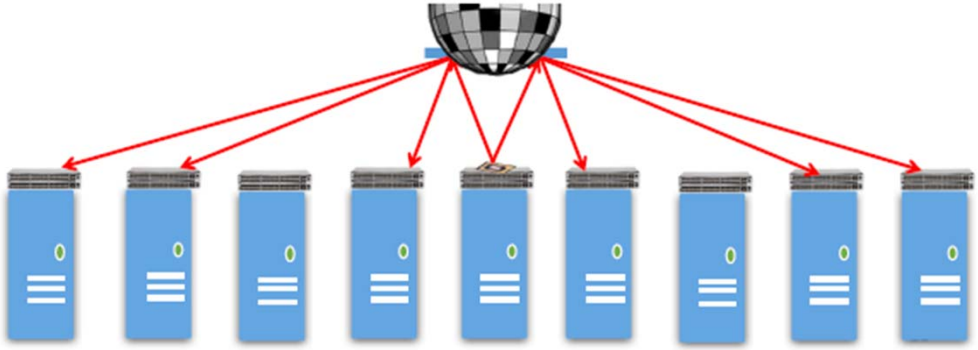
Reconfigurable examples in DCs:

→ Using Free-Space Optics

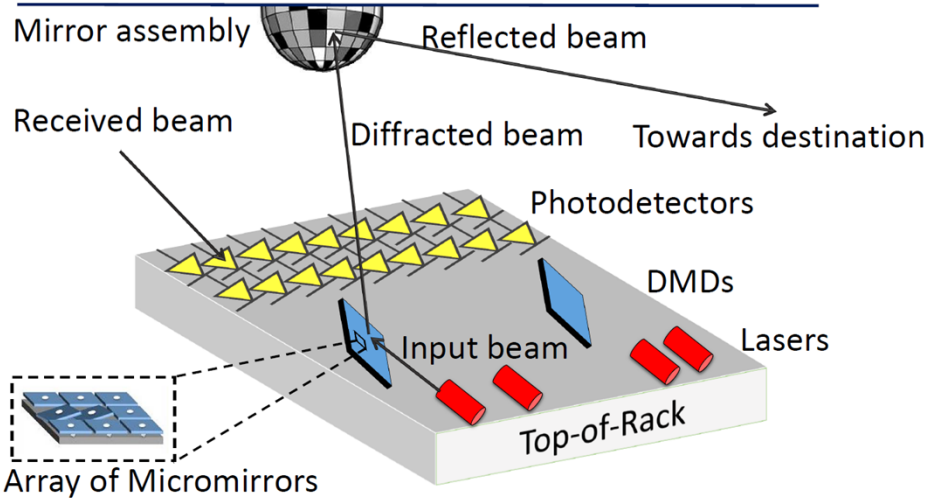
→ (Homemade) Optical Circuit Switches

[1] W. M. Mellette et al., “RotorNet: A Scalable, Low-complexity, Optical Datacenter Network,” in Proceedings of the Conference of the ACM Special Interest Group on Data Communication - SIGCOMM ’17, Los Angeles, CA, USA, 2017, pp. 267–280.

ProjecToR: Agile Reconfigurable Data Center Interconnect [2]

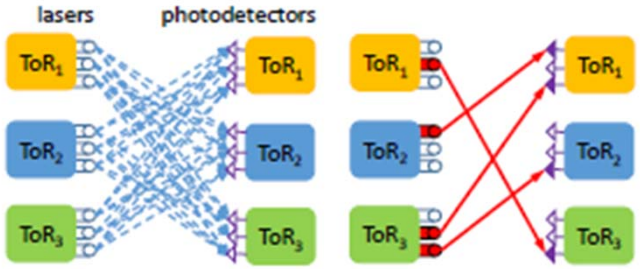


ProjecToR Topology



Interconnect

- Free-space topology (seamless)
- 2500 x faster than optical circuit switches



Reconfigurable Topology

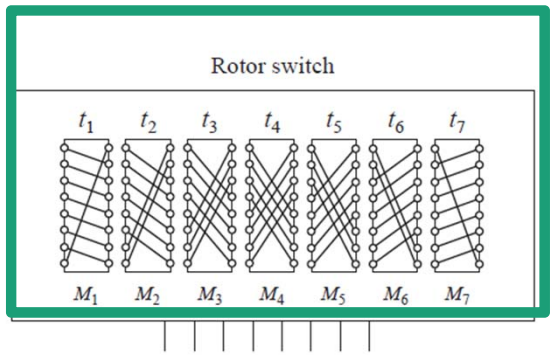
[2] M. Ghobadi et al., “ProjecToR: Agile Reconfigurable Data Center Interconnect,” in Proceedings of the 2016 conference on ACM SIGCOMM 2016 Conference - SIGCOMM ’16, Florianopolis, Brazil, 2016, pp. 216–229.

RotorNet [1]

- Custom designed OCSes
- Switches rotate independently through fixed, static set of reconfigurations
- No centralized control plane

Matches and configurations

(a)



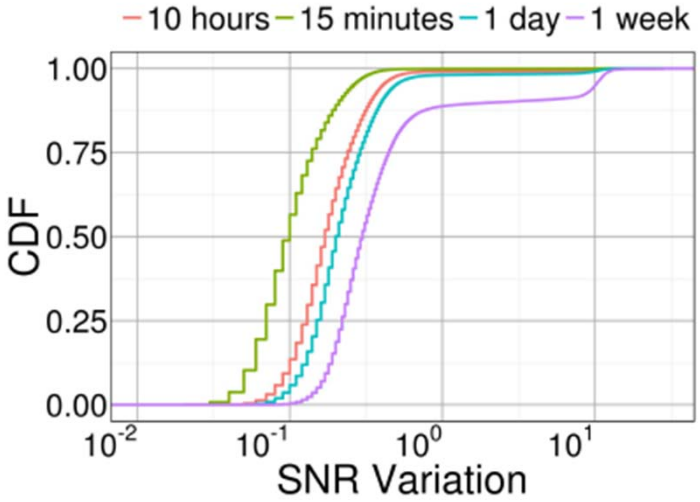
$N_m = N_R - 1$ matchings

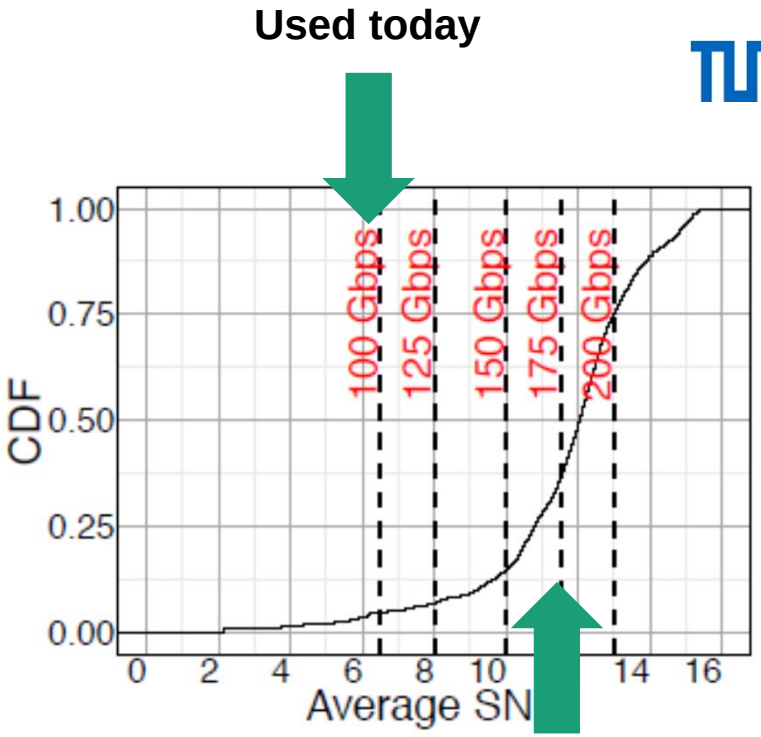
... of $(N_R)!$ possible

[1] W. M. Mellette et al., “RotorNet: A Scalable, Low-complexity, Optical Datacenter Network,” in Proceedings of the Conference of the ACM Special Interest Group on Data Communication - SIGCOMM ’17, Los Angeles, CA, USA, 2017, pp. 267–280.

And in Wide Area Networks: RADWAN [3]

- Rate Adaptive Wide Area Network
- Adapt the capacity of fiber optic links based on their signal-to-noise ratio (SNR)
- Centralized WAN controller adapts the modulation
- Similar idea like in Wireless, however, SNR varies less in optics – high potential





Potential: 64% could Support 175 Gbps

[3] R. Singh, M. Ghobadi, K.-T. Foerster, M. Filer, and P. Gill, “RADWAN: Rate Adaptive Wide Area Network,” in Proceedings of the 2018 Conference of the ACM Special Interest Group on Data Communication, New York, NY, USA, 2018, pp. 547–560.

more coming soon on

www.5G-munich.de

we are open for collaboration