

Networking the bits and pieces

e-INFRA CZ Conference 2024

Jan Růžička, Petr Adamec

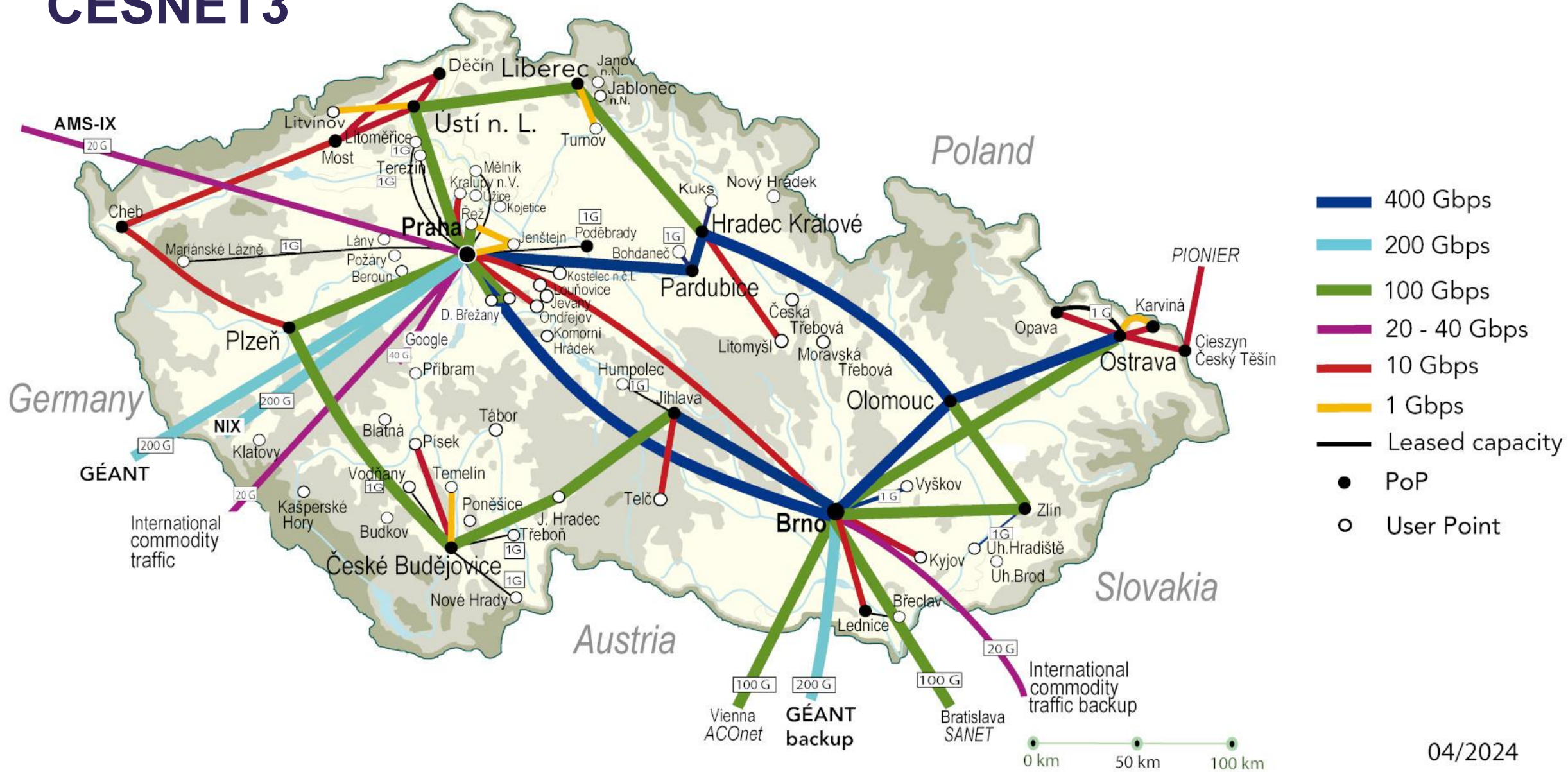
Introduction



- Discussion is the key – **we are partner not just service provider**
- Reveal your plan and needs in advance, so we can discuss, help and prepare
 - Port speed upgrades, expected needs (client vs core port price)
 - The preparation of a new route (optical route) can take more than six months
- We carry out own research and development
 - Time/Frequency
 - QKD
 - Security
 - High quality, low latency transmissions (video, audio, visualisations)
- European and international cooperation – GÉANT, I2, ...

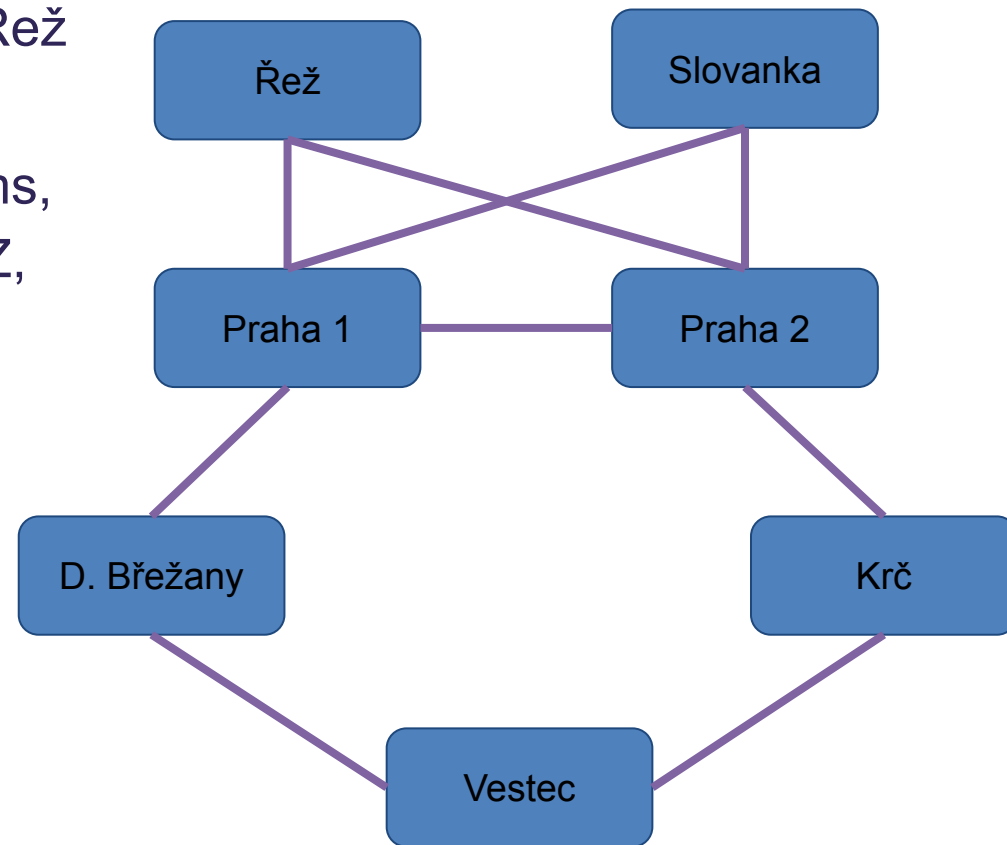


CESNET3



CESNET3 – Prague ring

- Integration of Dolní Břežany, Vestec, Krč, Slovanka, Řež to the network core
- Better services for research infrastructures (ELI-Beams, HiLase, BIOCEV, Bioimaging, Openscreen, CERN-CZ, Auger, COMPASS.....)
- Hosting sites of e-INFRA CZ storage and computing resources
- Finalisation during 2Q 2024
 - 200Gb/s to each site with redundancy
 - with possible capacity upgrades
- IP and non data services
- Better access to GÉANT



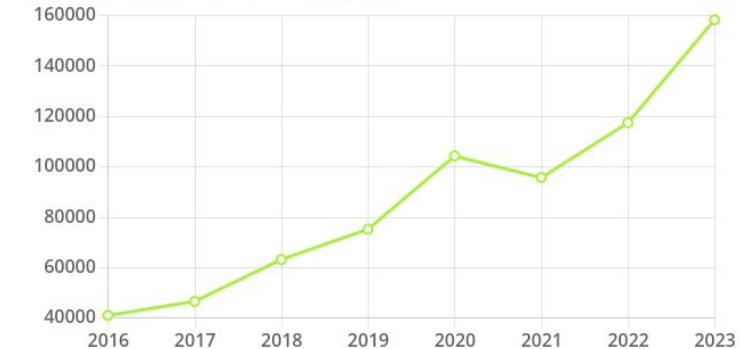
High capacity networking infrastructure



Overall network architecture

- **Flexgrid DWDM**
 - New core is completed, Prague ring under construction
 - Advanced photonic services (spectrum sharing, T&F, QKD ready)
- **IP layer flexibility** (new PoP design)
 - Gradual upgrade, **400G core** → edge, Terabit core
 - **External connectivity ~ 700Gb/s**
 - recent upgrade of **GÉANT link to 200Gb/s**
 - planned upgrade to 400Gb/s during 2026
- **Specific services** – custom overlays
 - dedicated interconnection at different levels – spectrum service, VRF
- Automated and user-defined security/defense rules
- Precise Time Synchronisation – White Rabbit
- **GÉANT** – key partner for international collaboration and future Terabit pan European network

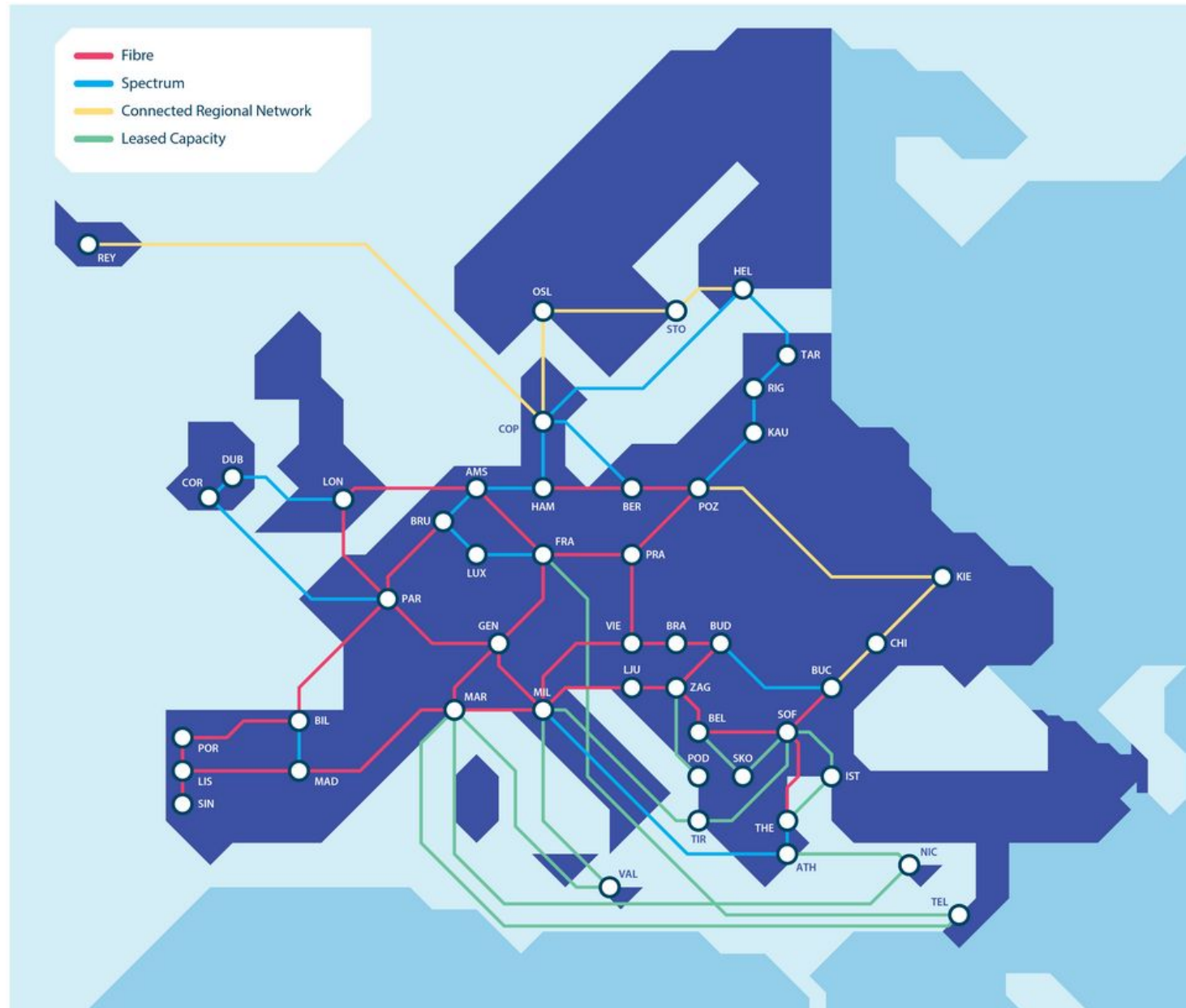
Traffic from external network



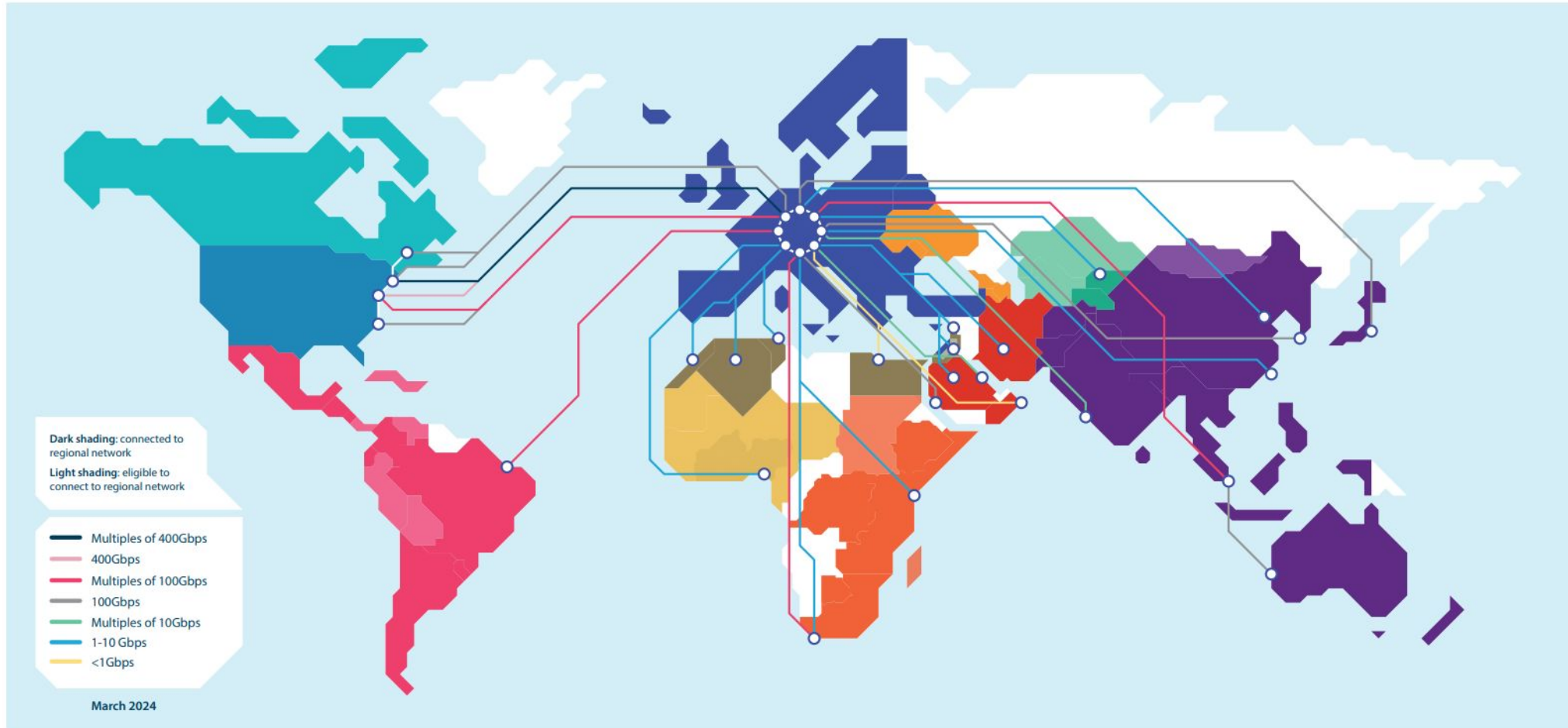
Traffic to external network



GÉANT – European Backbone



GÉANT – part of the world wide network



Canada & USA

Latin America

Europe

North Africa & Eastern Mediterranean

West & Central Africa

Eastern & Southern Africa

Central Asia

Asia-Pacific

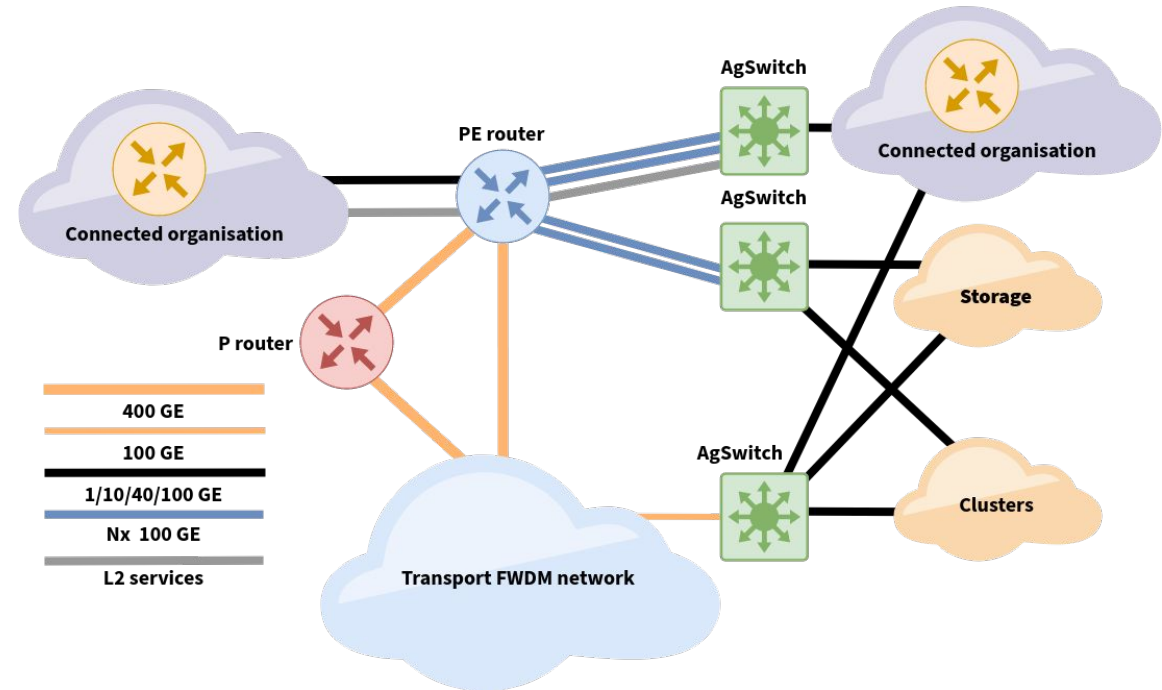
Other R&E Networks



Big data transport

Prepare yourself with our help

- Transport of 1PB over 100Gb/s ~ 1day
- Network is just part of the story
- Firewalls can't have such throughput
- Use the right tools and settings
- Transport/Network optimisation
- Science DMZ
- VRF
 - with or without internet
 - tailored defence



Use cases

Specific services and examples of extensive network usage

- Managed wavelength – BIOCEV CCP – IMG Krč – 2x100Gb/s
- VRF (L3 VPN) – LHCONe
- VRF – IMTM UP Olomouc – HPC cluster at IT4I Ostrava
- VRF – BIOCEV – IMG Krč for Storage interconnection
- VRF – hSOC, SAPnet
- VRF – Cloud partition interconnect (Metacentrum Brno – IT4I Ostrava)
- VRF vs L2 VPN – flexible, measurable
- Low latency video and simulations (MVTP+UG), 8k60 – 33Gb/s



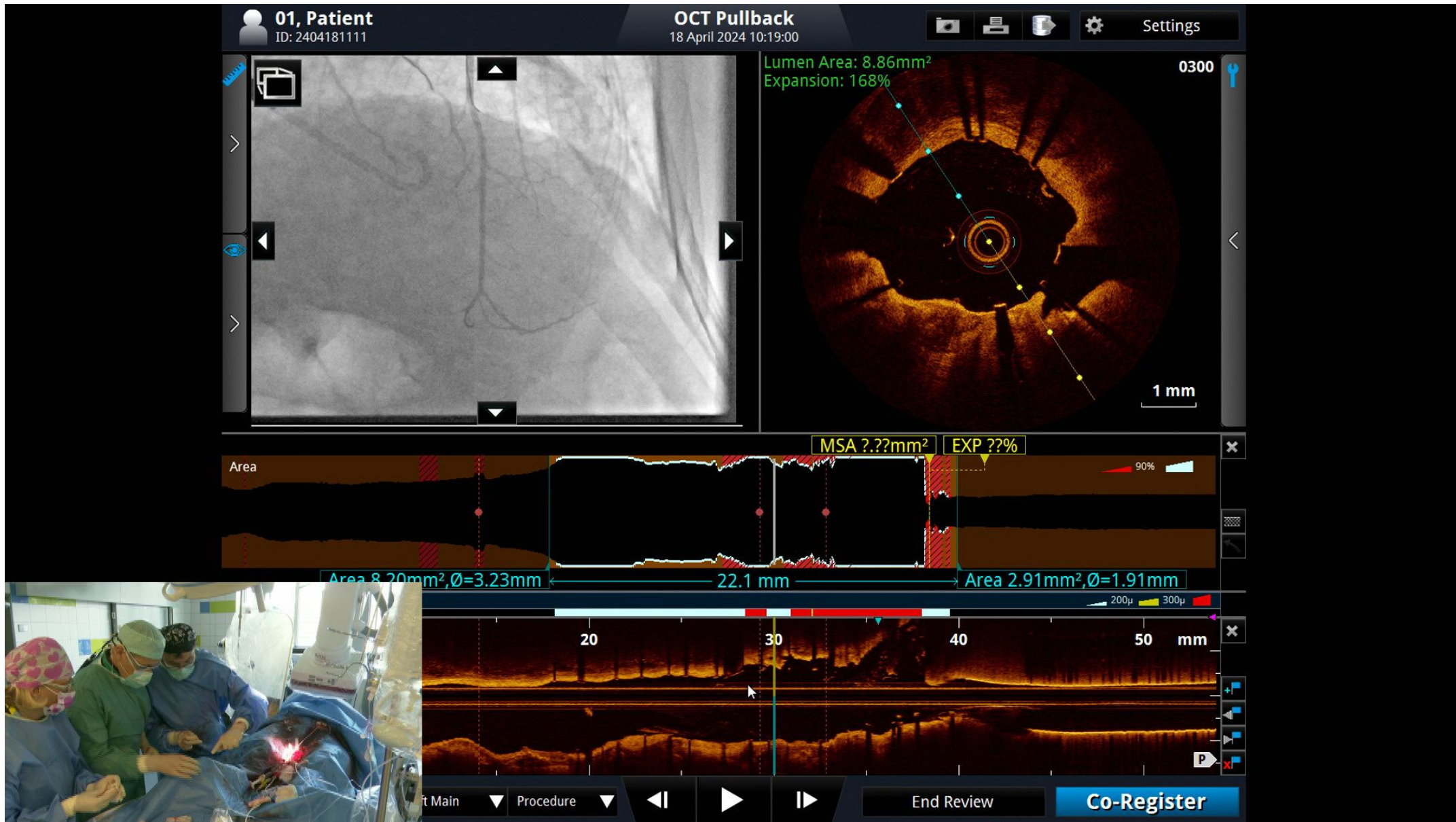
Use cases - low latency video



Use cases - low latency



Use cases - low latency



01, Patient
ID: 2404181111

OCT Pullback
18 April 2024 10:19:00

Lumen Area: 8.86mm²
Expansion: 168%

0300

1 mm

MSA ?..mm² EXP ??%

Area 8.70mm², Ø=3.23mm

22.1 mm

Area 2.91mm², Ø=1.91mm

90%

200µ 300µ

20 30 40 50 mm

Main Procedure

End Review

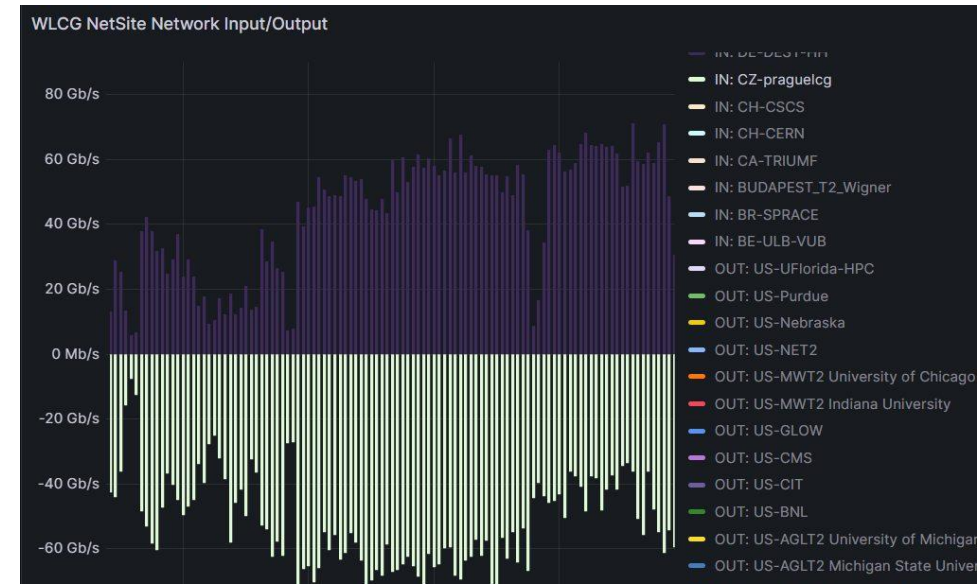
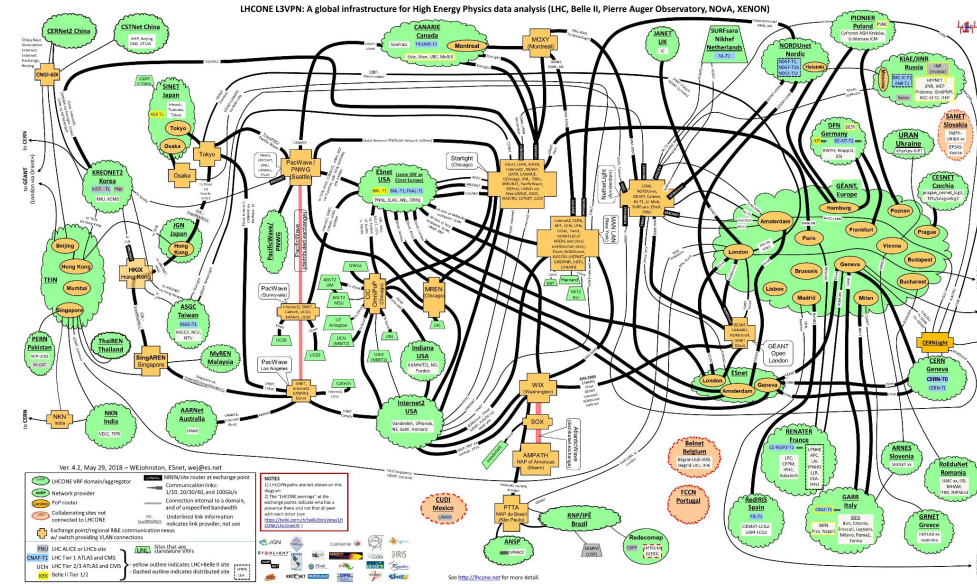
Co-Register

Use cases - LHCCONE



Large Hadron Collider Open Network Environment

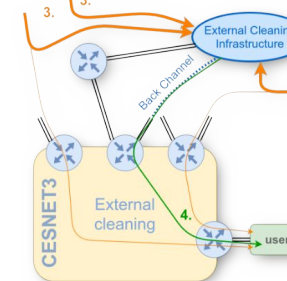
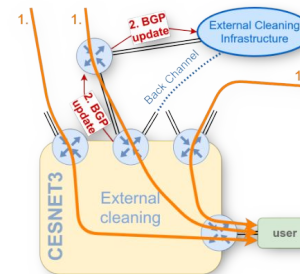
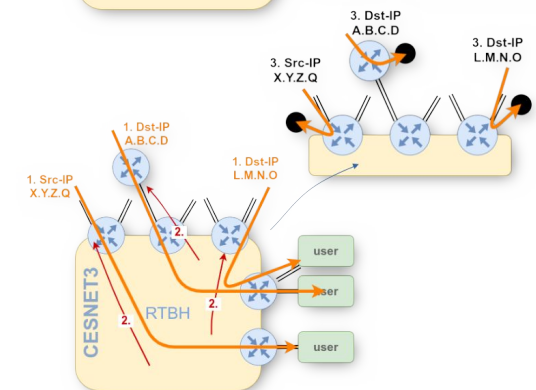
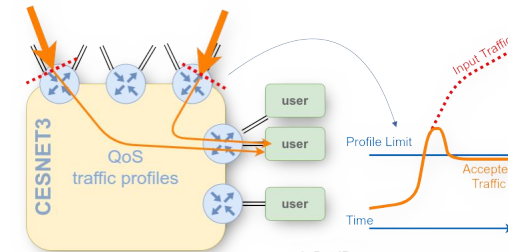
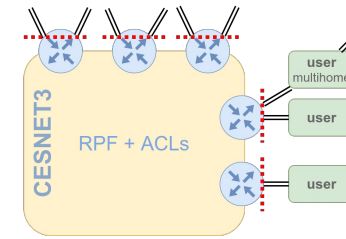
- Worldwide environment developed to distribute LHC data
- Advanced and protocols tools tested and developed
- DC24 2 weeks during February, preparation for HL-LHC 2029
 - DC21 – 10 %, DC24 25 % of 2029, DC26 - 60 %
 - IN: avg 51,6 Gb/s max. hourly avg. 75,9 Gb/s
 - OUT avg 43,5 Gb/s max. hourly avg. 71,1 Gb/s.
 - Total: 4,5 days received 2,5 PB, sent 2,1 PB.



Network defense

We care a lot

- Flow based monitoring
- Layered defence mechanism
 - General purpose
 - e.g. RPKI, ACL, QoS, BCP, RTBH, FlowSpec
 - Automated
 - Natural part of connection to the infrastructure
 - **Tailored to service or organisation**
 - User defined rules (ExaFS)
- Joint solution



Precise synchronisation

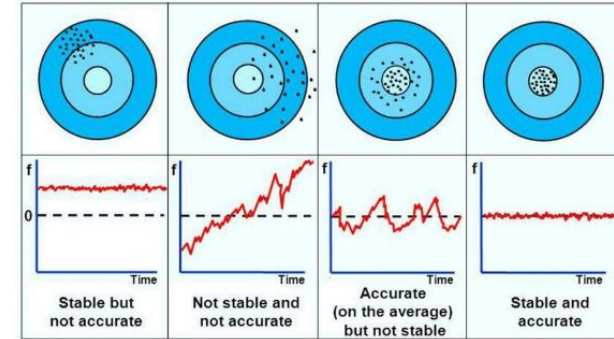
- Need for precise synchronisation of distributed equipment
 - Physics (CERN Colliders)
 - Astronomy (LOFAR 2.0, SKA)
 - ESA/Galileo
 - National Time Labs cooperation, source comparison
 - Network packet timestamping

Science Case	Application	User Need	European Impact	Required Service
1 Telecommunication and Networks / Position, Navigation, and Timing	Resilience for GNSS based on PNT	High	High	Absolute Timing Service
	Network Synchronization (5G or 6G)	Low	Low	Frequency & Timing
	Optical Timescales	High	High	Absolute Timing Service
2 Quantum Technologies	Improving real-world QKD	Medium	High	Frequency & Timing
	Development of new protocols	Medium	High	Absolute Frequency Service
	Entanglement distribution beyond QKD	Medium	High	Frequency & Timing
3 Fundamental Science	Precision spectroscopy to search for BSM physics	High	High	Absolute Frequency Service
	Improvement of optical clocks	High	High	Frequency & Timing
	Redefinition of the SI-second			
4 Earth Observation / Geodesy	Height system unification	High	High	Absolute Frequency Service
	Satellite gravity mission validation	Medium	High	Relative Frequency Service
	Geodetic network consistency	Medium	High	Relative Timing Service
5 Astronomy	Radio interferometry and VLBI (reference frame realization)	High	High	Frequency & Timing
	Laser ranging	High	High	Frequency & Timing

Precise synchronisation

White Rabbit to every family

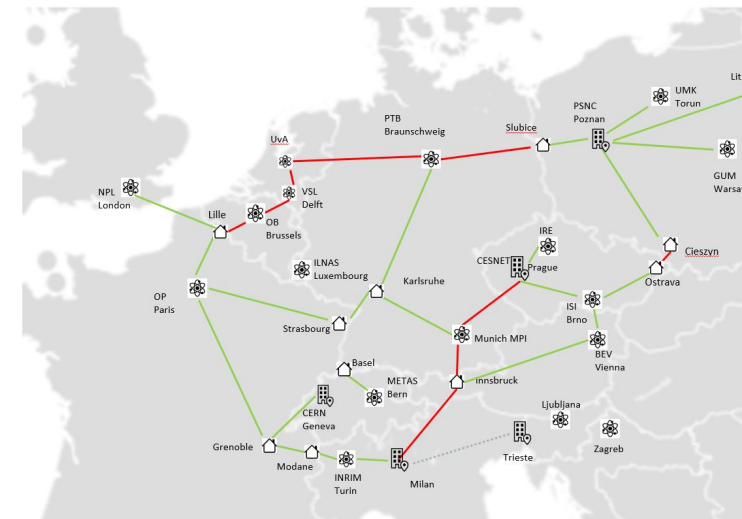
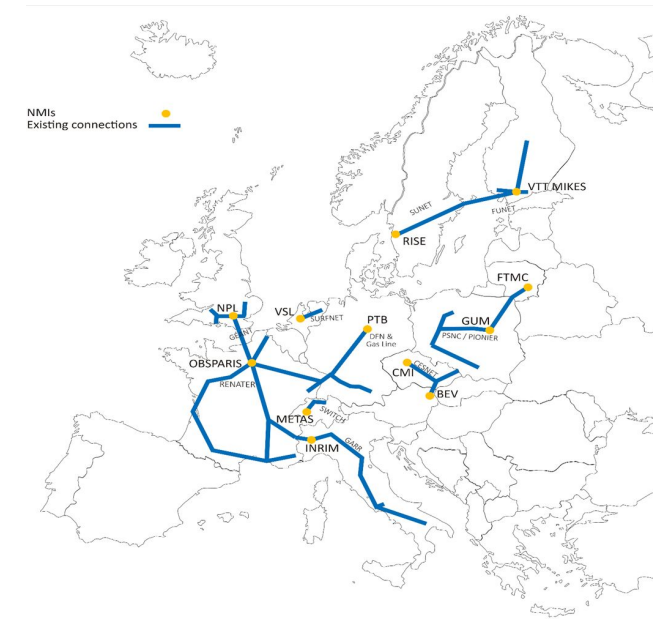
- GPS/GNSS might not be enough
 - Direct visibility needed, roof space availability
 - Weak signals can be jammed or spoofed
 - Limited accuracy ≤ 30 nanoseconds with special equipment
- Optical transport can be used in complex buildings, mines, etc.
 - Cannot be jammed easily without direct access to the fiber
 - Guaranteed accuracy ≤ 1 ns
 - WR open HW from CERN, manufactured and enhanced by several companies



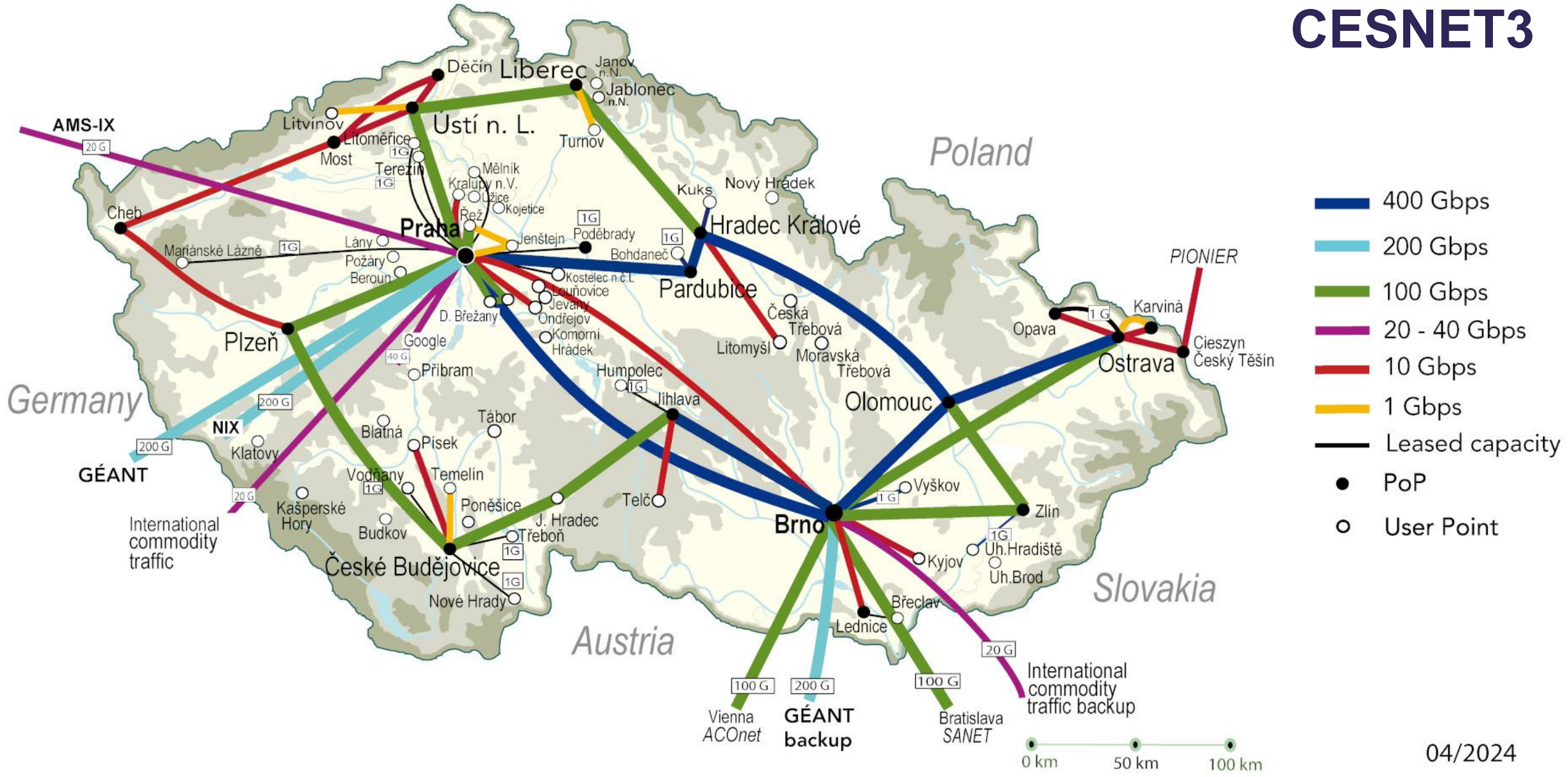
WR in CZ and Europe

White Rabbit to every family

- CESNET has long term experience in T&F area
 - CITAF (CAS IPE, IPP, ISI, FEL&FJFI CTU)
 - operational experience
 - IPE/Prague – BEV/Vienna, since 2011, 550km
 - IPE Prague – Geodetic observatory (VUGTK) Pecný since 2014
 - Prague – Brno – since 2014, 306km
- Major expansion of availability
 - Use of current backbone
 - WR switch in major PoPs
 - Planned as a Service
- European scale
 - GÉANT - crossborder fibers
 - Other NRENs also expanding the service



CESNET3





Thank you
Questions?

