

Towards National Research Infrastructure for Clock Network Services

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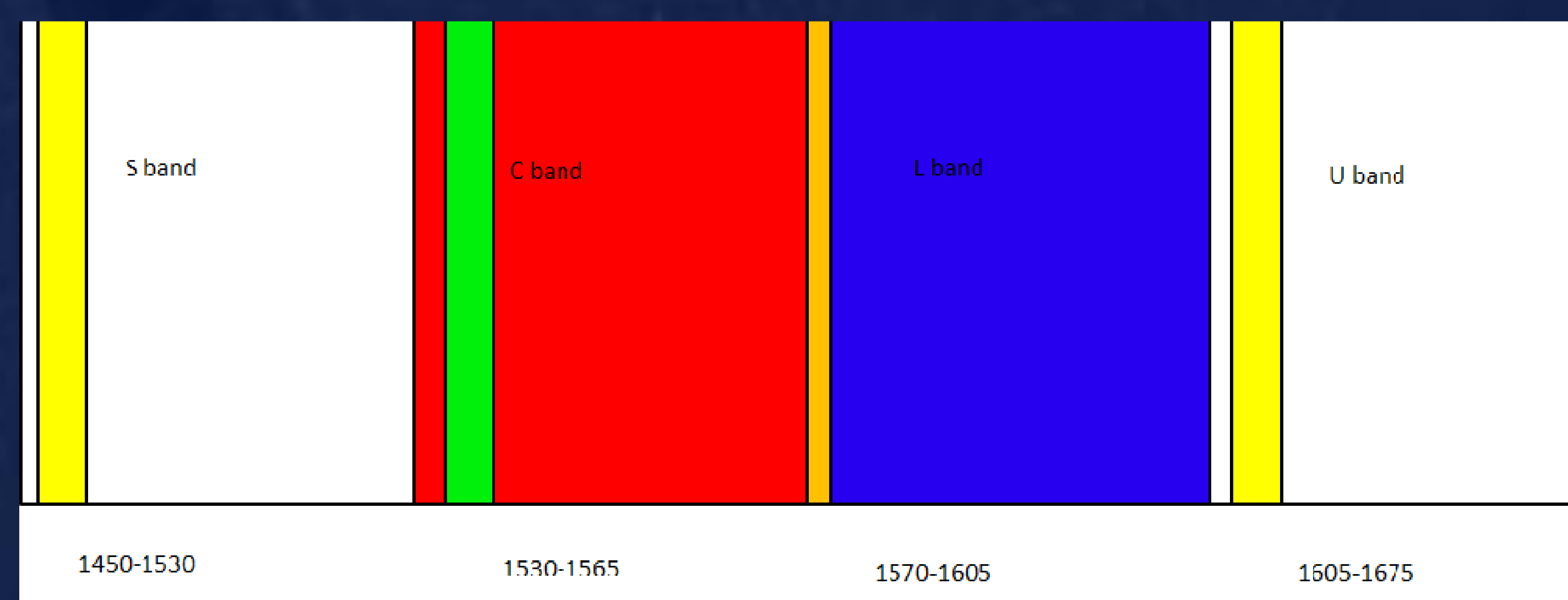
Precise Time Transfer (1800+ km)

- Two complementary technologies
 - Self-developed time transfer adapters
 - White Rabbit technology
- TTA – UFE Prague – BEV Vienna 550 km since 2011
<https://archiv.ces.net/events/2012/cef/p/E2E%20photonic%20services%20and%20fibre%20sharing%20for%20R&E%20Community.pdf>
- Comparison of UTCs
 - UTC(TP) - UTC(BEV)
 - UTC(TP) - UTC(PL)*
- Distribution to demanding users
 - Extreme Ligth Infrastructure
- Synthetic Time Scale
- Multiple transfers between Cs and H clocks

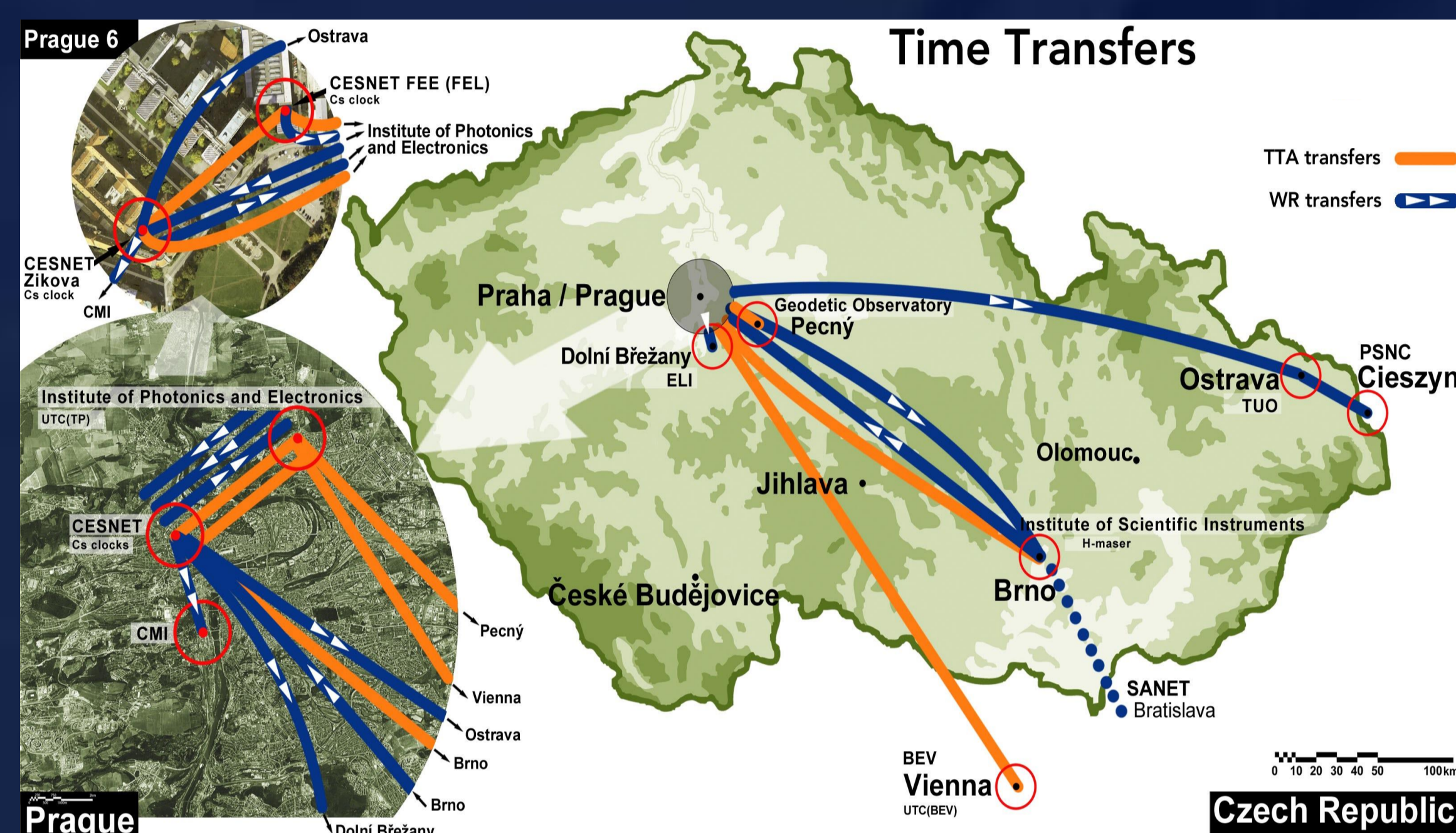
* under development

New 400Gbit/s coherent optical CESNET network roll out 2021

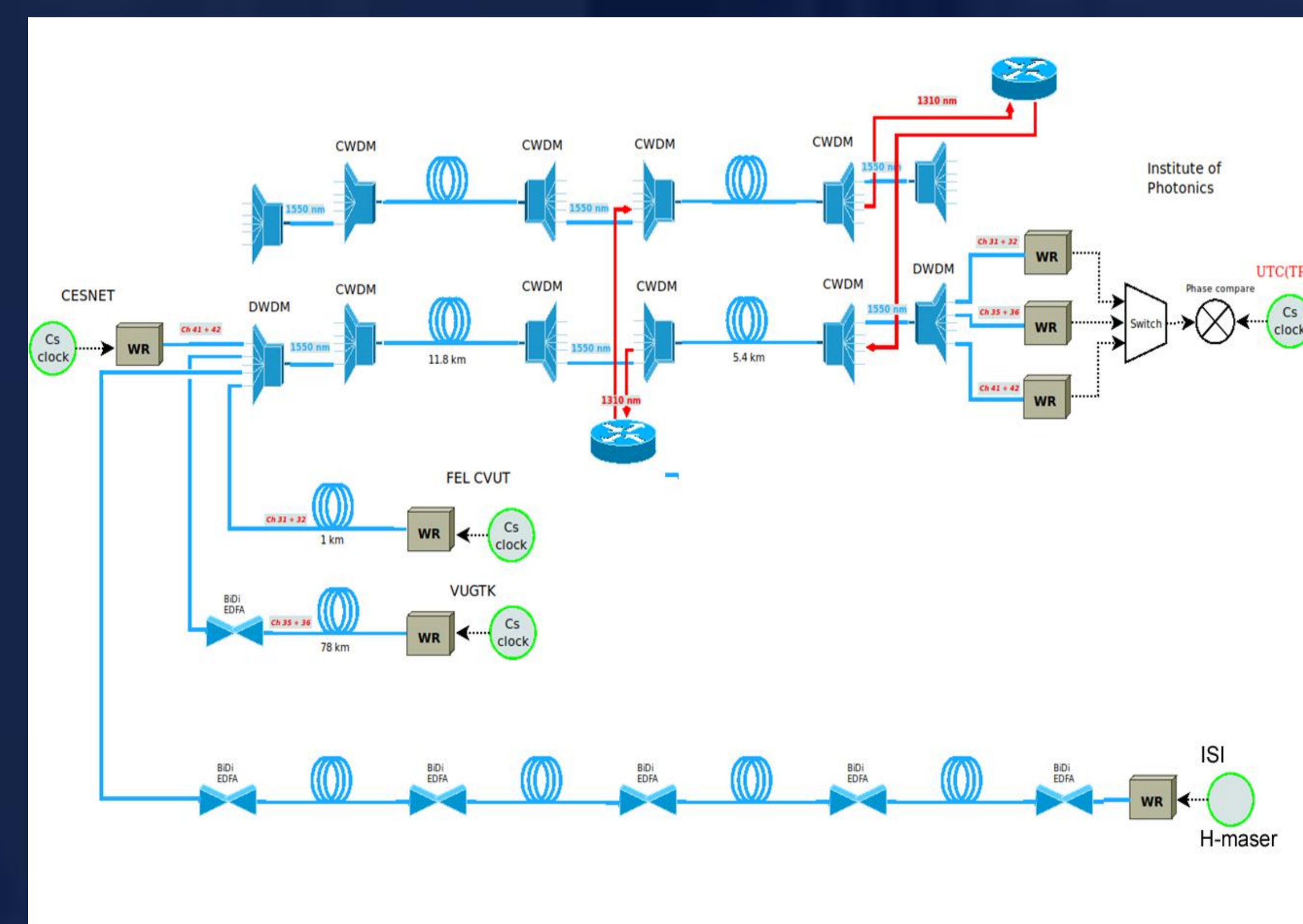
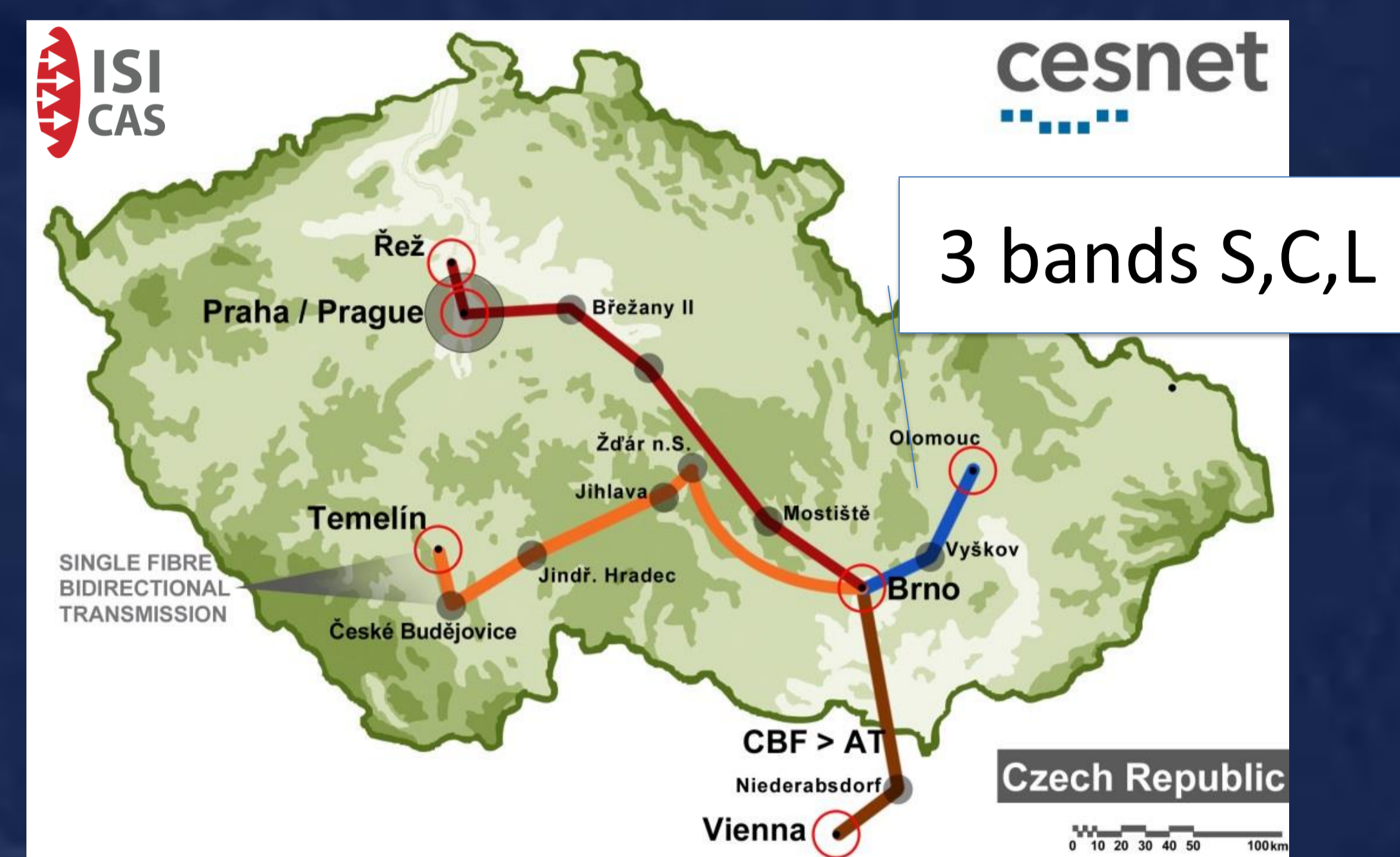
- Dedicated bandwidth for time, frequency and quantum transfers
- Allows multiple transfers (incl. Ch. 46 1540.5 and Ch. 44 1542.1 nm)
- Now 21 BiDi EDFAs, > 29 in 2021 (available from 3 vendors)
- Filters deployed for Ch. 46-39 (green), Ch. 9-6 (orange)
- Tested also 1610 and 1460 nm transfers, incl. bidi amplification (in yellow)
- Plans to phaseout AM signals from C band (green)



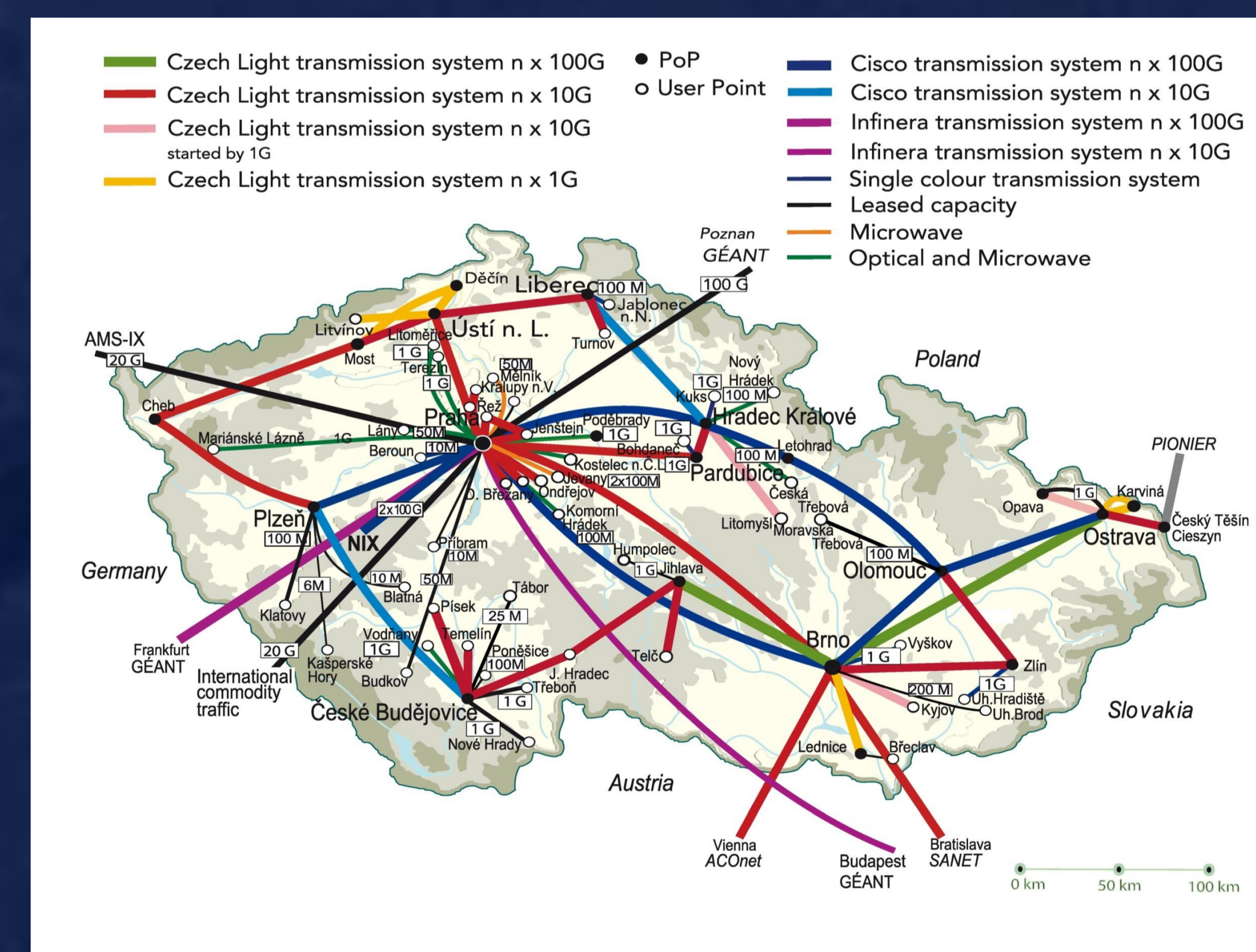
Spectrum dedicated for data transfers in red and blue



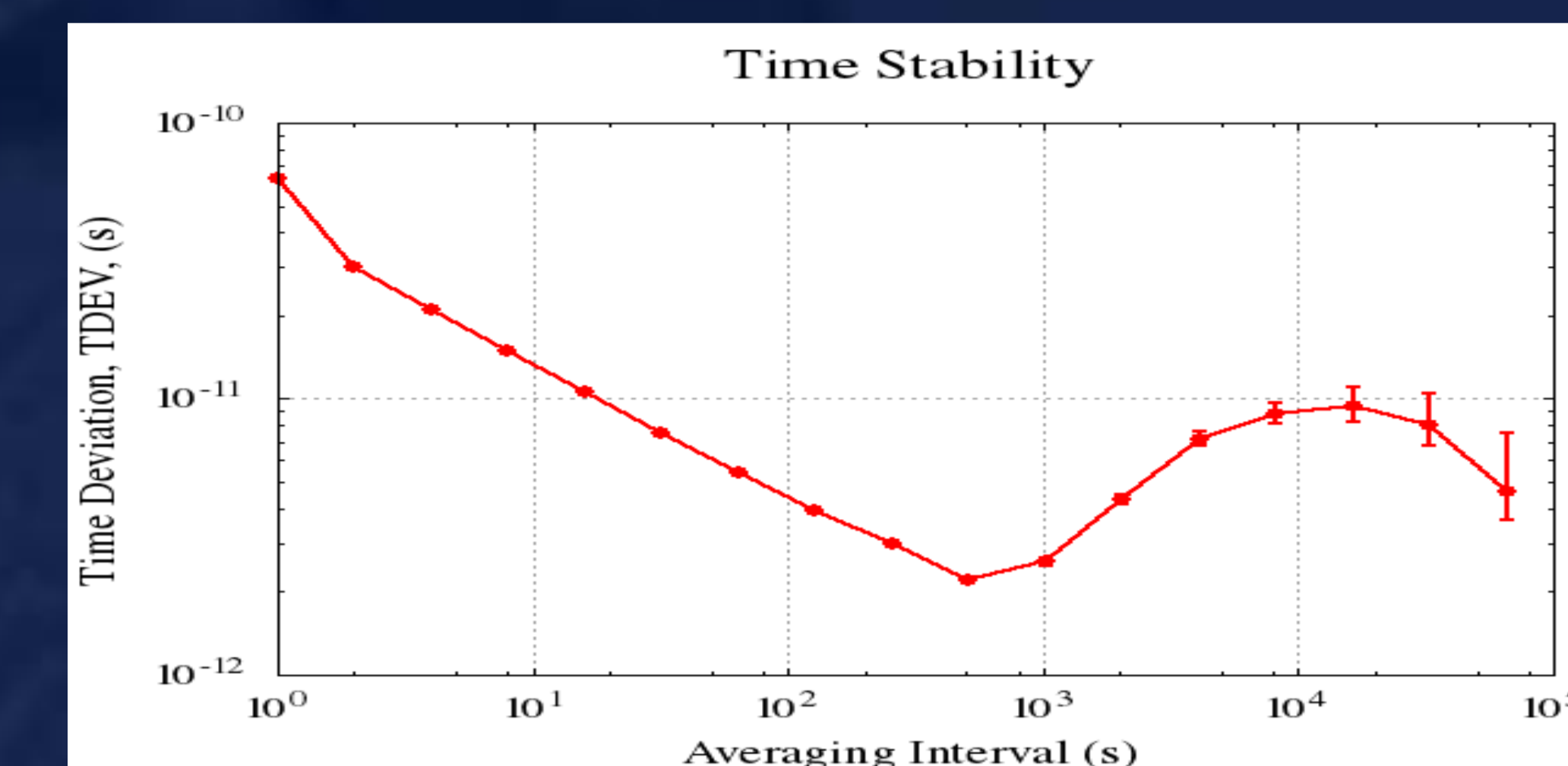
Time and RF frequency - Time Transfer Adapters + White Rabbit over 1800 km



Synthetic timescale, three Cs clocks connected to DI time lab in UFE, H maser connection under development



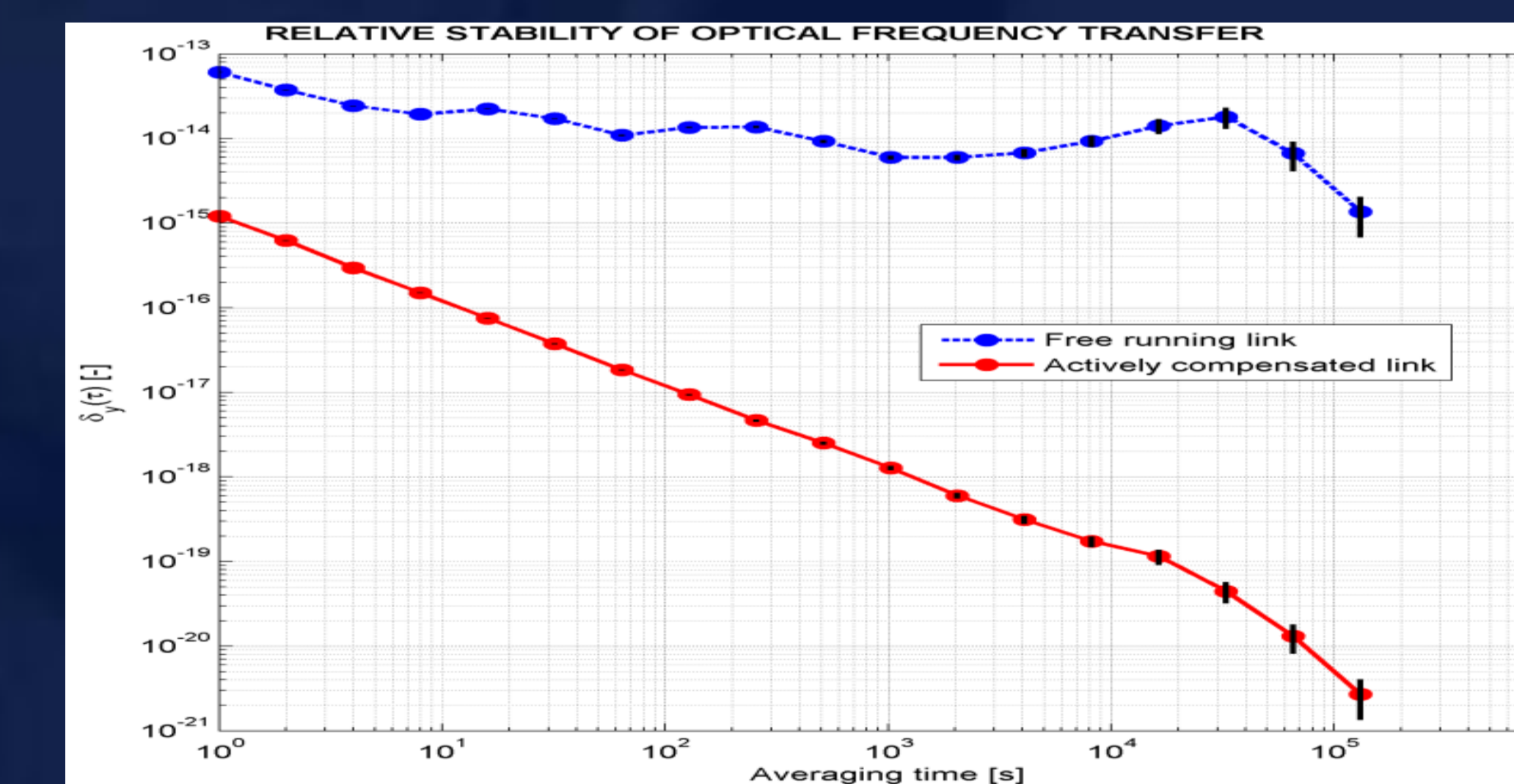
Dark fibre based optical network CESNET2, part of e-Infrastructure CZ



Stability of time transfer in terms of TDEV down to 2 ps (180 km field deployed fibers)

Coherent Optical Frequency Transfer (1100+ km)

- Now 1100 km, developed in cooperation with ISI
- Optical Frequency + TTA - 305 km Prague Brno since 2015
- Allows multiple simultaneous transmission (incl. Ch. 46 1540.5 and Ch. 44 1542.1 nm)
- 700 km bidirectionally lit as a service (since 2015)



Optical frequency transmission stability in terms of ADEV down to 10^{-19} at 10^4 s averaging. Brno-Prague line, in-loop

