CESNET

Infrastructure overview with the focus on Experimental Facility

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Preface

Authors participate on following projects:

Large infrastructure CESNET (www.cesnet.cz),

GÉANT, GN3 (www.geant.net),

Presented content don't necessarily represent an official opinion of mentioned institutions and projects

Outline

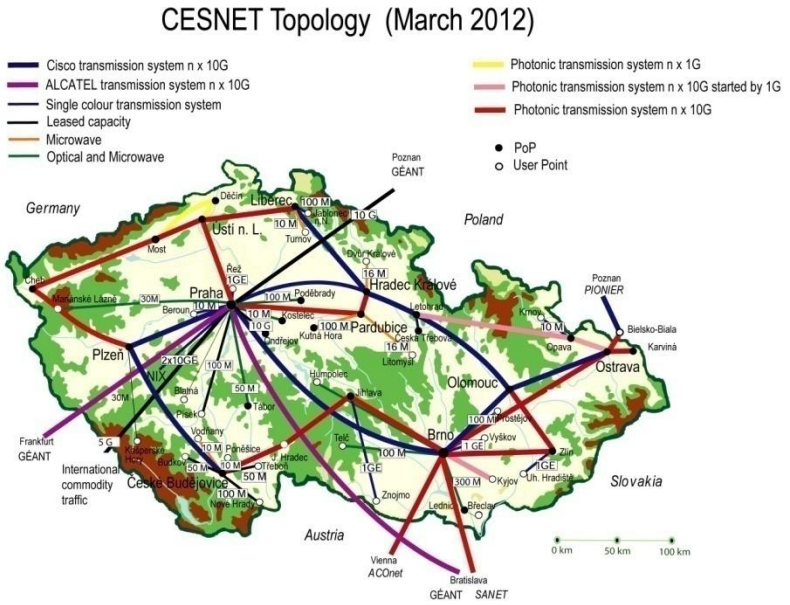
1. Czech Education and Research Network.
2. Topology & Interconnection
3. CESNET (Trans)Mission.
4. Utilization.
5. Services.
   - Bidirectional Single Fiber Communication.
   - Atomic Clock Synchronization.
6. Additional Services
7. Experimental Facility.
8. Conclusion.

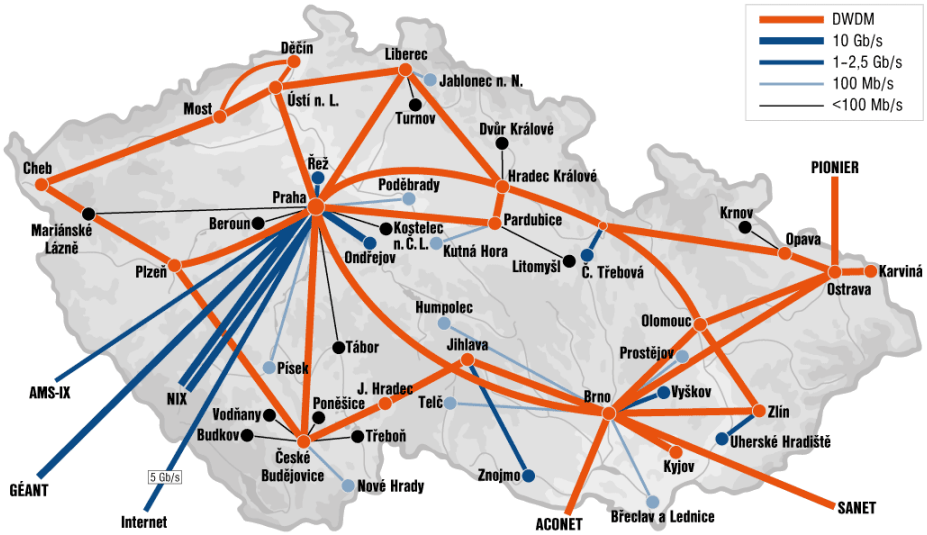
CESNET
Another Czech ISP?

- NO! – Common misunderstanding!
- CESNET (Czech Educational and Scientific Network) - NREN in the Czech Republic.
- Established as Association of Legal Entities (z.s.p.o.) in 1996 – not for profit.
  - All public universities + Czech Academy of Sciences.
- Available to all non-profit organizations and associations.
- CESNET operates:
  - National research and educational network – CESNET2.
  - Dark Fiber Experimental facility.

Topology

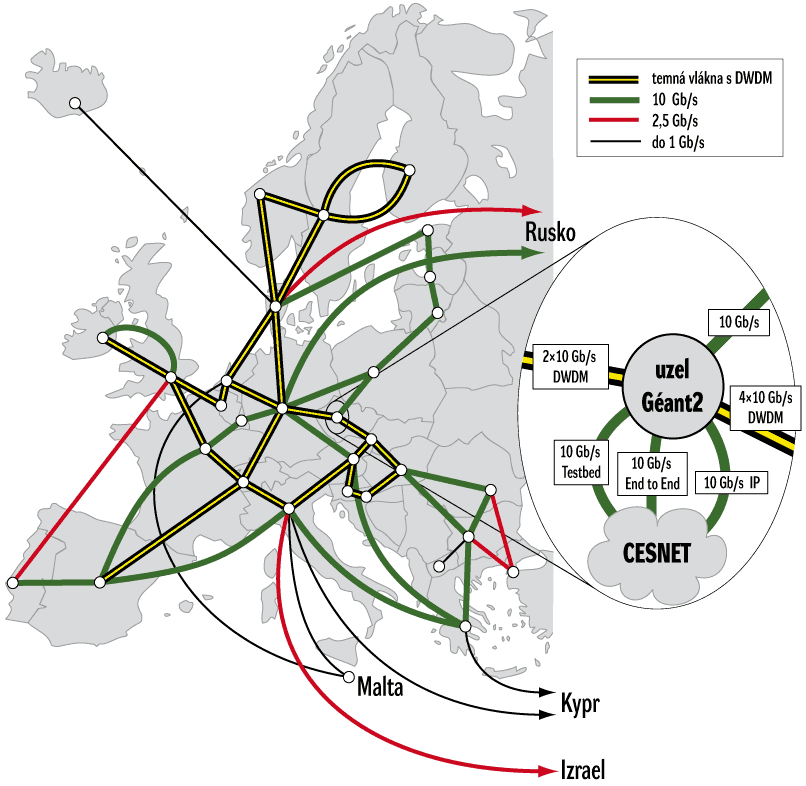
- Status - January 2012.
- **5 120 km** leased fibre lines in total.
  - High density among NRENs (65m/km^2).
  - 4760 km in production network (CL + Cisco DWDM).
  - Includes almost 1000 km of SF bidirectonal lines.
  - Covers also 360 km of Experimental Facility dark fibre.





Interconnection

- GEÁNT - 10Gbps - node hosted directly in CESNET HQ in Prague.
  - Key foreign NREN connection.
- USA – Telia 2,5Gbps.
- Key neighbor NREN individual connection (all 10Gbps):
  - SANET (.sk)
  - ACONET (.at)
  - PIONIER (.pl)
- Other Czech Commercial ISPs – NIX.cz – 2x 10Gbps.
- GLIF connection – 10Gbps – CESNET CzechLight („CL“) photonic testbed.



CESNET (Trans)Mission

- Topology made of fully leased dark fibers.
- Focus on NIL approach (since 2002) and prefer (if possible) passive components in between.
- Single fibre bidirectional transmission (since 2002).
- Cross Border Fibres (CBF), since 2003.
- Open transmission system, since 2004.
- Combination of equipment developed for commercial ISPs and flexible solution tailored to special needs of R&E network.
  - **Cisco DWDM system**
    - 8 lines n x 10G
    - 1 410 km
  - **Open DWDM system**
    - 20 lines (5 lines n x 1G plus 15 lines n x 10G)
    - 2 660 km

Infrastructure Improvements & Evolution

- CESNET Large Infrastructure project.
- Nowadays POP main DWDM devices are in process of exchange.
- Requirements are:
- 40G Ethernet ports at minimum.
  - With possible upgrade to 100G.
- At least terabit routing capacity.
- Grid Infrastructure evolution to Interconnect Infiniband dedicated centers with Long Haul IB Connection.

Photonic Services

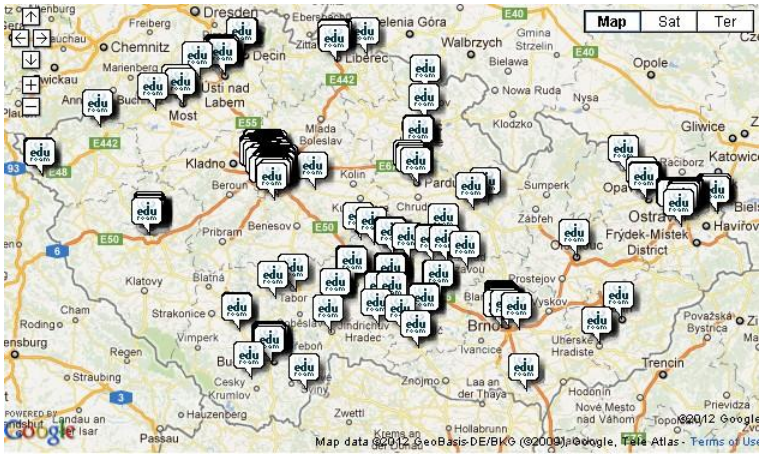
- CESNET suggested Photonic services as a general new type of service in future GEANT network.
  - To allow more than simple IP services.
  - To support „real time“ applications (e.g. remote instrument control).
  - Critical (Emergency) applications (Natural disasters monitoring).
  - Low and fixed latency.
  - Radio frequency over fibre (signals from radio locator, sonar, atomic clocks etc.)
- Some results:
  - Multi-channel low-latency video transmissions for 4K/2K and 3D HD applications in medicine, engineering (CAVE-to-CAVE) and audiovisual processing.
  - Surgery demonstration for conference: http://www.ces.net/doc/press/2010/pr100304.html
  - Remote demonstration of a kidney surgery by robotic instrument (da Vinci robot) from the Masaryk Hospital in Ústí nad Labem to the Prague (about 130 km by fibre). Signal delay along the transmission stream was less than 1 ms, enabling a truly real-time 3D Full HD stereo broadcast: http://www.ces.net/doc/press/2010/pr100618.html

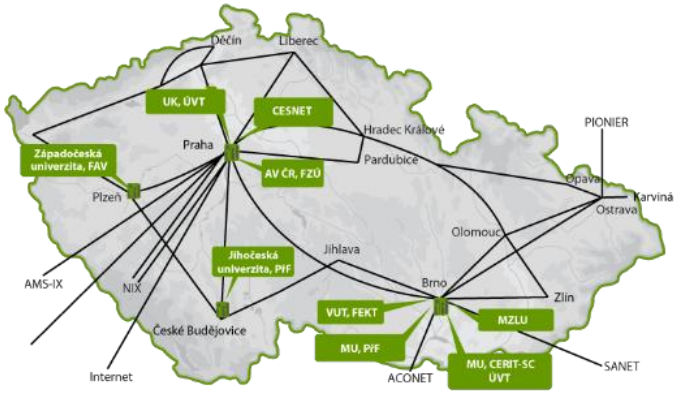
Photonic Services continues…

- Lit fibre service.
  - Thanks to our R & D and CL devices CESNET is tireless promoter of SFBT systems.
  - Tested on our Experimental Facility.
  - Can be ordered as a service.
  - Providers have acquired experience with new type of service based on Open DWDM photonic system developed and licensed by CESNET and can offer this new type of service to other customers.
- Highgly Accurate Crock Synchronization.
  - Time stamps transfer demonstrates the new capabilities of photonic networks.
    - Transition from Cisco DWDM to CL DWDM (298 km + 221 km).
    - CESNET-ACONET (Prague - Vienna) experiment.
      - Involved national time and frequency labs in Prague and Vienna: IPE (Institute of Photonics and Electronics of Academy of Sciences of the Czech Republic) and BEV (Bundesamt für Eich- und Vermessungswesen),
    - The purpose was to compare time scales of atomic clocks.
    - Accuracy of *1ns* was achieved!
    - Adoption as advanced photonic services to those research institutions which can benefit from it (e.g. as primary (or backup) solution to standard GPS time synchronization).
    - Press release: "A new method of accurate time signal transfer demonstrates the capabilities of all-optical networks" http://www.ces.net/doc/press/2010/pr100401.html.

Additional Services

- Carrier Ethernet Transparent L2 Service.
- Fiber-to-X.
- Eduroam Wireless Infrastructure.
- MetaCentrum – CESNET Grid Infrastructure
  - Four geographic locations.
  - Computational intensive applications.
  - About 4000 cores in total (about half CESNET).
  - Connection to CESNET **Data Storage Department.**
- CSIRT – CESNET Security Team
  - Security Incidents.
  - Whole AS2852 responsibilty.
  - Intensive Scanning, Spam, Copyright, violation , Phishing etc.



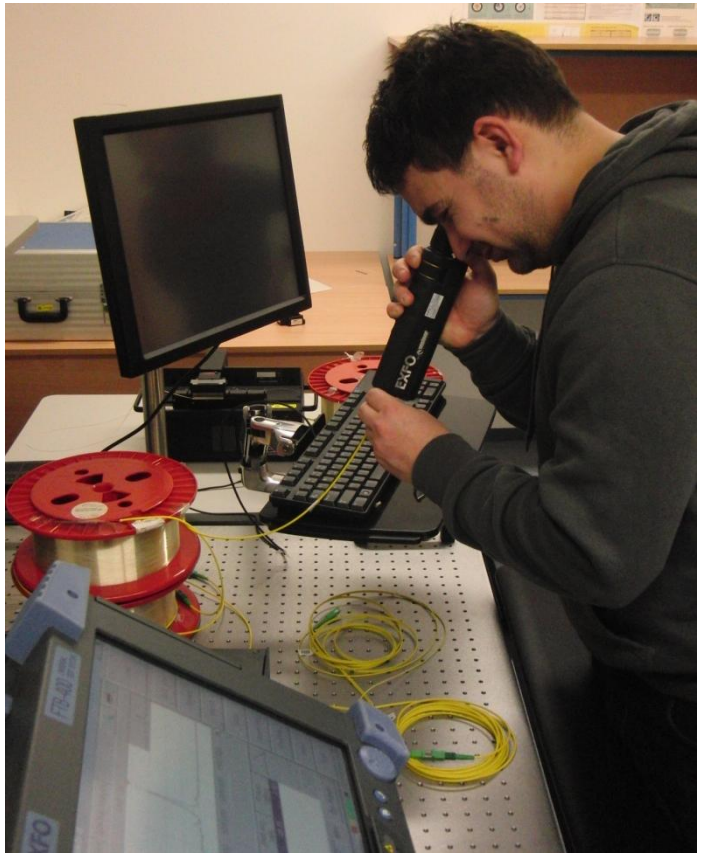


Single Fiber Bidirectonal Transmission

- Back to 2002 CESNET demonstrated and proved SFBT (N x 10Gbps).
  - Overall costs of the line were reduced by 40% than in traditional dual-fiber solution.
- Can solve lack of fibers.
- Second fiber can be added (and paid) later on if necessary.
- We also use this this solution to have backup access to our POPs (if will and $ are on our side).

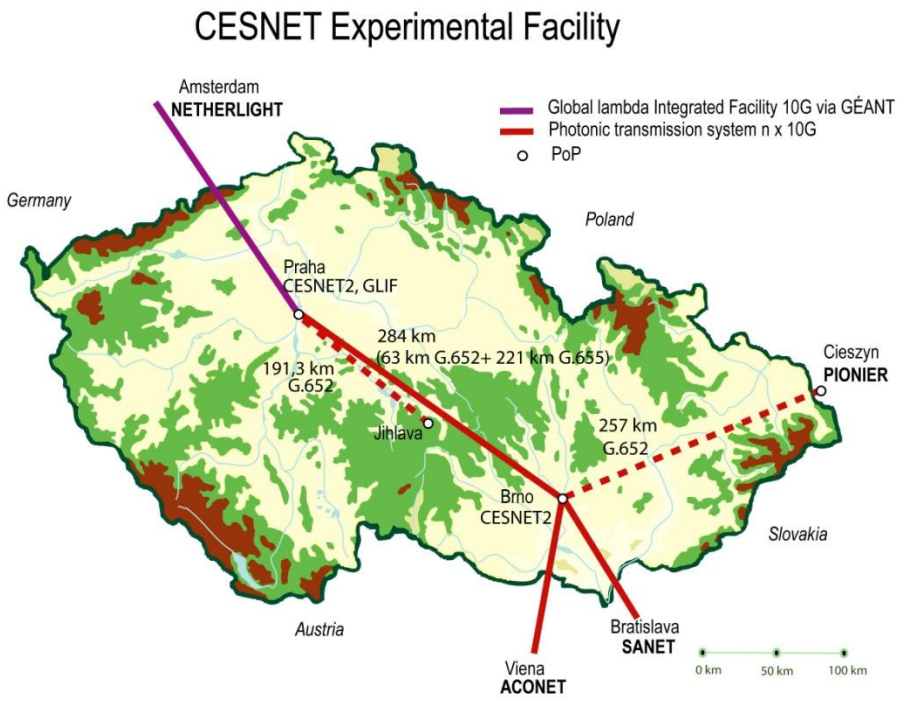
Optical LAB

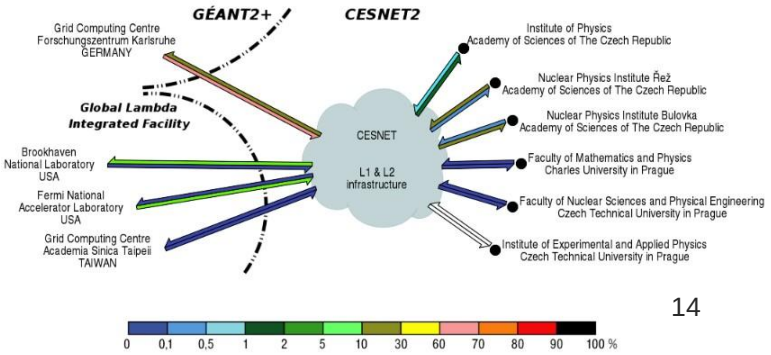
- OOD R & D Lab.
- CL device family testing.



CL Experimental Facility

- CESNET OND dark fiber experimental facility (EF).
- Illuminated by mainly by CL devices.
- Fully leased open dark fibers for testing of new technologies.
- We distinguish between EF and testbeds (EF is multi-purpose, long term and less technology/vendor dependent)
- Connected to GLIF (10Gbps, NL – NetherLight).
- Dedicated EF for Physicicts.





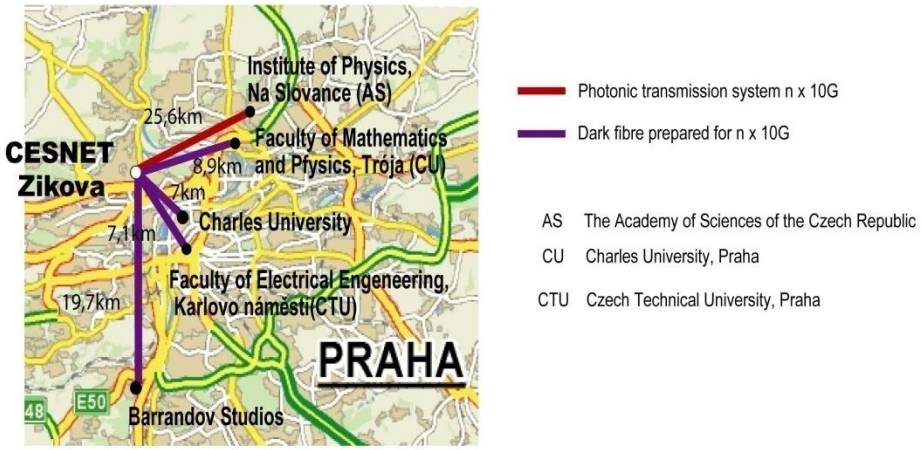
CL Experimental Facility

- Infrastructure intend for testing of new photonic devices developed by CESNET.
  - Can be also used for testing in cooperation with our partners and in international research projects.
  - 100Gbps Alcatel-Lucent transmission systems made recently.
- Used for technology transfer of networking R & D results.
- CESNET uses EF for:
  - Testing of new CL devices and new photonic products,.
  - Building and operation of testbeds.
  - Disruptive experiments with new services and products before deployment.
  - Support of experiments with new applications and research.
  - Collaboration.
  - First mile solutions testing.

CL Metropolitan Testbed

- OND Optical Testbed in Prague.
  - Research cooperation with connected universities and their labs.
  - Connecting CESNET optical labs.

Metropolitan Experimental Facility for e2e connections



Conclusion

- EF offers new opportunities for CESNET and allows us to test new technologies and applications.
- CESNET also focus on light delivery and advanced photonic services to new institutions which can use them (metrology, seismology, geomagnetism etc.).
- Advanced applications covers also remote device management in real-time.
- We are searching for partners on Experimental facility utilization.
- CESNET Infrastructure is capable of 100Gbps. Upgrade of L2/L3 devices in progress.

- THANK YOU FOR YOUR ATTENTION!
  - QUESTIONS?