Innovative photonic devices for emerging NRENs

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Outline

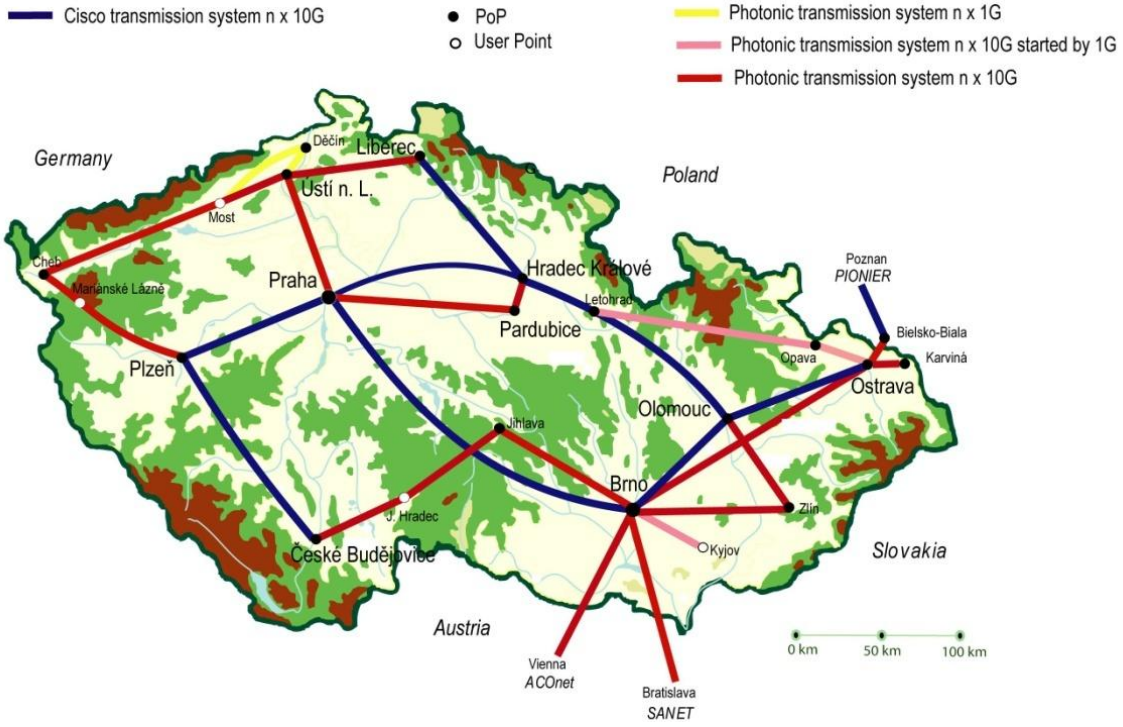
- Czech Research and Education Network CESNET
- NRENs purpose
- NREN optical core network optimization
  - Customer Empowered Fiber Network
  - Nothing In Line
  - Single Fiber Bidirectional Transmission
- Innovative photonic network devices
- New network applications
- Conclusion

Czech Research and Education Network
CESNET

Czech Republic
7x smaller than Republic of Kenya
3x lower population than Republic of Kenya

CESNET
the association of legal entities

- Non-profit organization
- 250 researchers and staff
- Optical core network, Programmable hardware, Network security and special network applications
- Connecting over 40 partners - universities, hospitals and research institutions
- Optical network ~ 5000km
- All–optical network with DWDM
- Innovative photonic network devices



NRENs purpose

National Research and Education Network

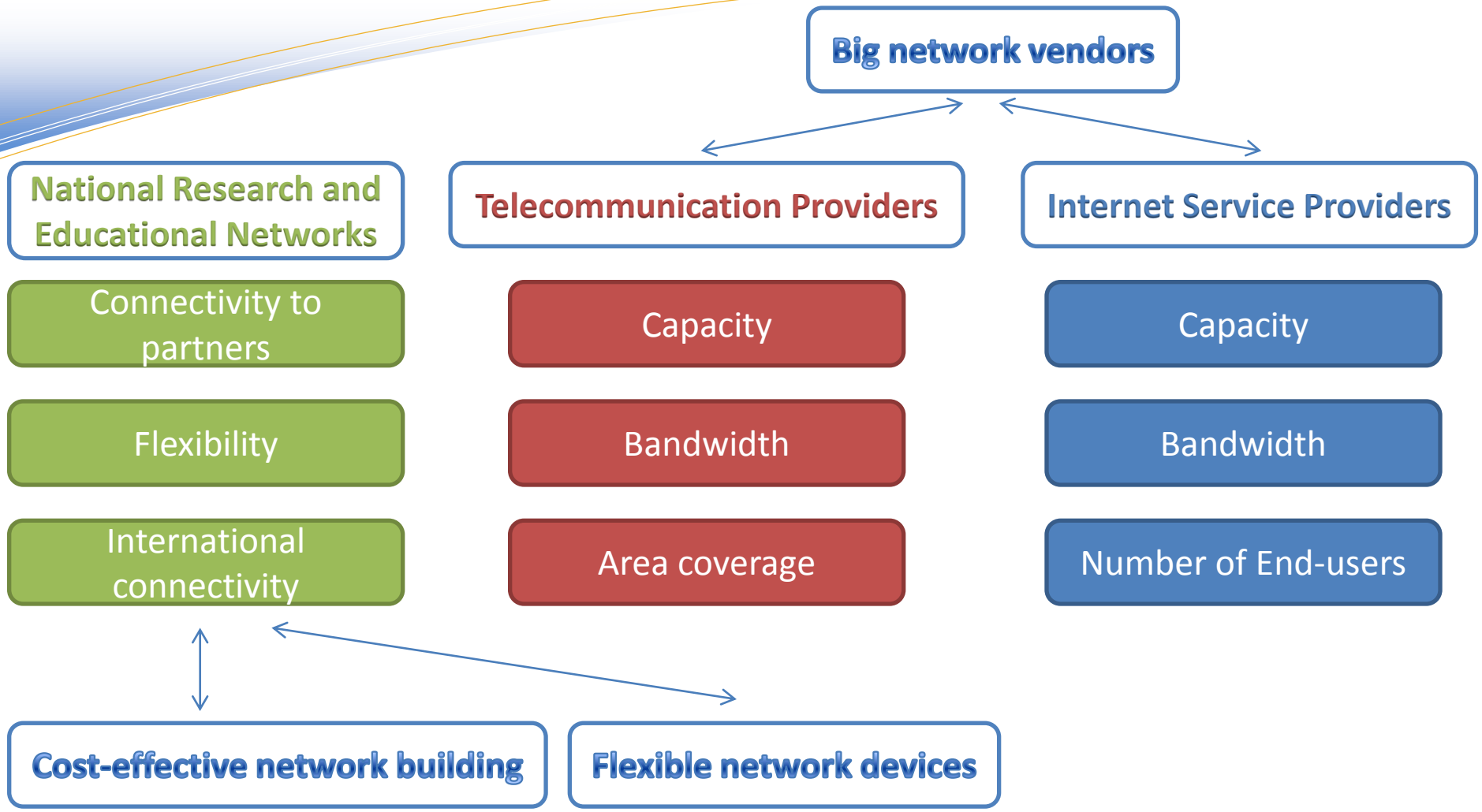
Purpose

- Support of R&E partners by delivery of network services (connectivity, grid computing, data storages, …)
- Providing partners with collaborative and educational environment
- Help partners to minimize distance and digital divide by forming development projects
- Research of networking and participation on global networking projects

NREN funding

- Usually cost share from partners for delivered network services, state projects, research projects, technology transfer

NREN network optimization



NREN network optimization

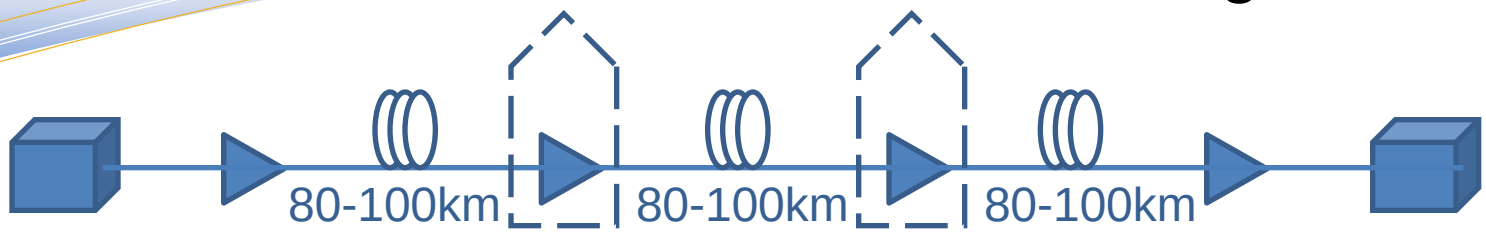
Customer Empowered Fiber Network

Optical Network flexibility
- Freedom in fiber lighting technology selection
- Flexibility in network capacity and technology change
- Quick adaptability to new technologies

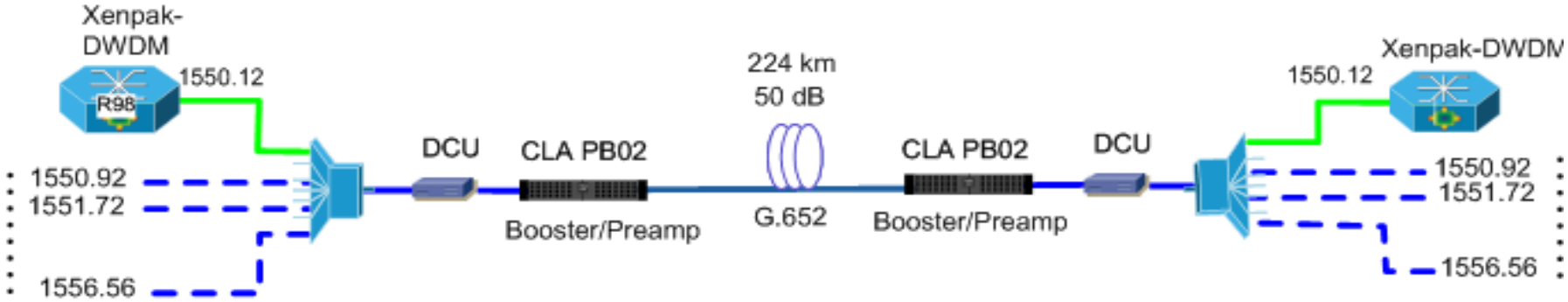
Dark fiber infrastructure
- Complete control over lighting technology
- Easily accessible for research purposes
- Perfect resource for innovations and education of experts
- Possible outsourcing – fiber rental, technical support
- Deployment of new fiber plant

NREN network optimization

Nothing In Line

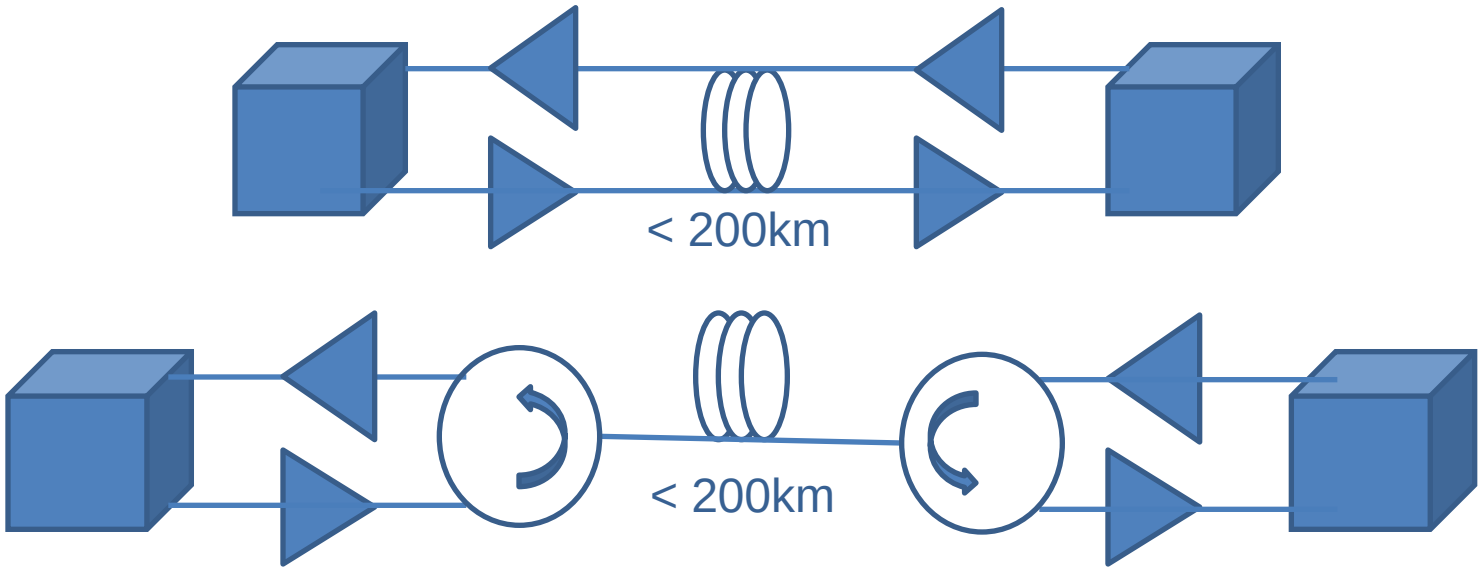


- Additional housing = electricity access, rental cost, security and more network devices
- NIL approach allowed us to reach more then 200km without intermediate housing or inline amplification
- Savings of CAPEX and OPEX of 1-2 intermediate housings
- Deployment of CzechLight optical network devices designed for this purpose



NREN network optimization

Single Fiber Bidirectional Transmission



Optical switch or ROADM

Optical amplification stage

Optical circulator

Optical fiber line

Single Fiber Bidirectional Transmission

- Rental cost savings (40% in central Europe)
- Just a little higher device complexity
- Halved available bandwidth as both directions share the fiber bandwidth
- DWDM in C-band ~ 80 channels x 10 Gbps / 2 directions = 400 Gbps available capacity for each direction
- Optimized for emerging network

Innovation photonic network devices

Czech Light family

- Full set of devices for optical core networks
- Allow to adapt core network optimization
- Open to repairs and modifications
- Optimal for staff training and education
- Technology transfer through licensing

New network applications

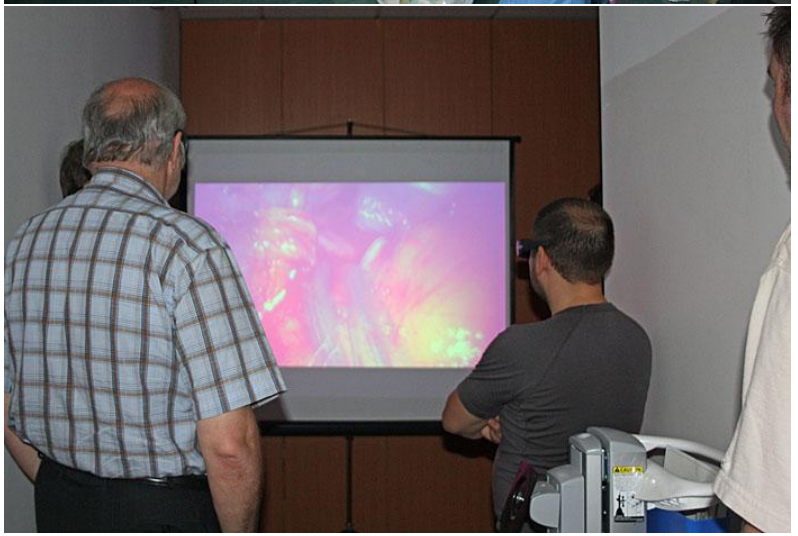
In general
- Important part of NRENs output
- Essential difference from ISPs
- Area and region specific
- Reflect current needs of R&E community

Special network applications
- **Broadcast of real time 3D HD video**

  (150km, 2.5 Gb/s , delay < 1ms)
- **Atomic clock comparison**

  (500km, uncertainty < 1ns, all-optical path)
- **Ultra-stable frequency transfer**

  (500km, RENATER, for metrology, astrology and particle physics)



Conclusions

- NRENs have different goals then ISPs or Telco operators
- NRENs network can be optimized cost-effectively
- We see three main ways of optimization: CEF, NIL, SFBT
- Open devices are good candidates for NREN networks
- Optimized NREN network allows new applications

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Thank you for your attention.

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