Experience with Cross Border Fibre connection in Europe

and with advanced optical devices deployments

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Presented ideas do not necessarily reflect an official opinion of the GLIF, GN2, CESNET or any other institution or project.
Research cooperation instead of fibre leasing can be successful start

- In some European countries, providing of telecommunication services (and especially fibre leasing) are still limited by legal or regulatory rules, but research is not restricted.
- First dark fibre line used in CESNET (Praha-Brno 324 km) since 1999 is part of contract with fibre owner company. Subject of contract is research cooperation (evaluation of some new usage possibilities, etc.).
- It is acceptable for Regulator (everybody cannot ask similar „exception“).
- It was better than wait for telco market liberalization
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Why dark fibre
for Research and Education Networks (RENs)?
(we have published this slide in TNC2004, Rhodes)

- Freedom in REN design
- Fixed costs of long-term use
- Transmission capacity up to Tbps
- Cost-effective ways of sharing (WDM, TDM, …)
- Multiple wavelengths possible (e.g. 1 – 256)
- Management of transmission
- Equipment selection, moving, design, …..
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Moving to dark fibres

- Moving of Research and Education Networks to dark fibres is successful and continues
  - CESNET, DFN, GRNET, Pioneer, RENATER, SANET, SURFNET, SWITCH…
  - Continental-wide RENs: NLR, GEANT2, Internet2
  - NRENs with long distances (Nordunet 2006-2007)
  - SEE and POS countries….
  - East Africa countries……

- Dissemination of experience can avoid repeating of mistakes

- Some other networks follow RENs (municipalities, hospitals, enterprises, … )
CEF Networks workshops

- One of the most important opportunities to exchange ideas about Customer Empowered Fibre Networks world-wide research and development are workshops in Prague. You can see
  - presentations of CEF 2004
  - presentations of CEF 2005
  - presentations of CEF 2006

Dark Fibres are crossing Borders

- Dark fibres connecting capitals or main PoPs, as in GEANT2 core or in National Lambda Rail (NLR) in US are crossing state borders, of course.
- By **Cross Border Fibre (CBF)** we mean other fibres, connecting NREN PoPs close to neighbour NREN.
- CBFs are usually short and non-expensive and carry high traffic between neighbour NRENs, saving expensive long distance fibres capacity.
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National dark fibre footprints for research (draft)
Cross Border Fibres in Europe

- Bratislava (SK) – Wien (AT) since 2002
- Bratislava (SK) – Brno (CZ) since 2003
- Cieszyn (PL) – Ostrava (CZ) since 2004
- Subotica (YU) – Szeged (HU) since 2005
- In production since 2006:
  - Brno (CZ) – Wien (AT)
  - Frankfurt/Oder (DE) – Slubice (PL)
  - Como (IT) – Manno (CH)
  - Basel (CH) - Kehl (DE)
  - Kehl (DE) – Strasbourg (FR)
  - Enschede (NL) - Münster (DE)
CBF to CBF traffic transit

- CBFs can be used not only for neighbours connection, but also for traffic transit through NREN.
- Transiting NRENs are (in historical order) SANET, CESNET and SWITCH – as pilots for evaluation of possibilities.
- In principle, transit service (EoMPLS, lambda, etc.) implemented by NREN can be less expensive than any other party service, but not free of charge.
- CBF to CBF transit is rather economical than technical issue.
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CBFs used also in GN2 project

- CBFs used for implementing 10G lambdas between GEANT2 PoPs:
  - Cieszyn (PL) – Ostrava (CZ) for Prague-Poznan
  - Frankfurt a.O. (DE) – Slubice (PL) for Frankfurt a.M.-Poznan

- CBF used for implementing 10G lambda connection for projects supported by GN2 (LHC, DEISA)
  - Como (IT) – Manno (CH)
  - Basel (CH) - Kehl (DE)
  - Kehl (DE) – Strasbourg (FR)
  - Enschede (NL) - Münster (DE)
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European dark fibre footprint for research (draft)

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Leased digital circuits for extension - example

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Cross Border Dark Fibre Triangle

- Multiple 10 gigabit connection of Austrian, Czech and Slovak research and education networks
- In the case of fibre failure, triangle connection allows redirection of traffic in less than 60 ms, so overall reliability of end to end connections is improved significantly.
- This is achieved by Level2 protocols (802.1q and 802.1w), avoiding slower and more complicated solution on IP level.
- 10 GE VLANs are implemented on this background, giving impression of distances between countries disappeared.
NIL 8 x 10 Gb/s over 224 km

- All devices have been installed only at the end points of the line in Brno (CZ) and Wien (AT) and no in-line elements have been deployed.
- Nothing In Line (NIL) approach has been used and according to our knowledge, 8 times 10 Gb/s over 224 km of dark fibre is the longest NIL distance that has been reported for any production network.
- The main advantage of NIL solution is represented by lower capital and operational costs and increased reliability.
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Enabled by advanced photonic technology

- The fibre pair from Brno to Wien has been equipped with CLA PB02 optical amplifiers, developed as a part of optical research activities of CESNET.
- Chromatic dispersion of G.652 optical fibre has been compensated by new compensating elements – Fiber Bragg Gratings (FBG).
- FBGs were successfully deployed and tested for the first time on the CESNET2 line Brno – Bratislava in February 2006.
- Terminal routers are equipped with Xenpak DWDM pluggable optical transceivers.
- First one company has received CESNET licence for CLA manufacturing, the second should follow shortly.
Fear of new results?

- Legacy approach: to buy transmission equipment from big vendors (remaining barrier in networkers mind)
- New approach tested by CESNET since 2002: take advantages of both legacy approach and new photonic products, i.e. use mixed vendor network design
- Similar approach of SWITCH see in CEF2006
- Resulting recommendation: do not afraid of
  - new products of photonic industry and
  - networking research results
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CESNET2 mixed lighting plan

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**IP traffic statistics are available on-line**

- Brno - Vienna
- All lines (actual, weeks, months)
Access to GLIF in Prague
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GLIF Infrastructure

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Above colleagues are not responsible for any my mistake 😊.