



Experiences in building a Pan-European Network over Dark Fibre: GÉANT2

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Outline



Connect. Communicate. Collaborate

- Researches and Communication
- DANTE and GÉANT2
 - GÉANT2 infrastructure
 - GÉANT2 components: Dark Fibre, DWDM and SDH equipment
- GÉANT2 services
- Conclusions

Researchers and Data Transfers



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- Typical usage profile in Research Networks :
 - Amount of users: Thousands
 - Amount of traffic: Kbits/sec.
 - Applications not very sensitive to network performance (ie. e-mails, FTP transfers)
- New additions in data transfer:
 - Amount of users: Hundreds
 - Amount of traffic: Flows of more than 1GBit/sec
 - Applications between well known sites very sensitive to network performance (ie. eVLBI, CERN LHC or DEISA)

DANTE & GÉANT2



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- DANTE:
 - Founded in 1993 by the European National Research Networks
 - Planning, Implementation and Management of successive Pan-European Networks
- GÉANT2:
 - Most recent successor of 7 generations of Pan-European Research Networks providing connectivity to the European National Research Networks
 - GÉANT2 predecessor used only SDH leased circuits
 - GÉANT2 uses leased dark fibre to provide DWDM, SDH and IP services

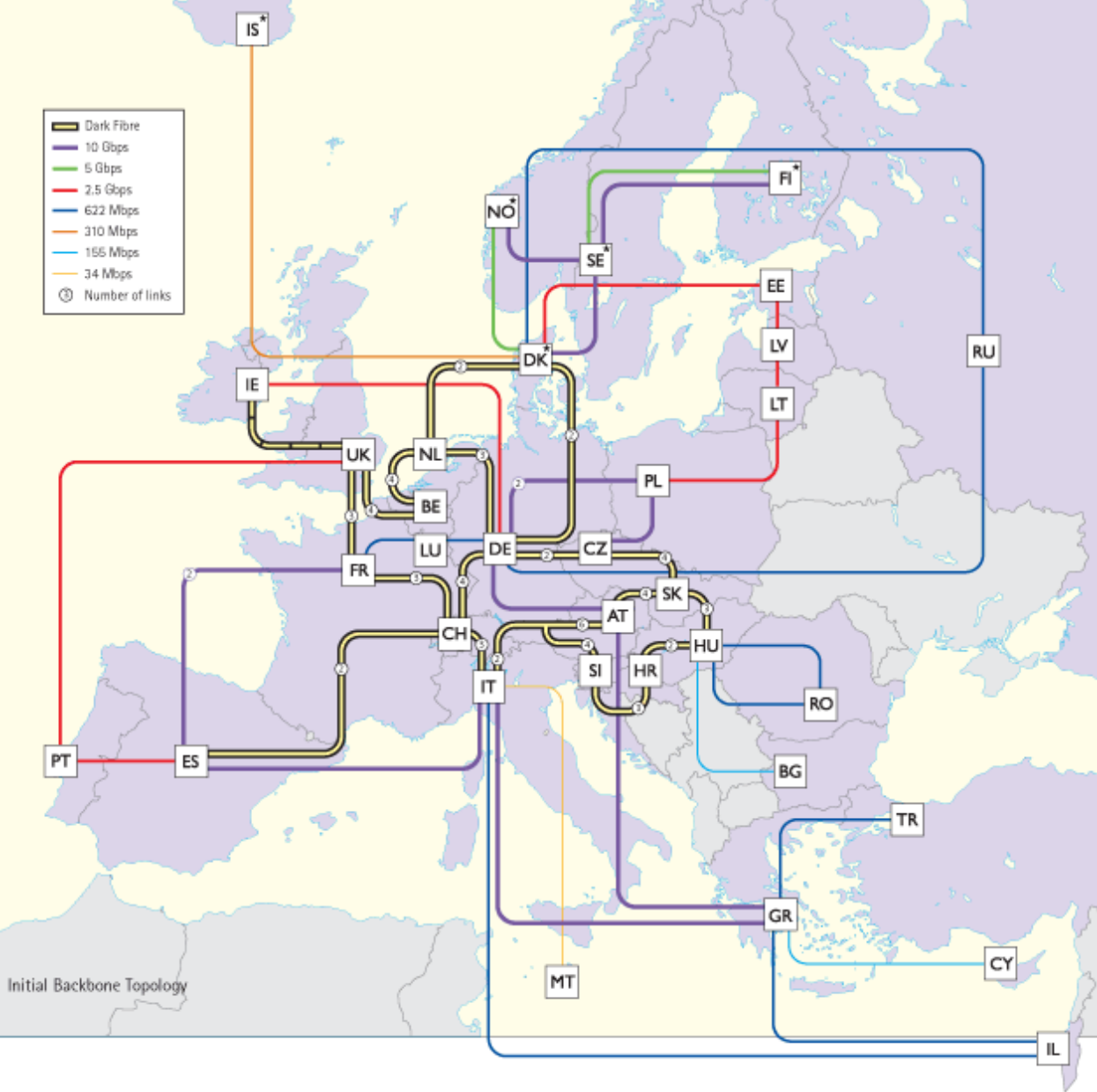




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GÉANT2:

- Connect 32 National Research Networks
- Over 3M users





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From GÉANT To GÉANT2

- From IP services over leased SDH circuits [GÉANT] => To WDM, SDH and IP services over leased Dark Fibre [GÉANT2]
- Main challenges:
 - Complex Connectivity and Equipment Tender process
 - Implementation of a network at that scale
 - Migration of services and customers without service disruption => Extra hardware and network connectivity resources needed
 - New Technology => New NOC and New Monitoring tools

GÉANT2 components: Dark Fibre



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- Current Situation: Easier access to Dark Fibre plus big advances in high speed optical transmission
- In GÉANT2:
 - 18 dark fibre routes (12,000 km of fibre across 15 European countries)
 - 26 leased circuits

GÉANT2 components: DWDM Equipment



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- Improvements during the last decade:
 - Less equipment footprint and less energy consumption
 - Increase in spectral density of the optical channels and capacity
 - Easier addition of new wavelengths
 -
- GÉANT2 uses Alcatel 1626 LM

GÉANT2 components: TDM Switching Equipment



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- Requirements for P2P (point-to-point) circuits (typically gigabit Ethernet up to 10 gigabit Ethernet)
- Looking for guaranteed jitter (prioritized switching, queuing mechanism) and deterministic connection=> Next generation OXCs
- SONET/SDH Cross Connects with Ethernet support => Using GFP, VCAT
- GÉANT2 uses Alcatel 1678 MCC

GÉANT2: Operational Steps



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- Dark Fibre delivered must meet contractual agreements in terms of: Diversity of paths, Attenuation, Chromatic Dispersion, ORL and PMD
- Optical Equipment must meet requirements in terms of hardware availability and network design done based on theoretical specifications
- Need to set up an Integrated Management System
- Build a new NOC to manage DWDM and OXCs on top of existing IP equipment

GÉANT2: New Services I



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- Typically available for NREN on the Dark Fibre Cloud
- Allows the establishment of switched point to point circuits to other locations in GÉANT2.
- Trial currently on going to provide Ethernet services between European and US locations

GÉANT2: New Services II



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- Gigabit Ethernet Service
 - Connection to a Gbit Eth in the GN2 switch => GFP needed
 - Connection to a 10Geth on the GN2 switch => VLANs and GFP needed
- 10 Gigabit Ethernet LANPHY via GN2 Switch
 - GFP needed
- 10 Gigabit Ethernet over G.709 wavelength
 - Using transmission equipment only
 - NREN connected directly to the DWDM system

GÉANT2: New Services III



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- SDH Service via the TDM switch
 - NREN connected to an SDH (STM-16/64) port on the switch
 - Sub-rates can be offered
 - NRENs can set up multiple SDH services => To configure SDH cross connections in GÉANT2
- SDH service via transmission equipment
 - Via DWDM system
 - Full transparency => NRENs can set multiple SDH services without notifying GÉANT2 network operator

Challenges ahead



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- Inter domain provisioning [control planes, GMPLs, Bandwidth on Demand] and monitoring of P2P circuits
- Security
- 40 Gbps in client interfaces

Conclusions



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- Many research networks have now access to Dark Fibre giving a new scope to the services that can be provided
- GÉANT2 answers new researches requirements at a Pan-European level.
- GÉANT2 implementation is completed at 95%
- IP services in production and P2P links being currently implemented



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Thank You!

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