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Networks for Research and Education in Europe in the Age of Fibre - Where do we move? -

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GN2 Exec, DANTE Board and DFN

CUC 2005, Dubrovnik, November 2005

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1. NREN Constituency

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- NRENs started with universities and research labs as main constituency
- For many NRENs this has been step-by-step extended to schools, museums and other educational institutions
- Idea: A good and content-wise rich network is good for other educational sectors as well
- **However: The main NREN constituency will be defined by the universities**

2. NREN users / adv. applications

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- Mainstream for a couple of years will be the provision of the Internet service through the NREN for all users in the constituency
- A couple of specific groups from research disciplines will however have to run advanced applications due to their demanding requirements or innovative approaches
- **This will drive NREN developments in the next years**

GÉANT2 - “Big” Users (Examples)

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- LHC
  - 11 Tier1 sites
    - » 7 in Europe
    - » 4 outside Europe (US, Canada and Taiwan)
- DEISA
  - 10 sites across Europe
    - » 4 already connected
- EVN (European VLBI Network)
  - 15 sites
    - » 5 already connected

Example advanced application

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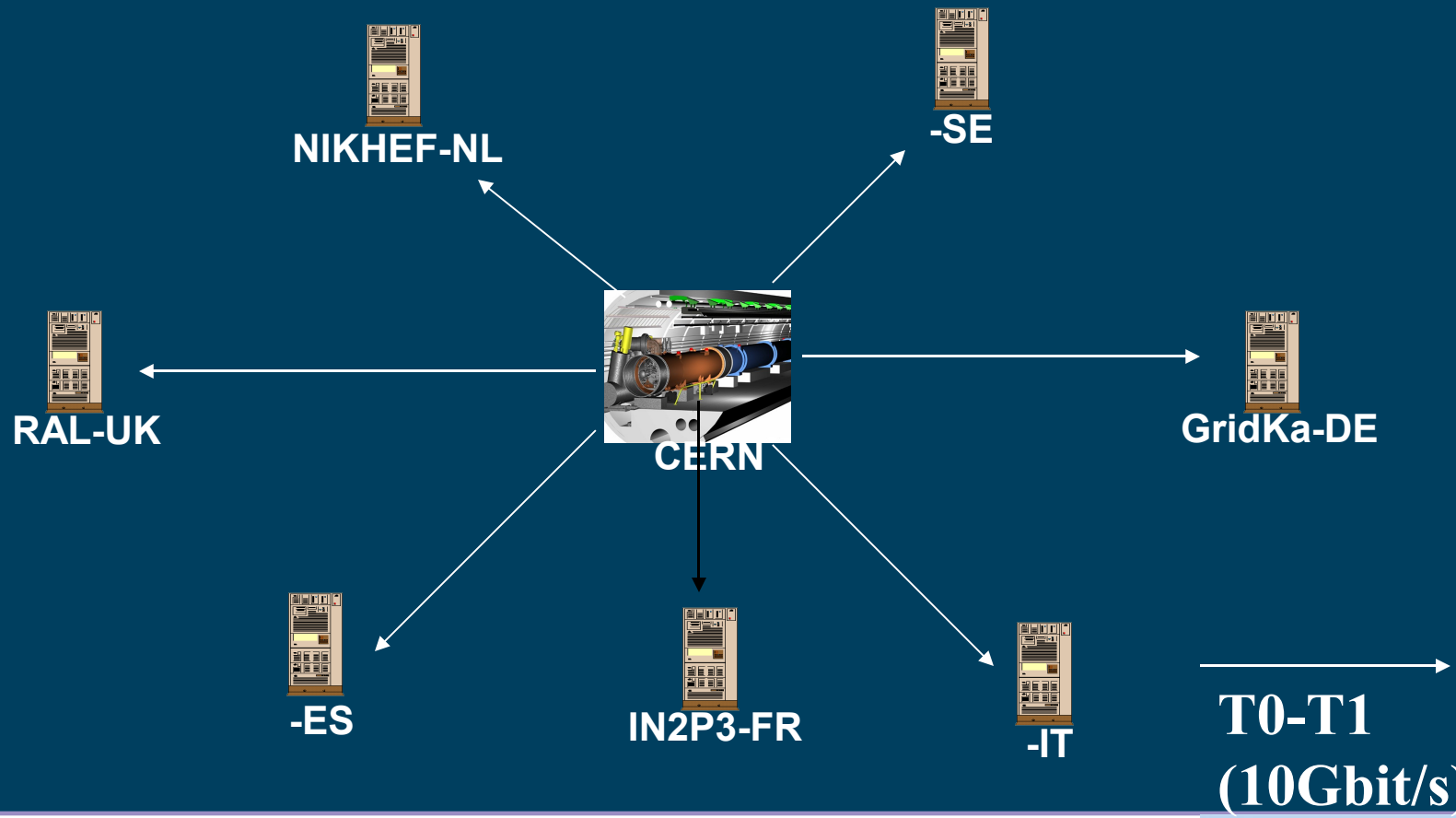
The LHC network in Europe



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3. Technology development

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- (a) IP networks (NRENs plus Geant2) have to be adapted to still growing needs
- (b) Optical technology is being introduced NOW (in most NRENs and on the European level as well)
- **Consequence 1: Bandwidth will no longer be a scarce resource**
- **Consequence 2: VPNs are economically / technically feasible solutions to special requirements such as Grid applications**

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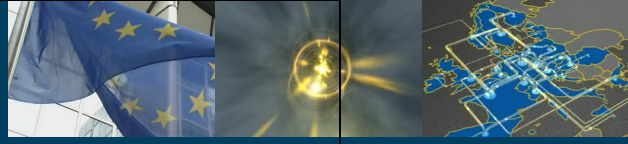
eIRG Recommendation on Hybrid Networking & GÉANT2



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"The eIRG stresses the importance of flexibly configurable, reliable end-to-end optical provision to European researchers and eScience projects. This service should co-exist with routed IP connectivity and follow the three tier hierarchical European paradigm: Campus LAN, NREN and Pan-European GÉANT network"

Den Haag, 19/11/2004

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GÉANT today - Services

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- Best Effort IPv4/IPv6
- Multicast IPv4/IPv6
- Premium IP
- Less than Best Effort IP
- MPLS
- L2-VPN
  - Martini L2-circuits, Juniper CCC

GÉANT2 - Service Plans

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- **Versatility to better facilitate E2E services**
- **Continue to provide quality IP transit services**
- **Tune existing IP service platform**
  - **Optimise platform**
  - **Enhance resilience**
- **Offer "Enhanced MBS" [or "lightpath" service]**
  - **"Wavelength" services for big users**
  - **Sub-wavelength services as well**
  - **Develop automated ("on demand") provisioning and advance scheduling**
  - **Up to 10G**
- **Endeavour to be prepared to implement 40G services**

Technology Scenario: P2P GEth

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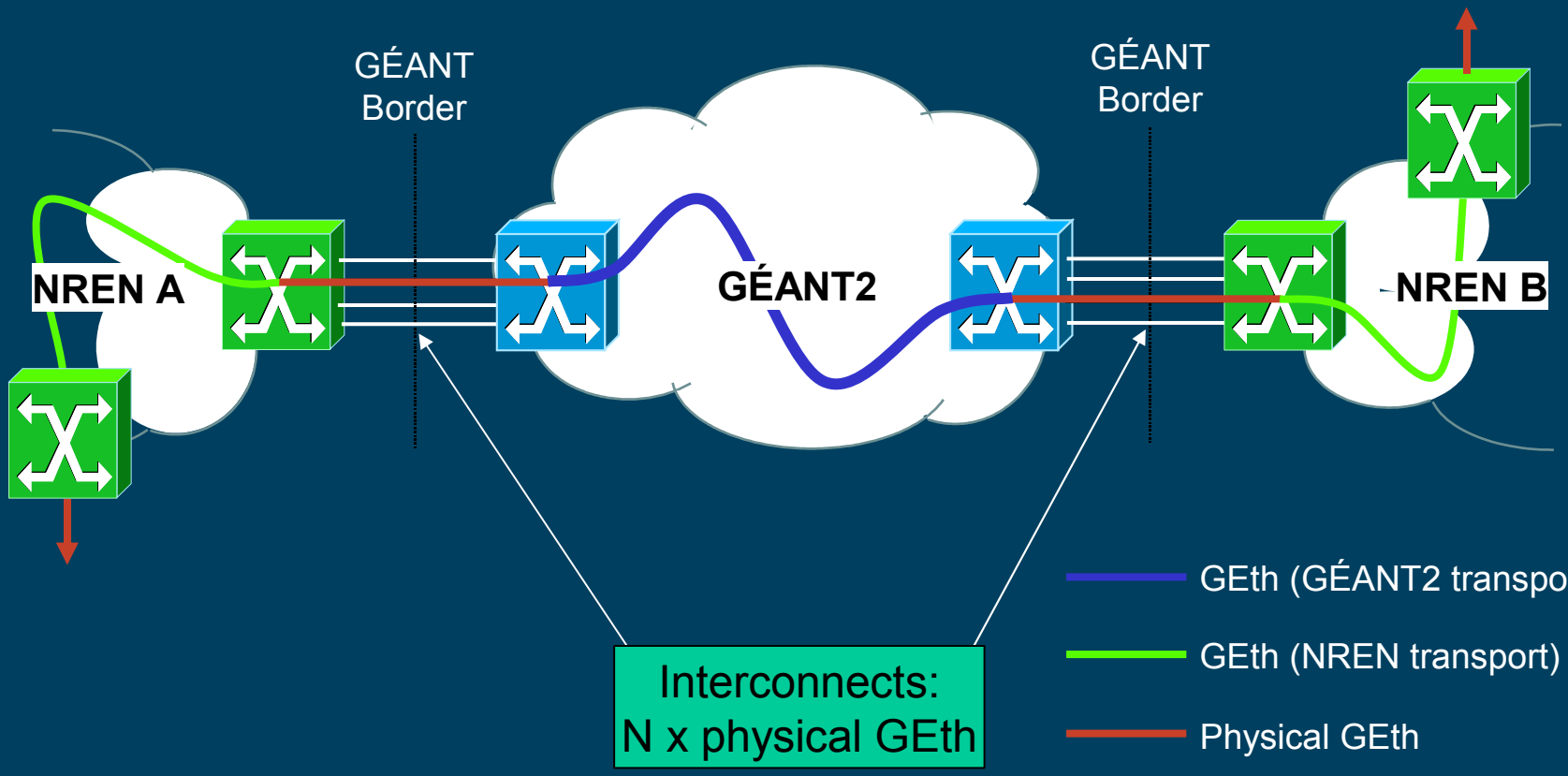
(GÉANT borders: physical GEth – physical GEth)



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4. Basic building block: dark fibre

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- Dark fibre is the basic element for any bandwidth provision
- Technology for lighting the fibre is available at reasonable prices
- If scenarios like LHC / VLBI /... are assumed to contribute more and more to networking demands then the consequence for NRENs and Geant-x (x>1) is clear: **Get as much fibre as affordable for the NRENs!**

Cross-Border Fibre

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- Within the lifetime of Geant2:
  - # fibre NRENs will have increased
  - dense web of fibre within NRENs and across Europe, perhaps small links missing
  - new technical and economic opportunities
- ==> Geant2 must be technically and organisational adapted to this evolving structure
- Cross-border link should be seen as complementary to traditional links

Economy fibre links (1) - DFN case

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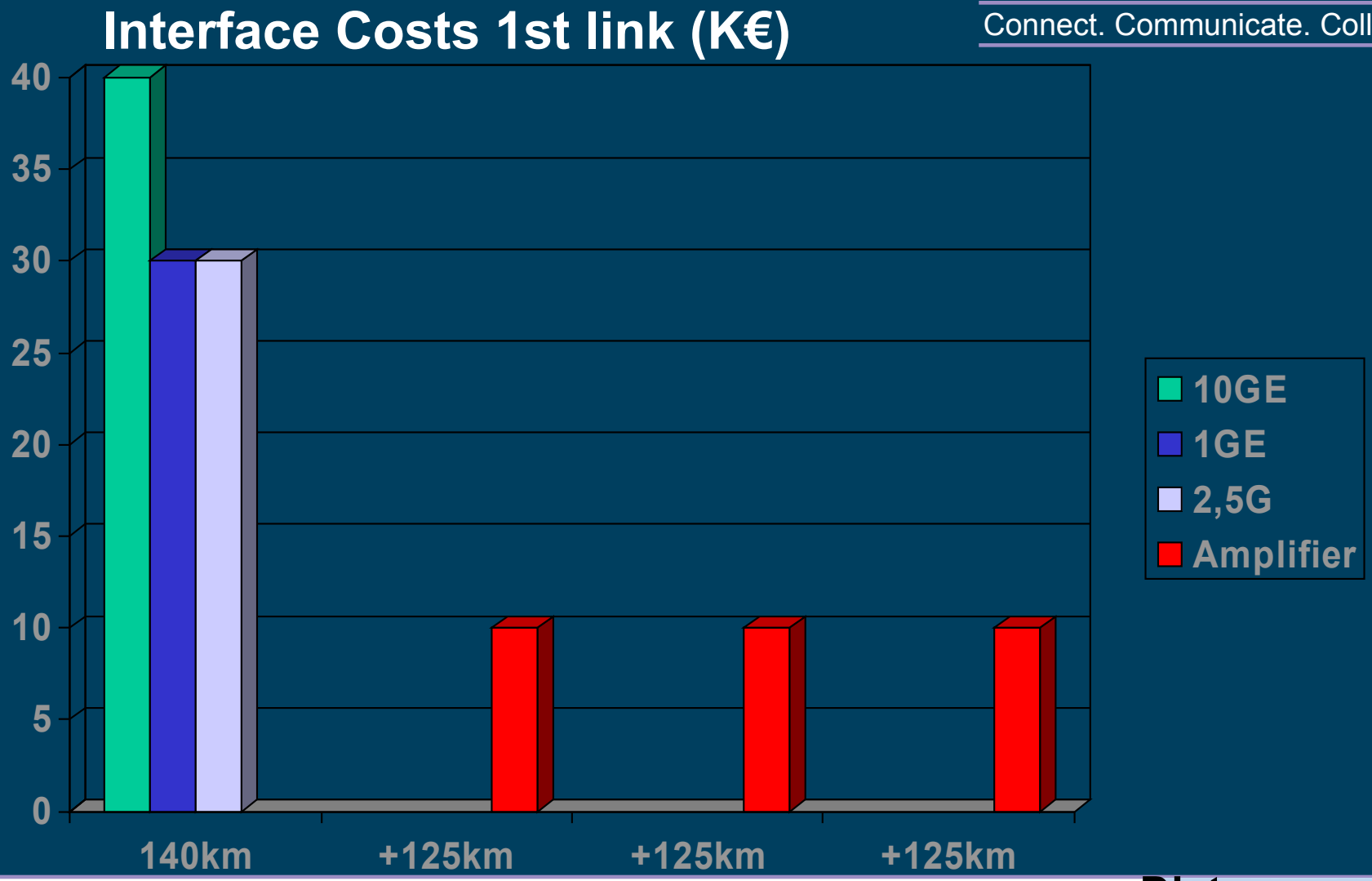

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Economy fibre links (2) - DFN case

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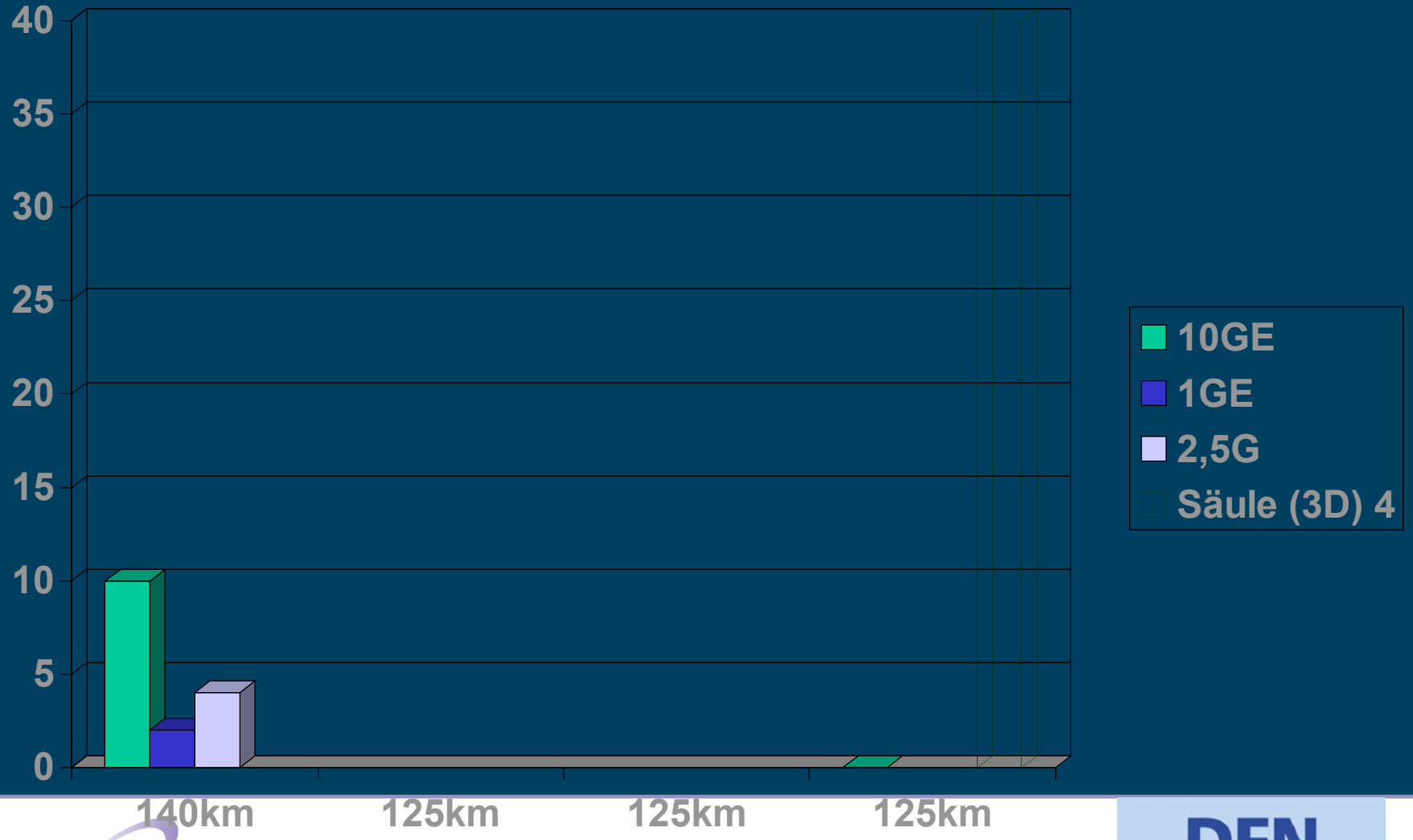
Interface Costs 2nd link (K€)



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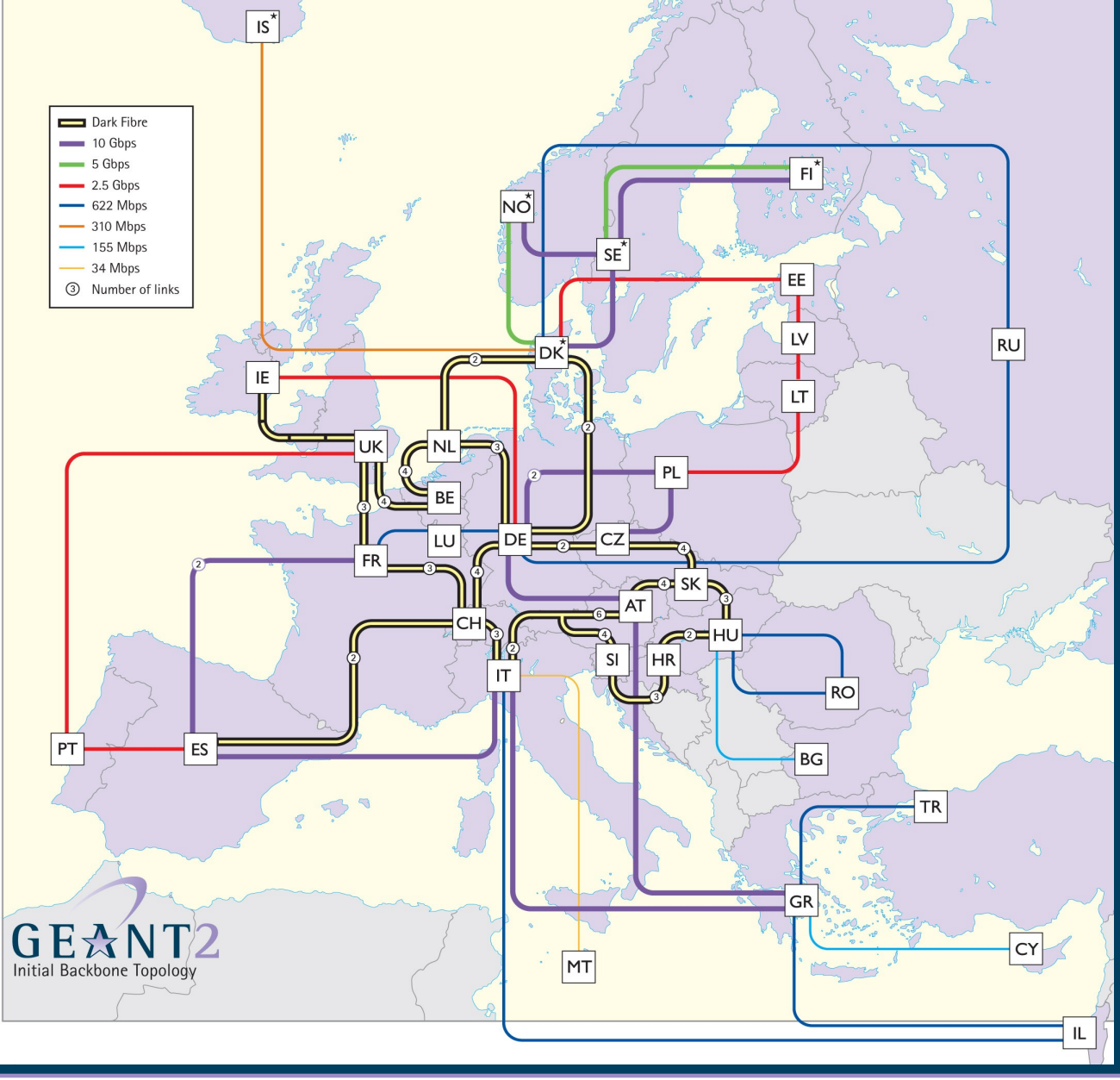

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GÉANT2 Topology

GÉANT2

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Geant2- Fibre Footprint as of 11/05

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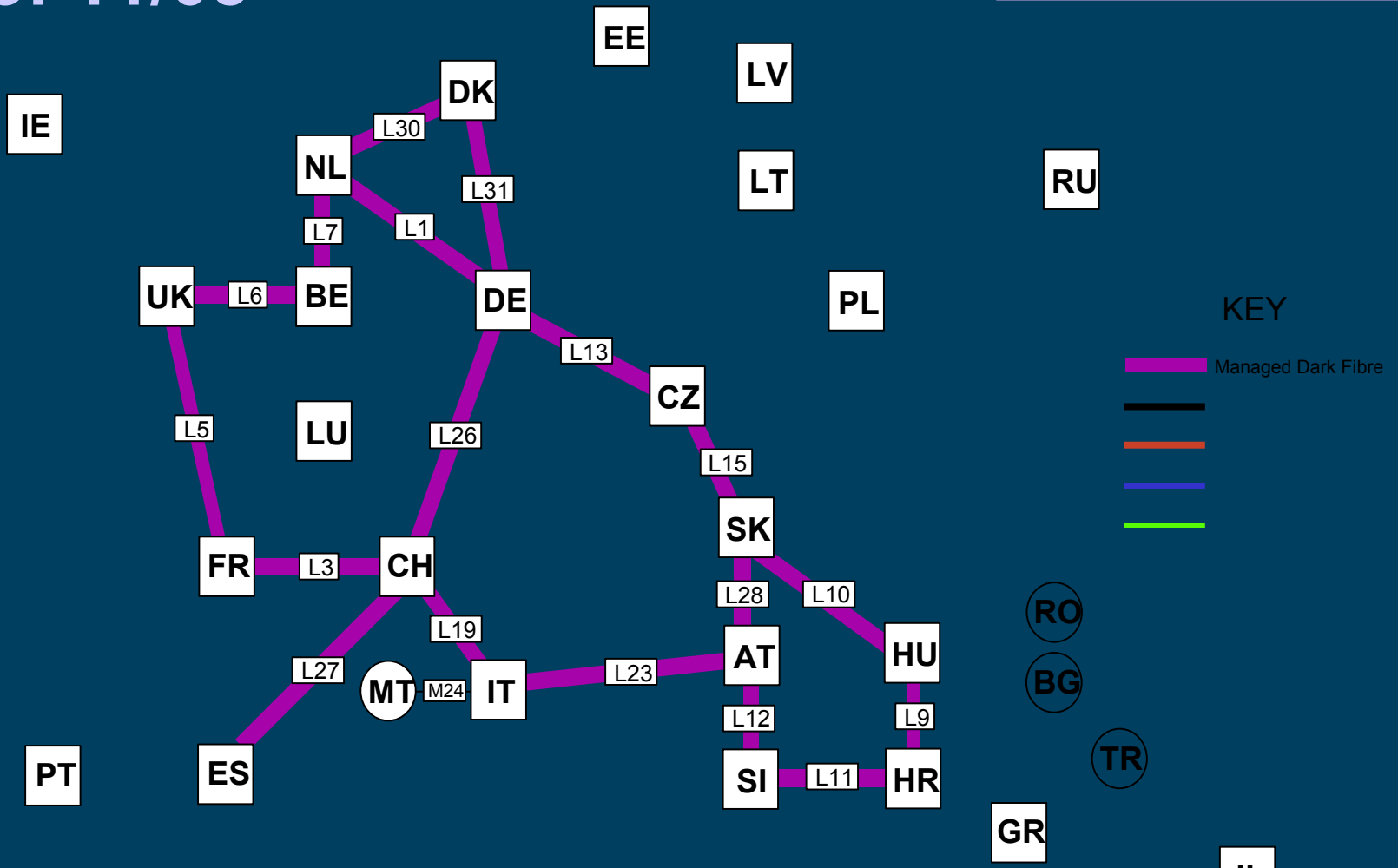

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X-WiN and cross-border fibre as of 11/05

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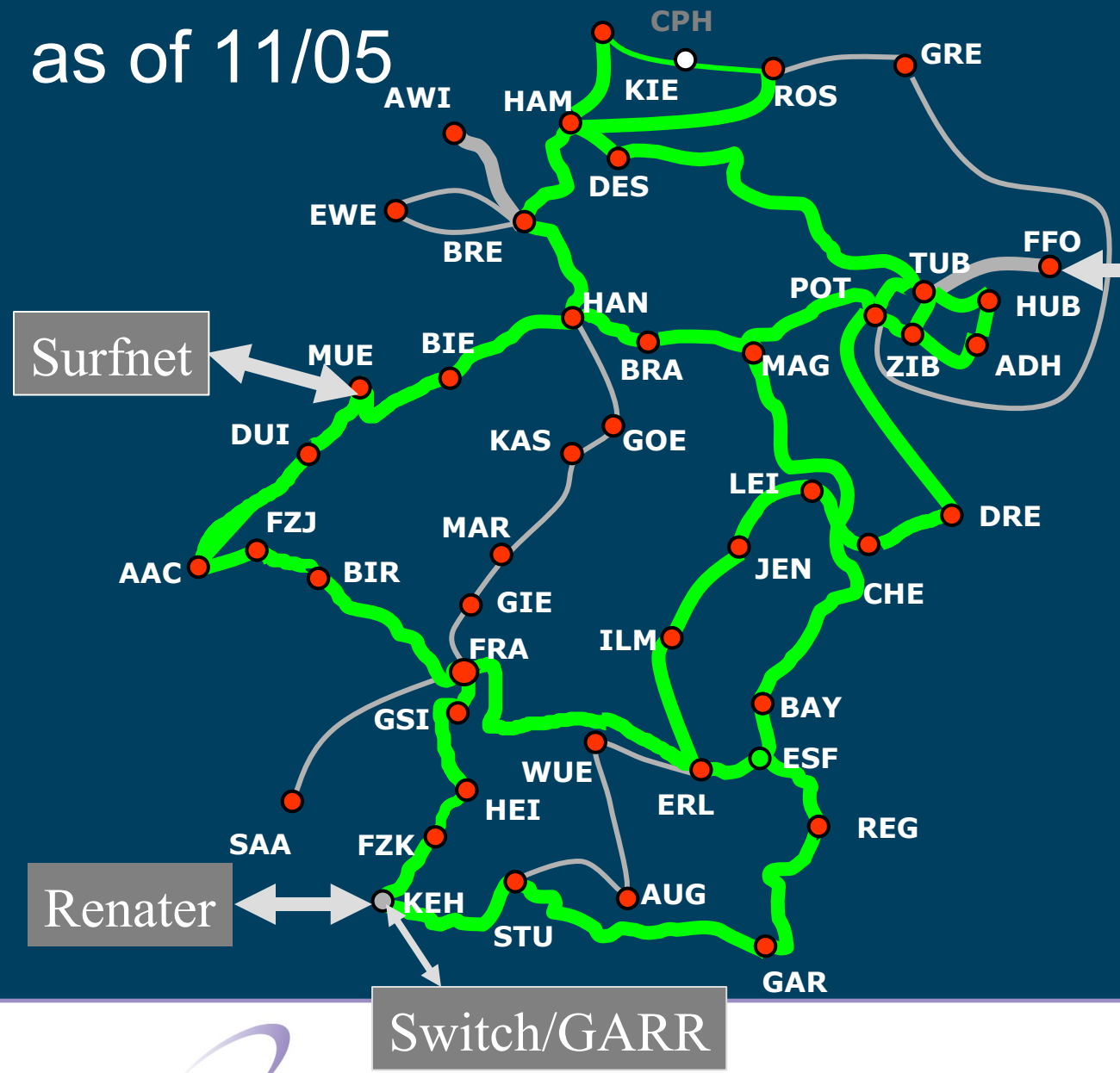

CBF
DFN PoP
Dark fibre
Wavelength

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LCG T0 – T1 Optical Private Network

source: *Roberto Sabatino* DANTE

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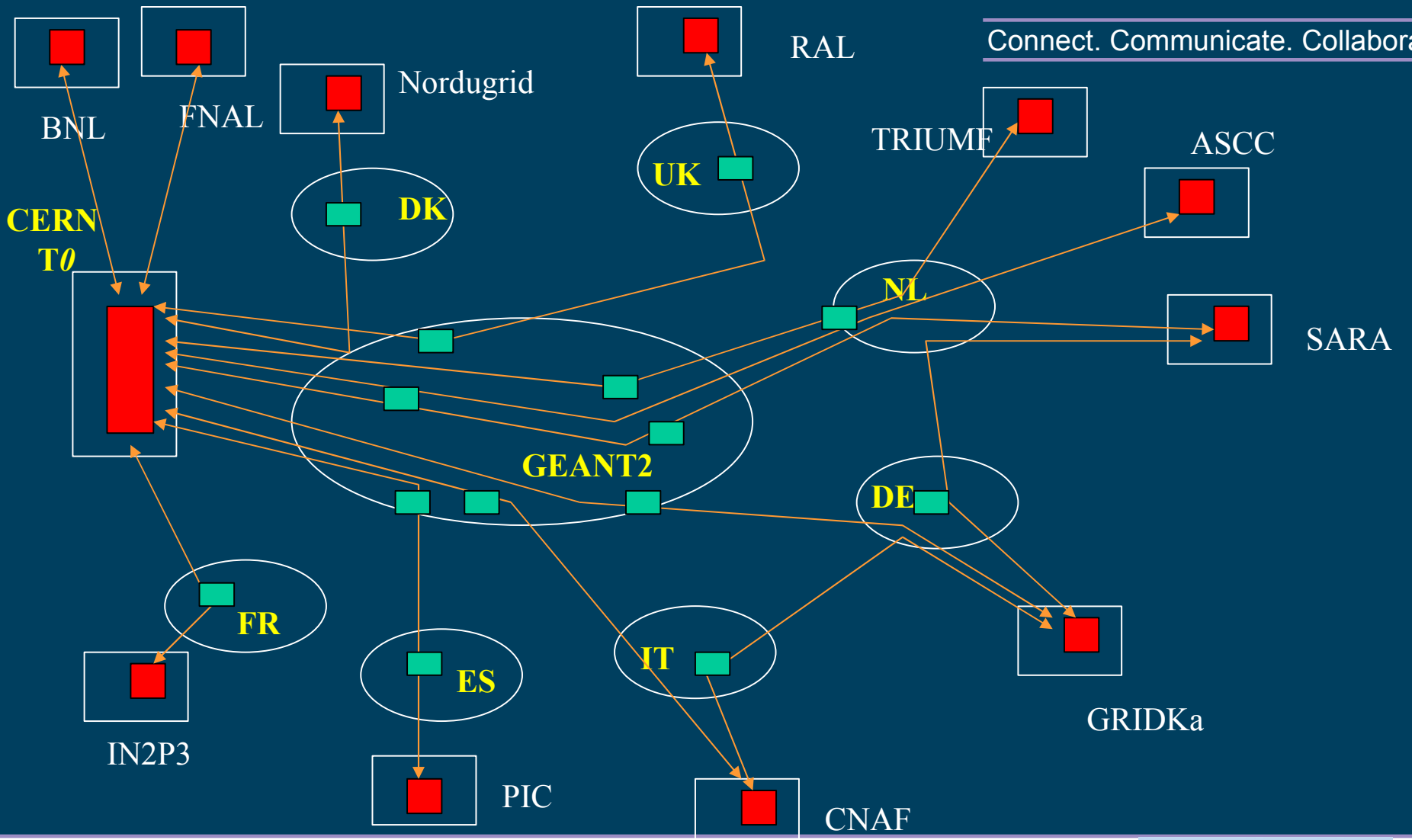

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5. Policy Framework

- Most existing policy concepts are adapted to Internet technology / economy
- New technical options like the IP-PoP reallocation option need to be mapped into new policies on the network
- Cost distribution scheme
- EDA (European Data Exchange) ...

New policy concepts have to be developed - however this will be relatively slow and more a complement rather than a revolution

Summary and Outlook (1)

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- **Constituency**

  Universities will remain to be the main NREN constituency for the next time

- **User Community**

  „Big“ user communities will drive NREN developments in the next years

- **Technology**

  Optical VPNs are economically / technically feasible alternatives to special requirements such as Grid applications

Summary and Outlook (2)

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- **Dark Fibre as essential building block**

  enlarge fibre footprint for ALL NRENs usage (including CBF)

- **Policy Framework**

  New policy concepts must be developed - however they will be complements rather than revolutionary issues. Basically cooperation oriented.