



National and European Networking for Education and Research

- Where will we go within the next five years? -

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Only the author of this presentation is responsible for the content, which is not an official opinion of the GN2 consortium or of DANTE

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1. NREN Constituency



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- NRENs started with universities and research labs as main constituency
- Many NRENs extended the constituency to schools, museums and educational institutions
- Idea: A good and content-wise rich network is good for the educational sectors
- **However: The main NREN constituency will be defined by universities and will be mainly the same in five years.**

2. NREN users / advanced applications



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- Mainstream for a couple of years: provision of global Internet service through NRENs
- Some specific groups from research disciplines will however have to run advanced applications due to their demanding requirements or innovative approaches
- **NREN developments will be driven by these requirements in the next five years.**

GÉANT2 - “Big” Users (Examples)



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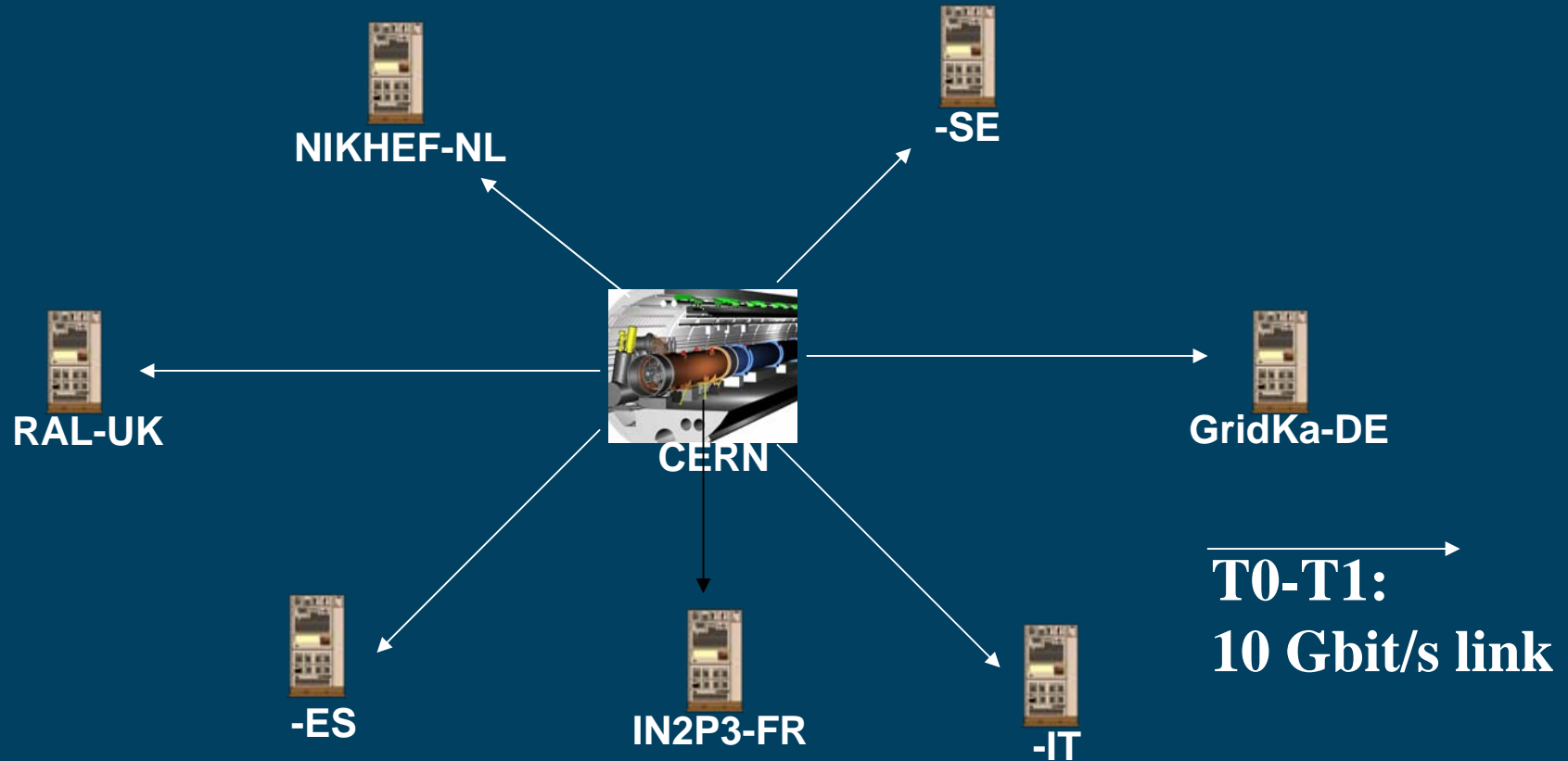
- **LHC**
 - 11 Tier1 sites
 - » 7 in Europe
 - » 4 outside Europe (US, Canada and Taiwan)
- **DEISA**
 - 10 sites across Europe
 - » 4 already connected
- **EVN (European VLBI Network)**
 - 15 sites
 - » 5 already connected

Example advanced application



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The LCG network in Europe



3. Technology developments



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- IP networks (NRENs plus Geant2) have to be adapted to still growing needs
- Optical technology is being introduced now (in most NRENs and on the European level

Consequences: Bandwidth will no longer be a scarce resource for NRENs on the „fibre cloud“ for the next five years. VPNs are therefore economically / technically feasible solutions especially to requirements such as Grid applications

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 e-Science 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”

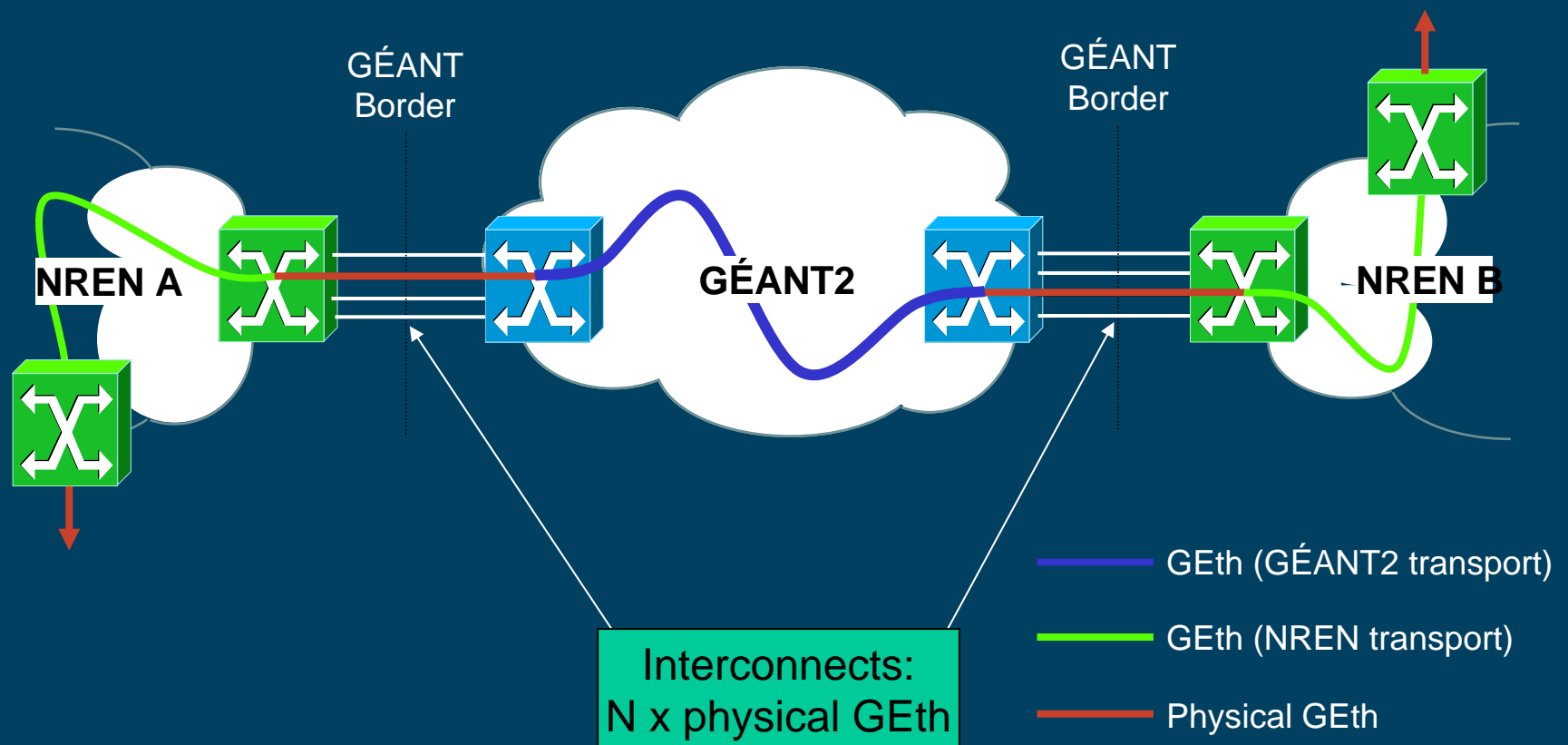
Den Haag, 19/11/2004

Technology Scenario: P2P over the Geant2 network



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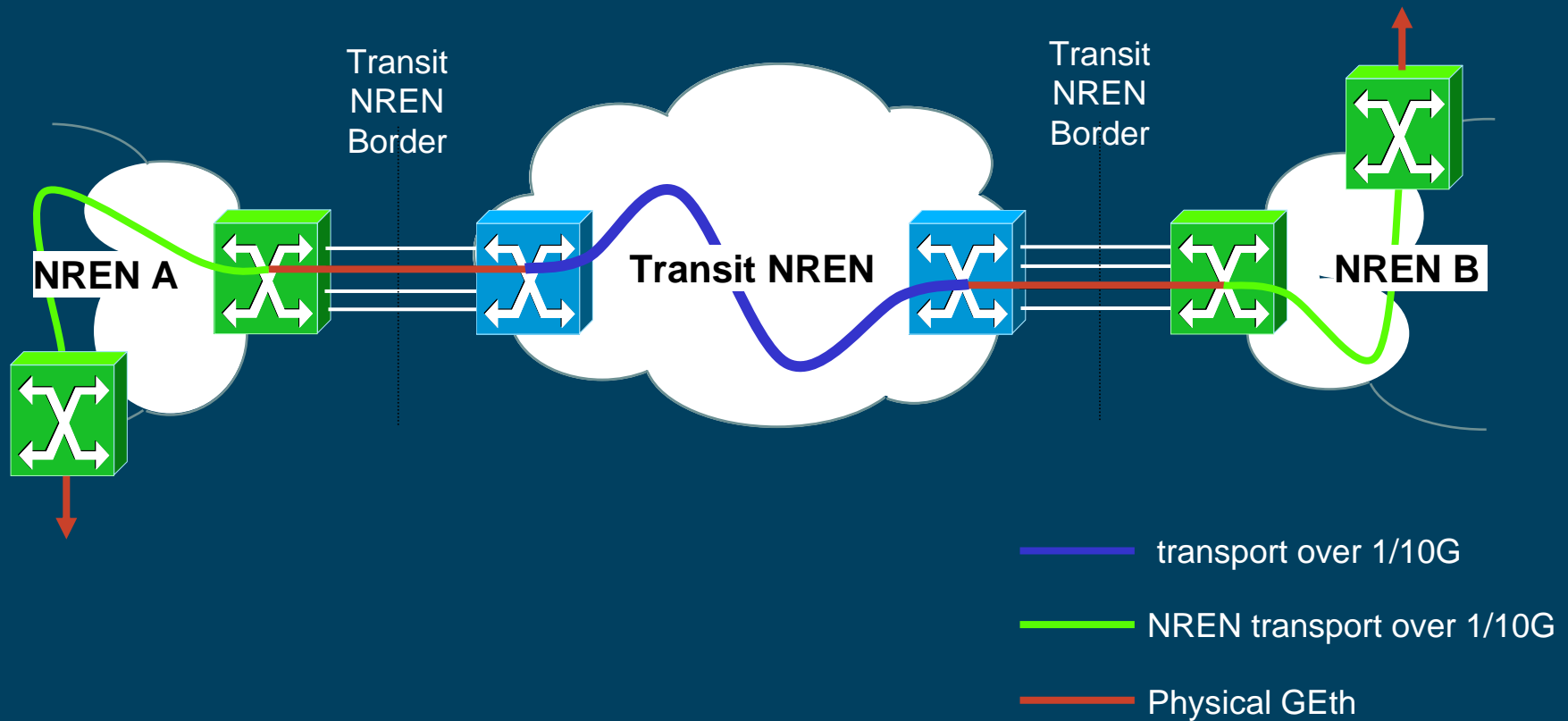
(GÉANT borders: physical GEth – physical GEth)



Technology Scenario: P2P link over cross-border-fibre



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4. Basic building block: dark fibre



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- Dark fibre is technically the basic element for any bandwidth provision
- Technology for lighting the fibre is available at reasonable prices; prices will continue to decrease over the next five years
- If scenarios like LCG / VLBI /... are assumed to happen then the consequence for NRENs and Geant-x ($x > 1$) is clear:
- **Get as much fibre as affordable for the NRENs!**

Cross-Border Fibre (1)



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- Forecast: within the lifetime of Geant2:
 - # „fibre cloud“ NRENs will steadily increase
 - => 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
- cbf provided links are complementary to traditional Geant links

Cross-Border Fibre (2)



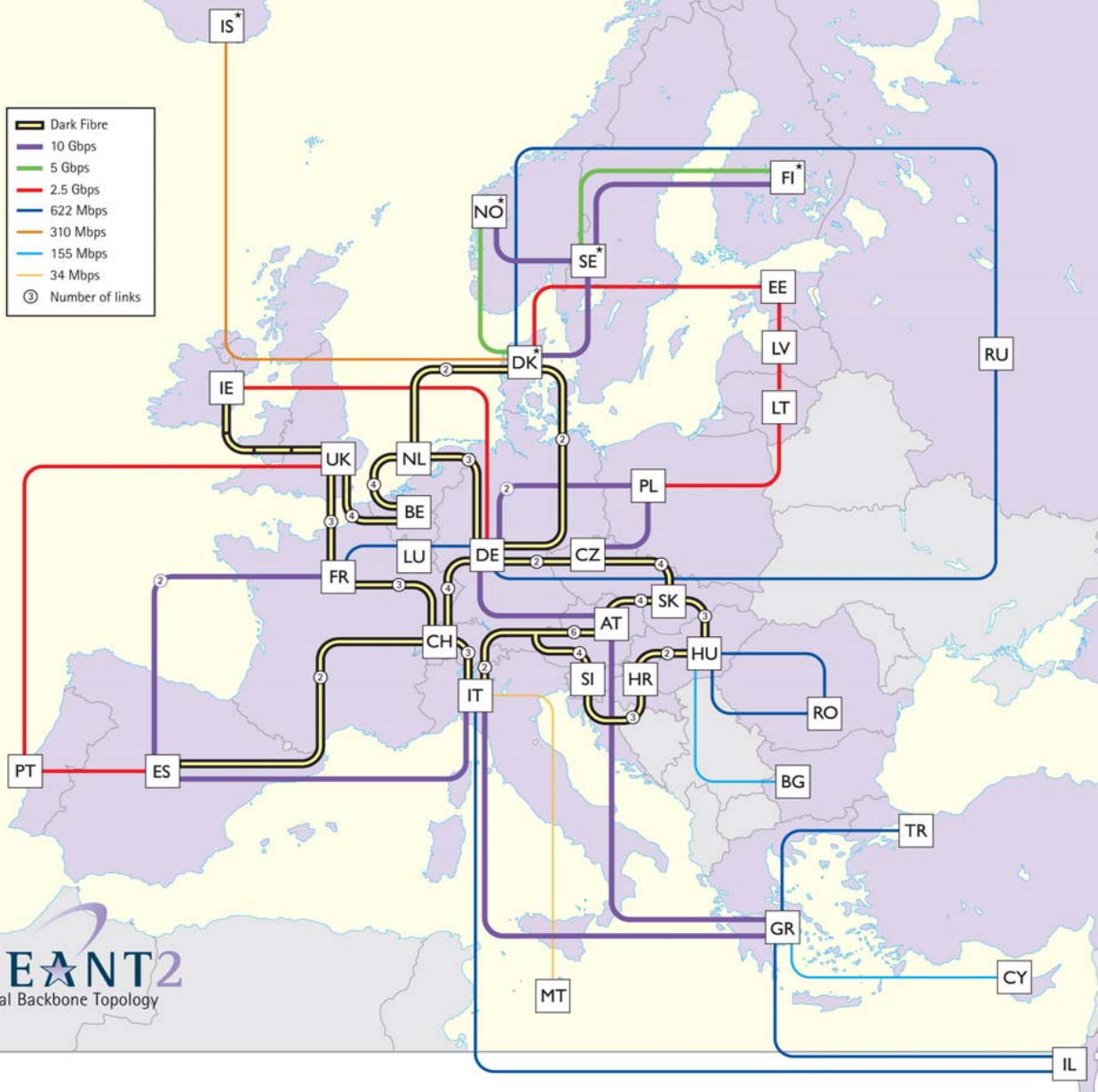
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- Additional technical developments (monitoring, data model etc.) necessary to build an **infrastructure** - done in JRA4.
- Complementary to the technical developments some tuning of organisational procedure is necessary - done in the cross border fibre committee for later approval in the NRENPC
- with these additional developments cross border fibre can develop into a new building block (option) for Geant2 provision.



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- Dark Fibre
- 10 Gbps
- 5 Gbps
- 2.5 Gbps
- 622 Mbps
- 310 Mbps
- 155 Mbps
- 34 Mbps
- ③ Number of links



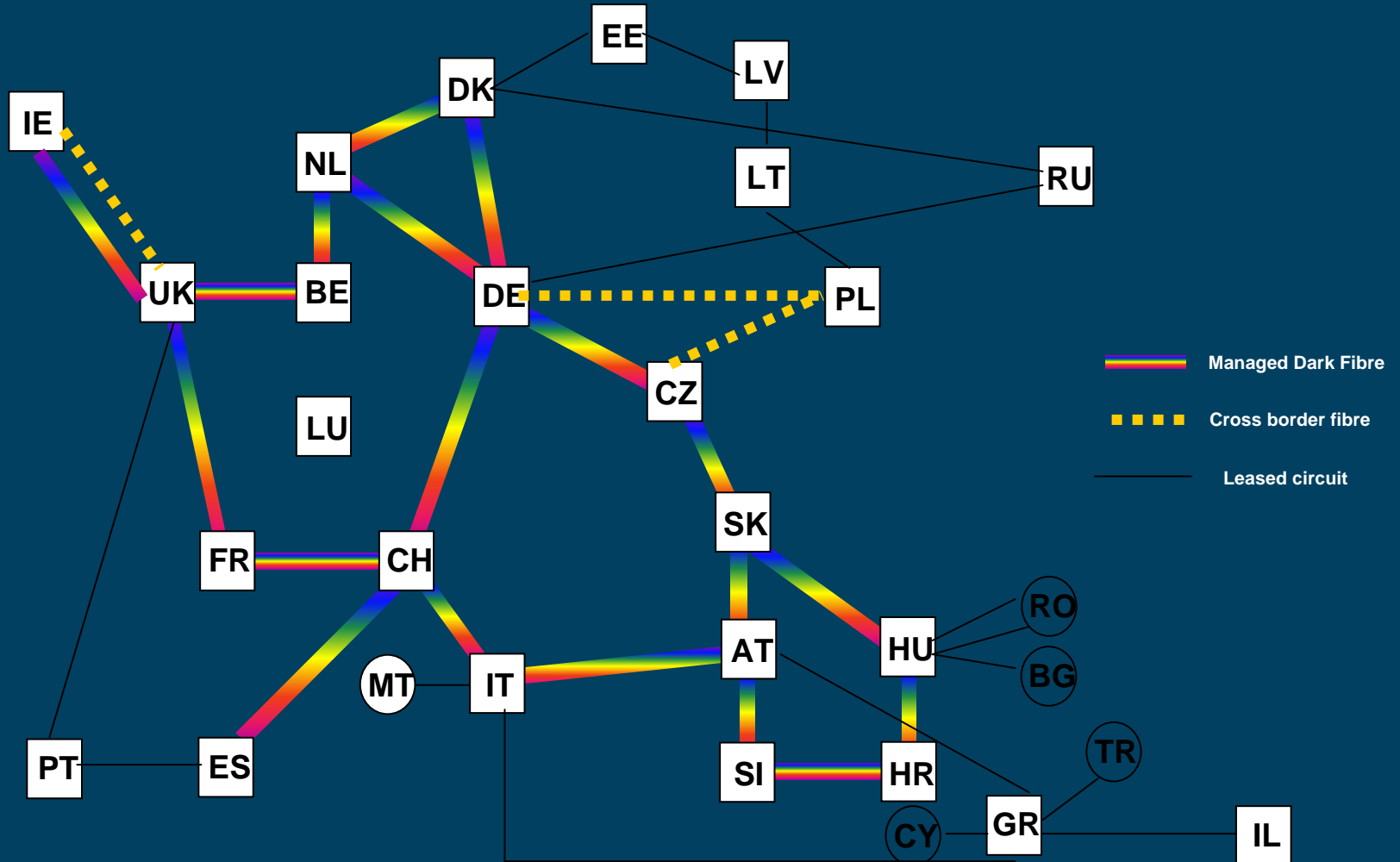
GÉANT2 Topology

GEANT2
Initial Backbone Topology

Geant2- Fibre Footprint



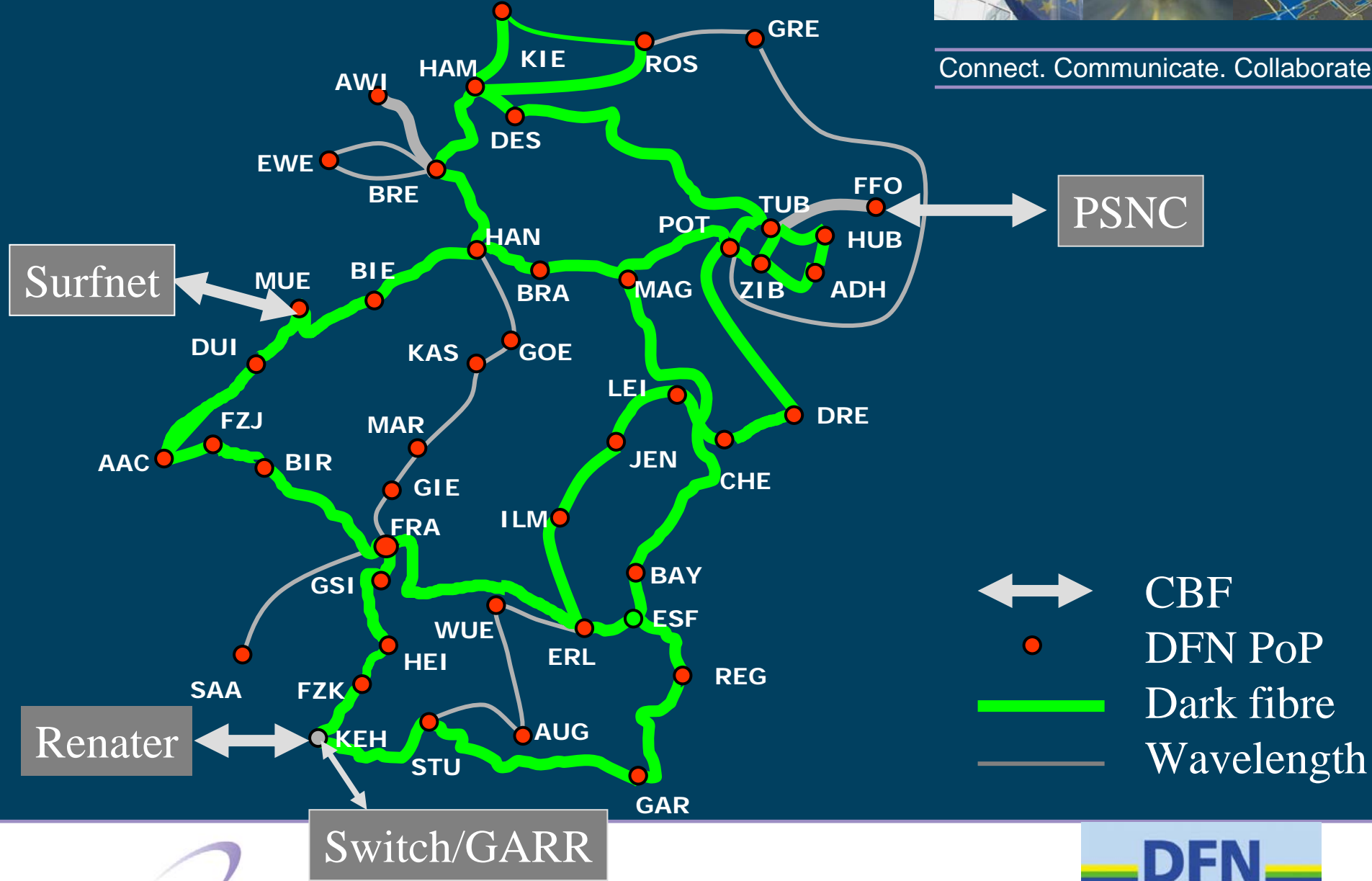
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X-WiN cross-border fibre 03/06



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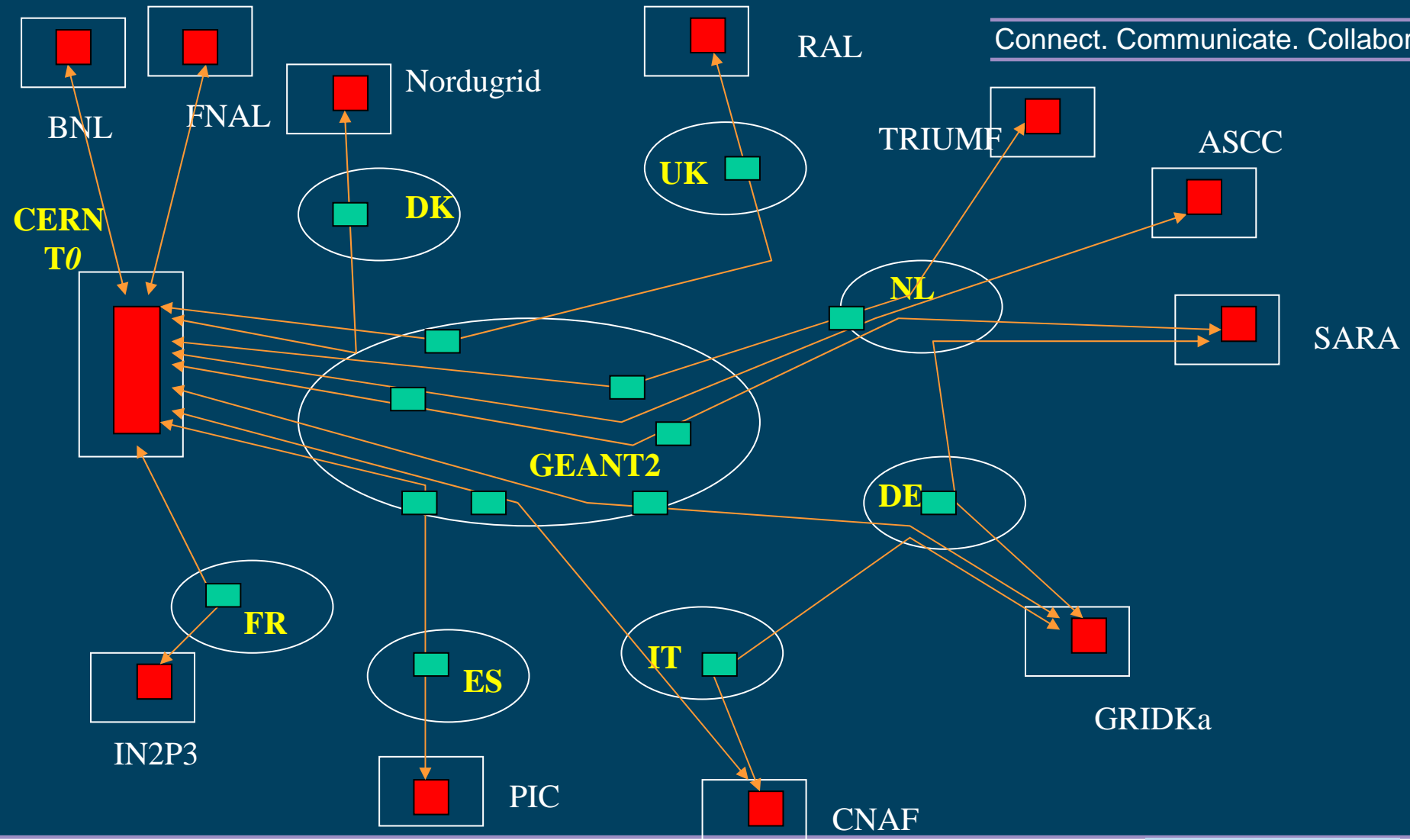
-  CBF
-  DFN PoP
-  Dark fibre
-  Wavelength

LCG T0 – T1 Optical Private Network

source: *Roberto Sabatino* DANTE



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New options for Geant2 (1)



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• Assumptions

- IP traffic growth will split into „normal IP“ and OPNs (like in the LCG or DEISA cases)
- Prices for optical equipment will steadily be reduced over the next years
- market for dark fibre will develop also in areas which today are not part of the „fibre cloud“
- cross border fibre will present a complementary building block for the Geant2 / 3 development

New options for Geant2 (2)



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- **Consequences**
 - The one-(IP-)Geant2-PoP per country concept is technically no longer necessary for NRENs on the fibre cloud
 - One-(optical-)Geant2-PoP per country may not be always a technically optimal solution (example RedIris case)
 - however: cost-split national / European necessary; common equipment may sometimes be complicated
- An ordered architecture redesign may be useful

New options for Geant2 (3)



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- Main goal (for the next 3 - 4 years): reduction of costs (perhaps 20-30%)
 - to be achieved through
 - redesign of the IP (sub-)network
 - better market conditions (fibre and equipment and leased circuits as well)
- Other goal: find (more) cost orientation in the Geant2 cost distribution scheme)

5. Policy and financial framework



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- Most existing policy concepts are designed for IP technology / economy
- New technical options like the IP-PoP reallocation option need to be mapped into new policies on the network
- It is likely that with the 7th framework program the allocation of funds per year (for GN3) is nearly equal to the situation today
- **New policy concepts have to be developed - however this will be relatively slow and more a complement rather than a revolution**

6. Summary and Outlook (1)



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- Constituency

Universities will remain to be the main NREN constituency for the next 5 years

- User Community

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

- Technology

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

6. Summary and Outlook (2)



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- Dark Fibre as essential building block

Enlarge fibre footprint for ALL NRENs usage including Cross Border Fibre

- Policy and financial framework

New complementary policy concepts must be developed. Finance situation for FW7 seems to be stable. Very good (may be improved) European cooperation of NRENs is needed.