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

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Contents

1. NREN Constituency

- 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

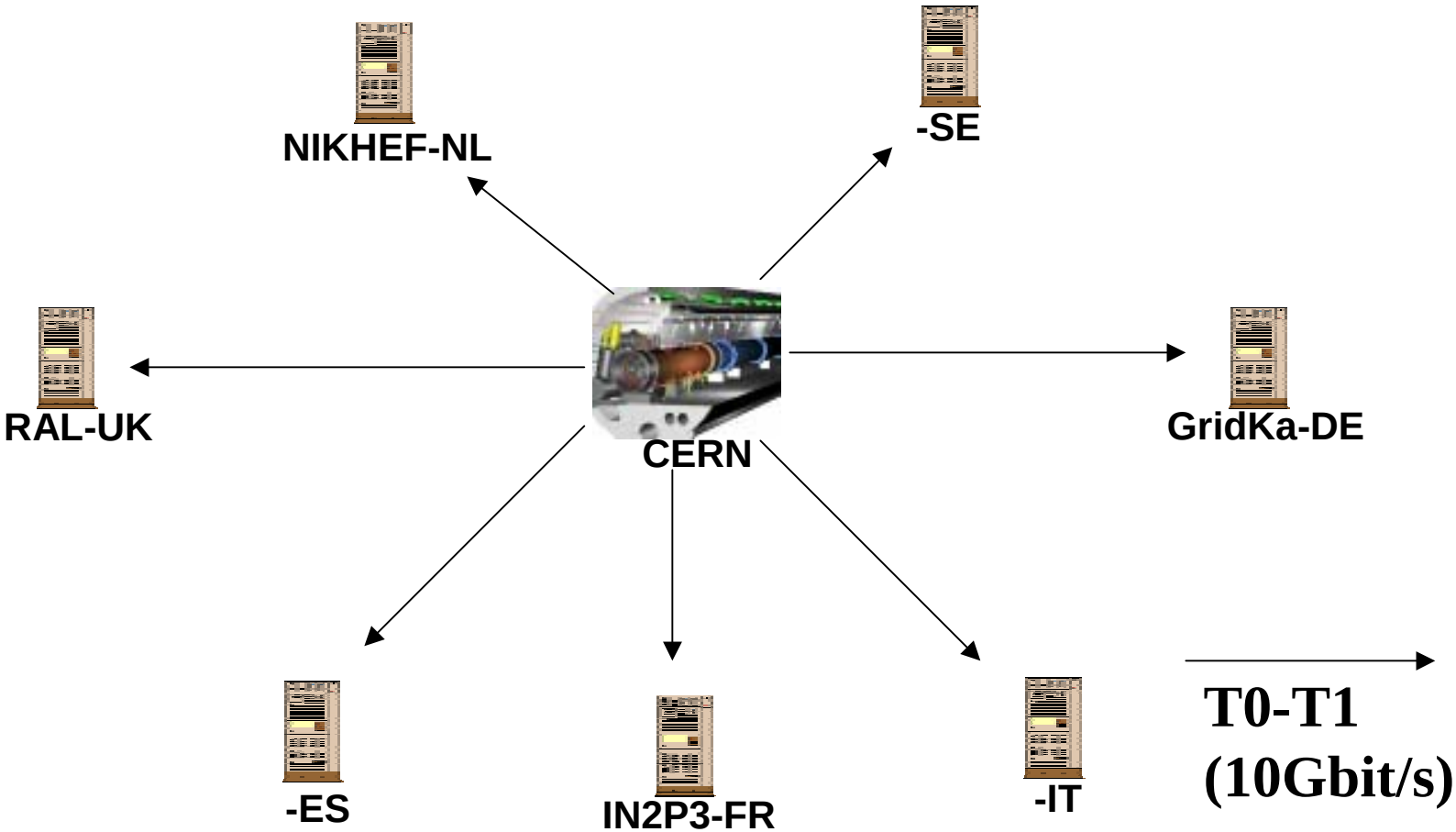
- Mainstream for a couple of years will be the provision of the Internet service through the NREN for all users in the constituency
- A couple of specific groups from research disciplines will however have to run advanced applications due to their demanding requirements or innovative approaches
- **This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

GÉANT2 - “Big” Users (Examples)

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

Example advanced application

The LHC network in Europe



3. Technology development

- (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**

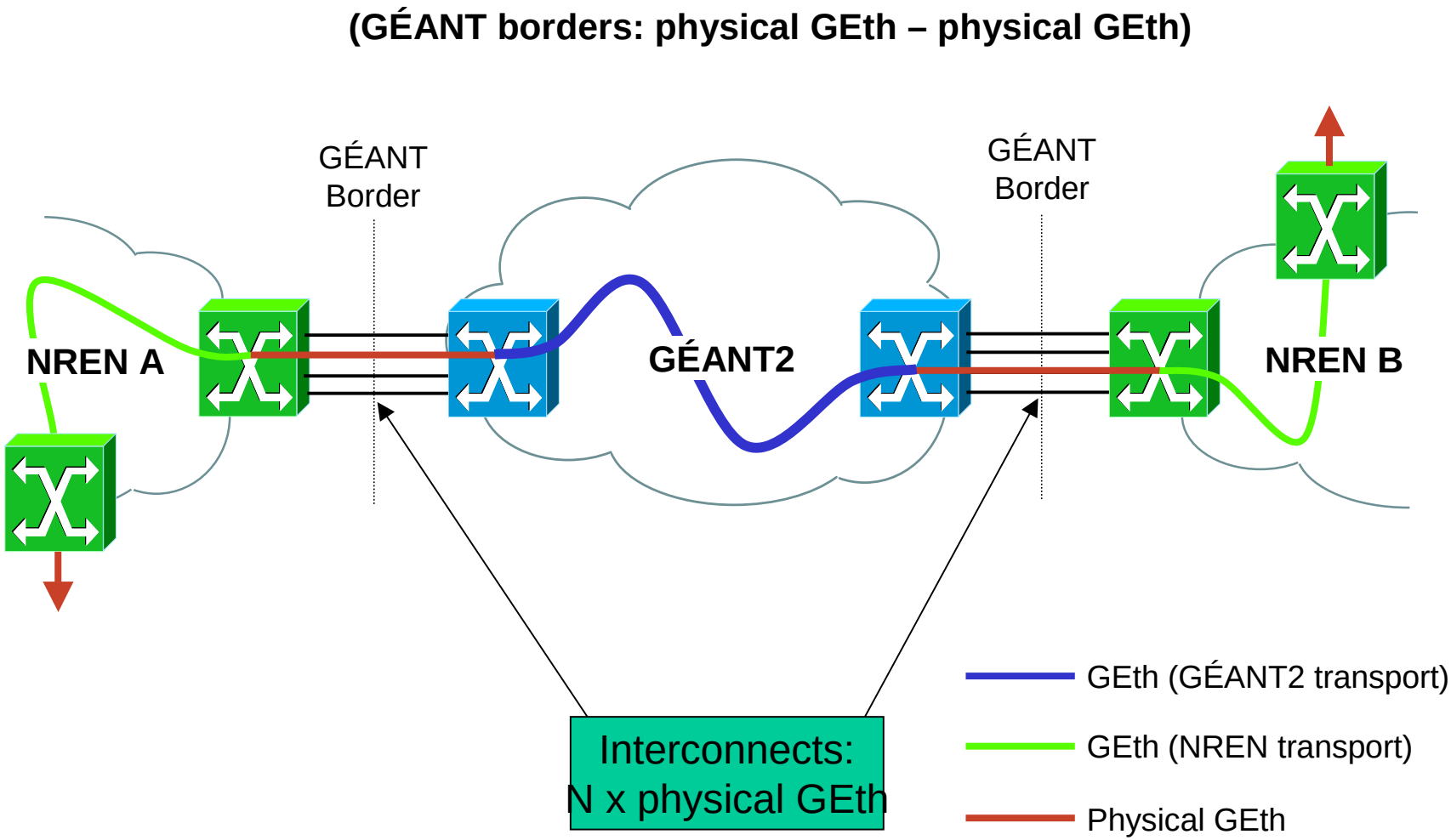
GÉANT today - Services

- **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

- 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

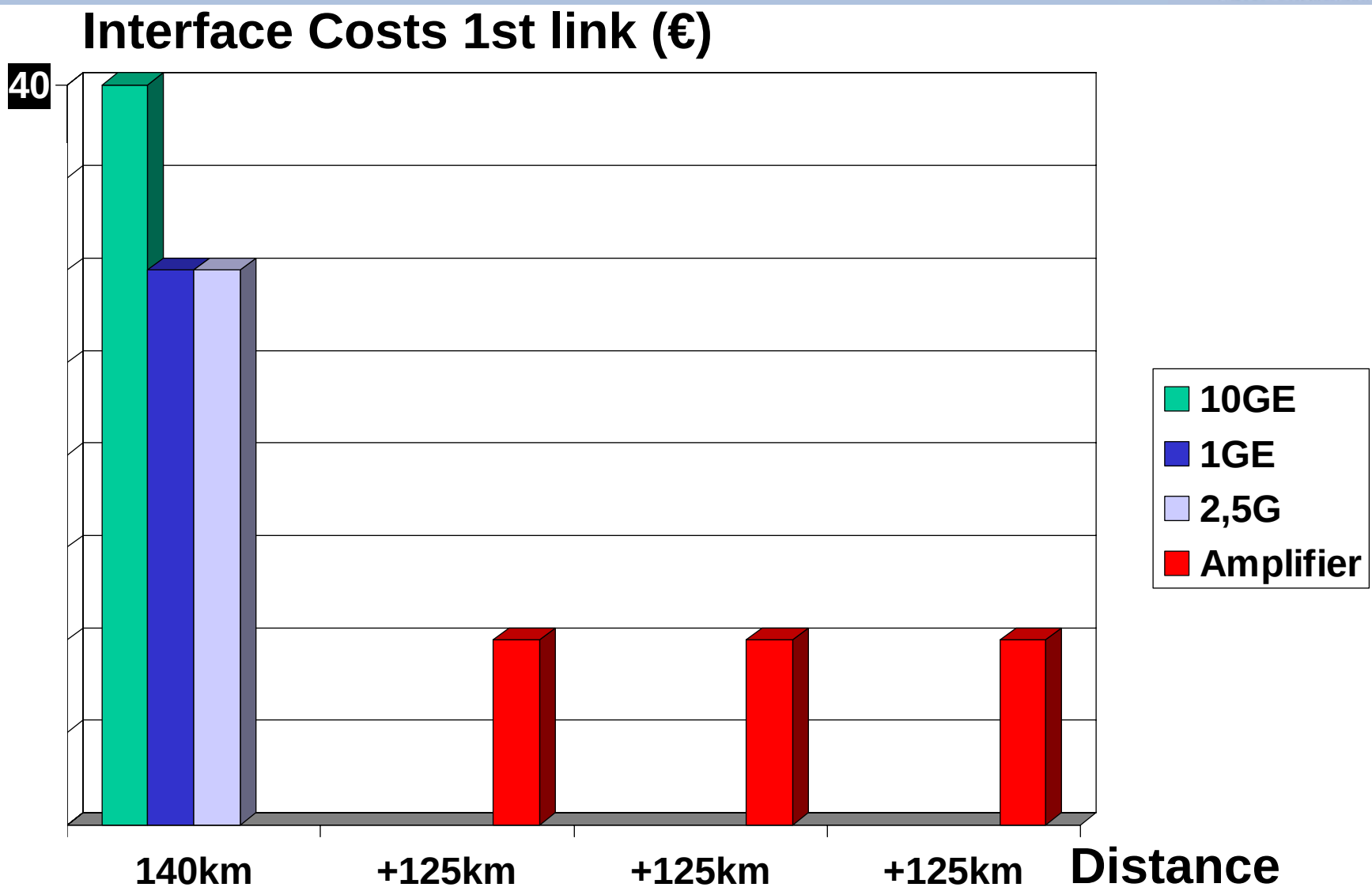


4. Basic building block: dark fibre

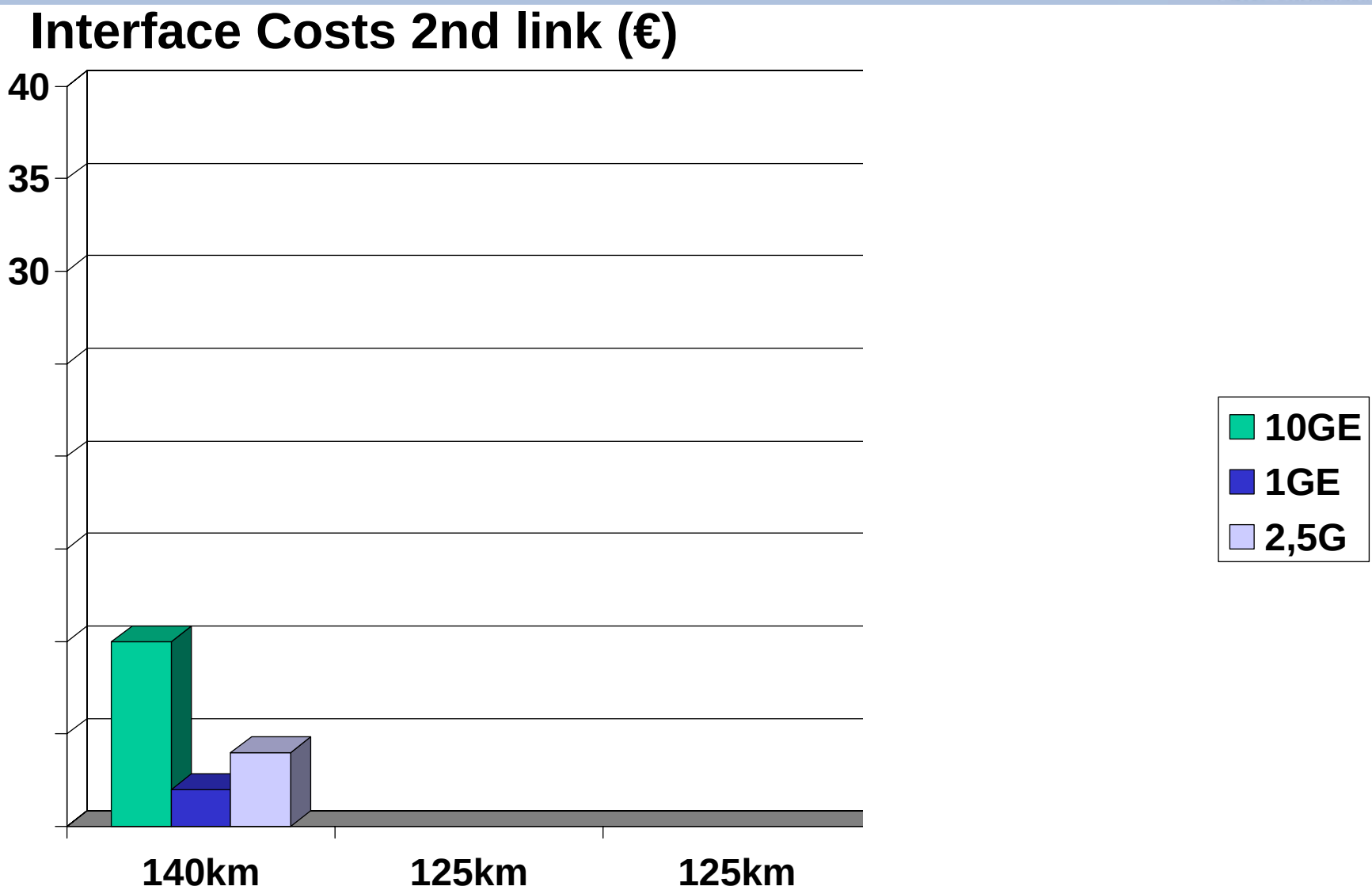
- Dark fibre is the basic element for any bandwidth provision
- Technology for lighting the fibre is available at reasonable prices
- If scenarios like LHC / VLBI /... are assumed to contribute more and more to the networking demands then the consequence for NRENs and Geant-x (x>1) is clear:

Get as much fibre as financially affordable

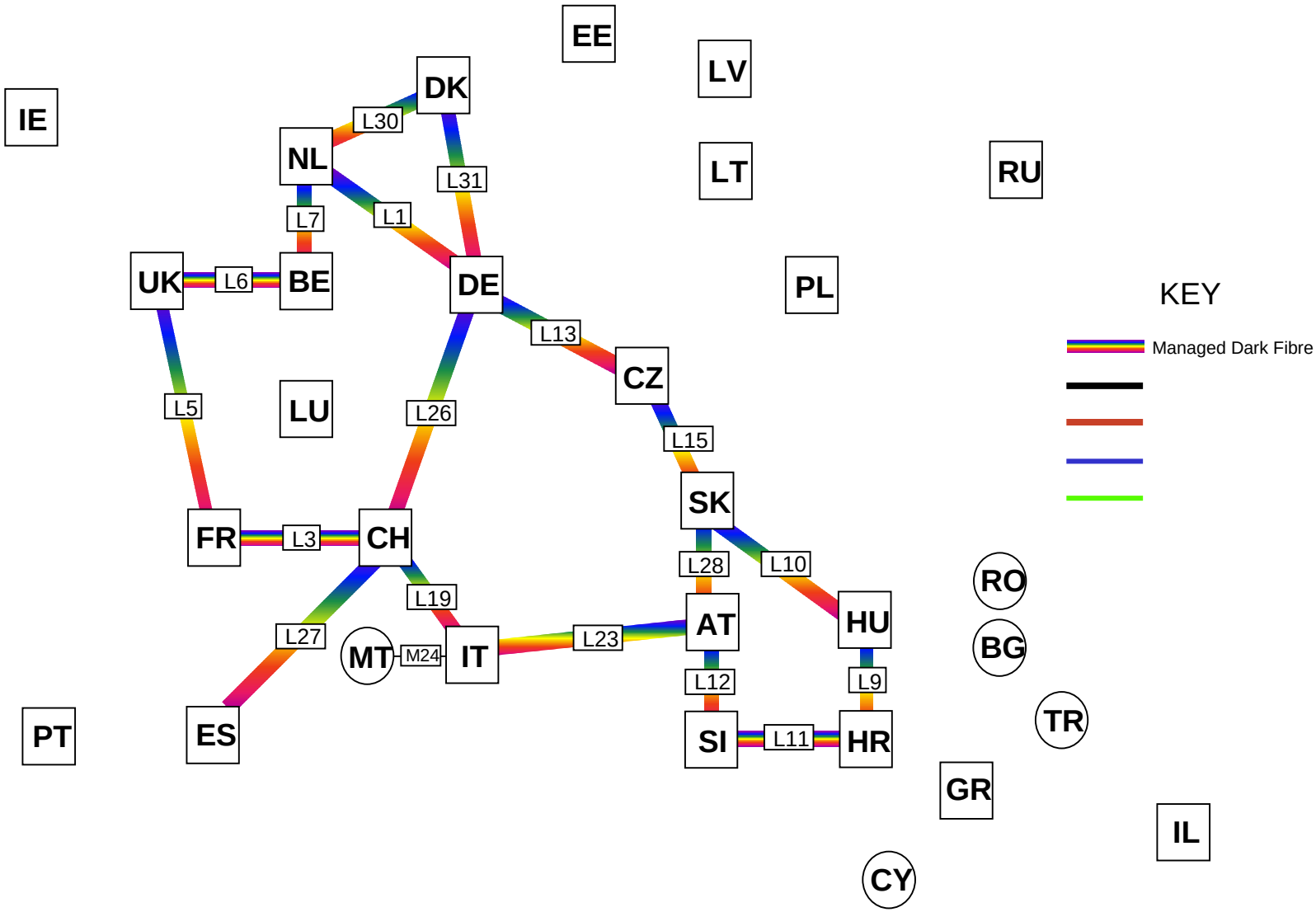
Economy fibre links (1) - DFN case



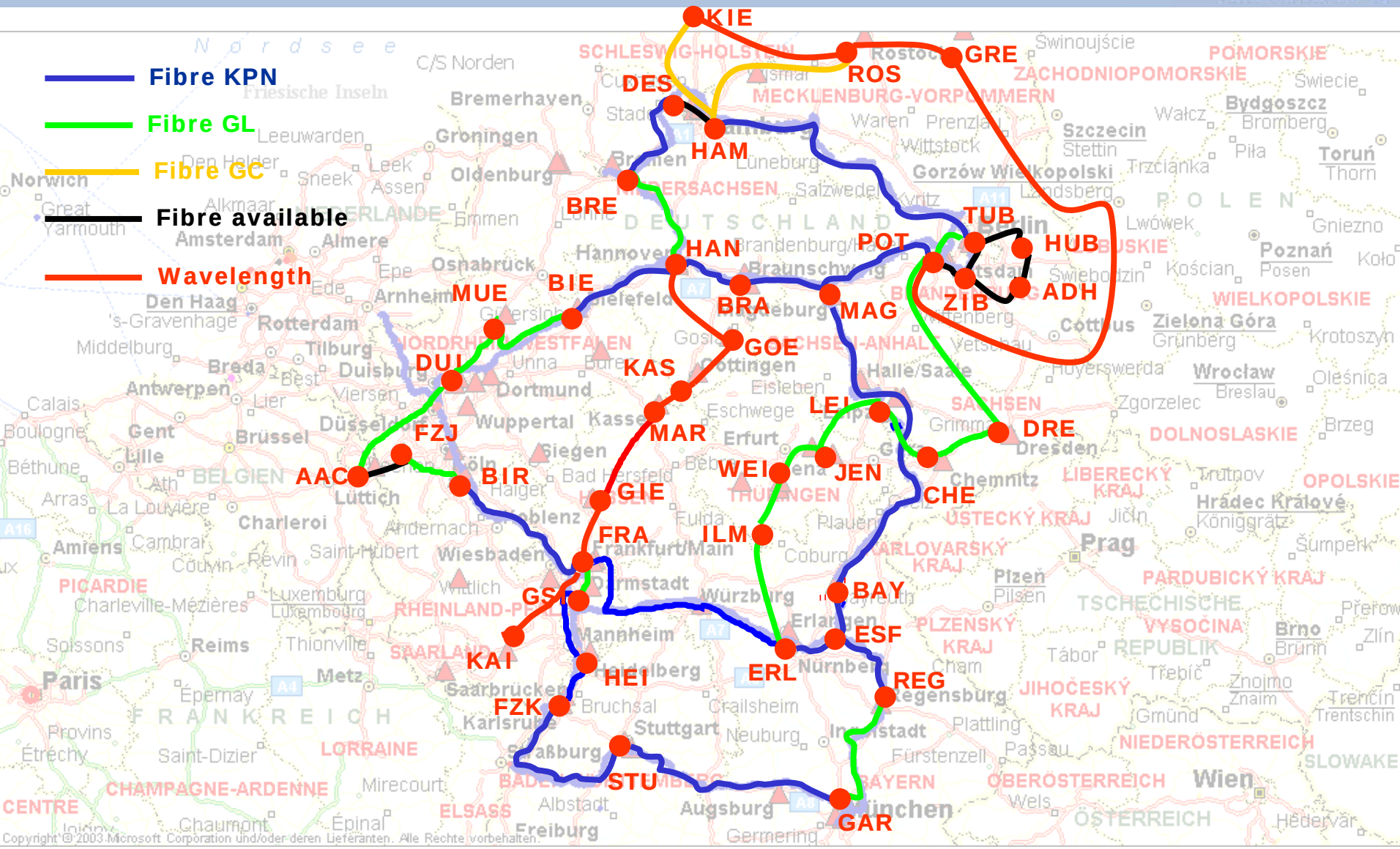
Economy fibre links (2) - DFN case



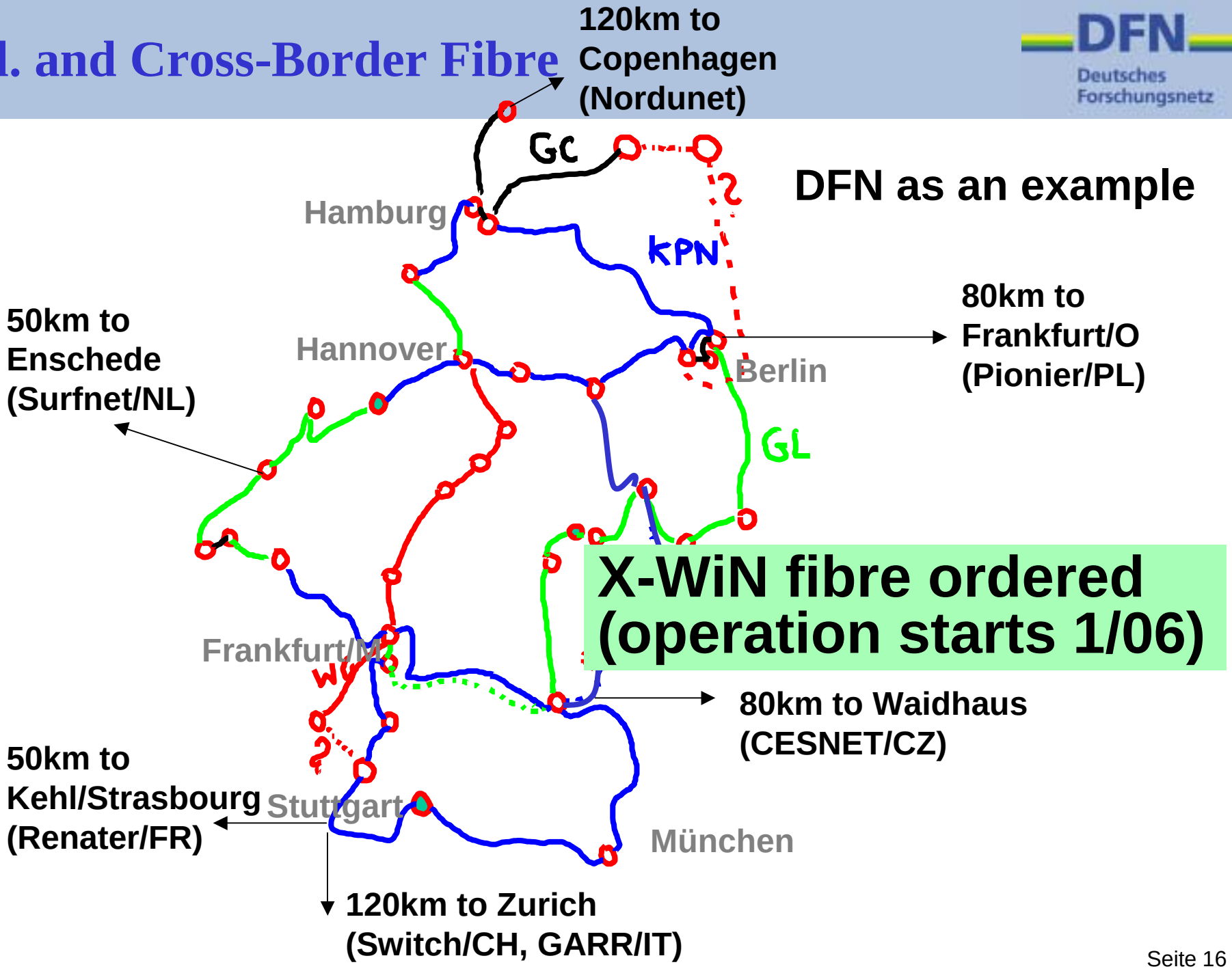
Geant2- Overall Fibre Topology



X-WiN (Fibres and Wavelengths)

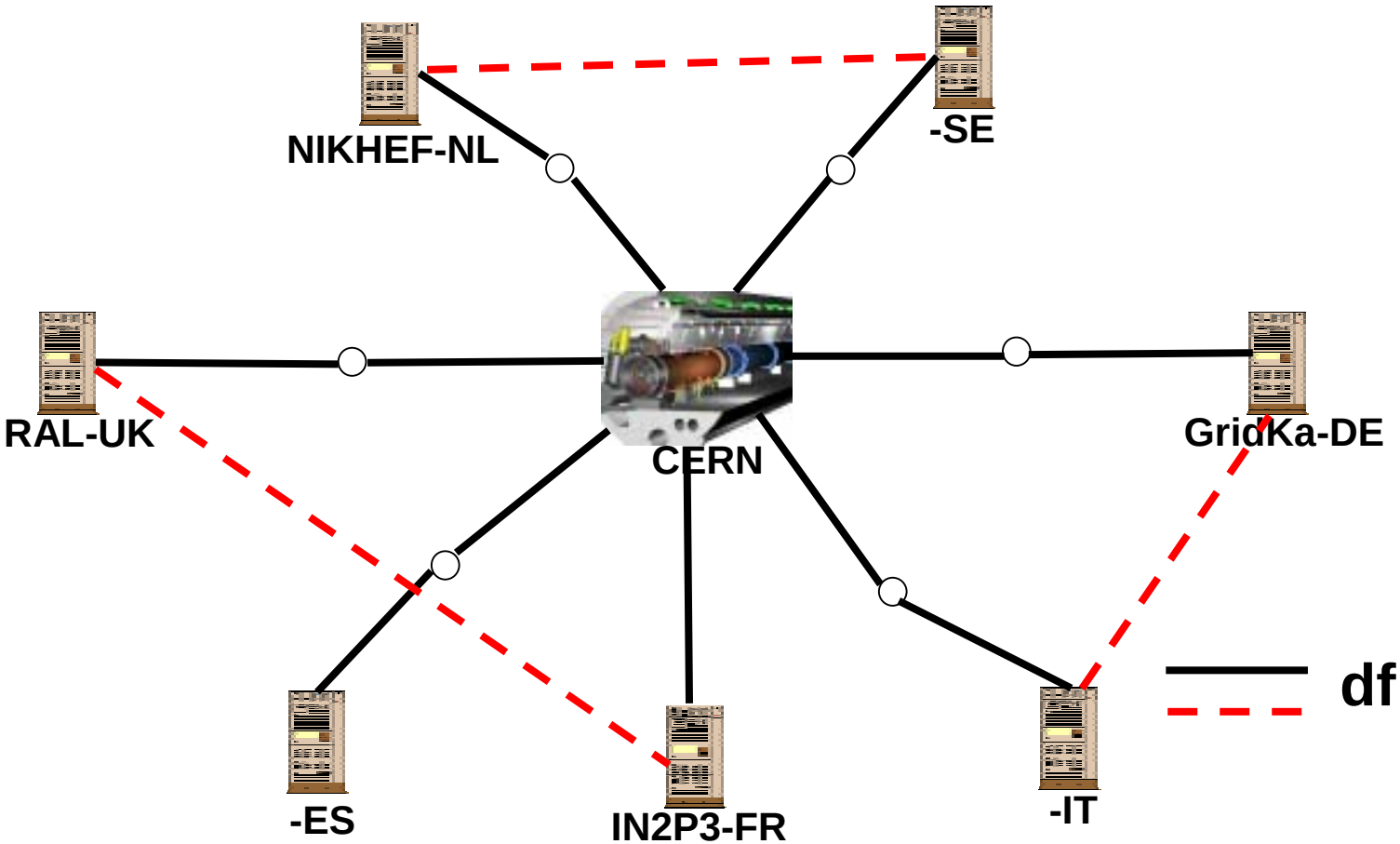


Ntl. and Cross-Border Fibre



Example for dark fibre usage

The LHC network in Europe



Cross-Border Fibre

- 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

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 develo-ped - however this will be relatively slow and more a complement rather than a revolution

Summary and Outlook (1)

- **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)

- **Dark Fibre as essential building block**

  Get as much fibre as financially affordable

- **Policy Framework**

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