

NORDIC Optical Network Projects

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Nordic Infrastructure for Research & Education



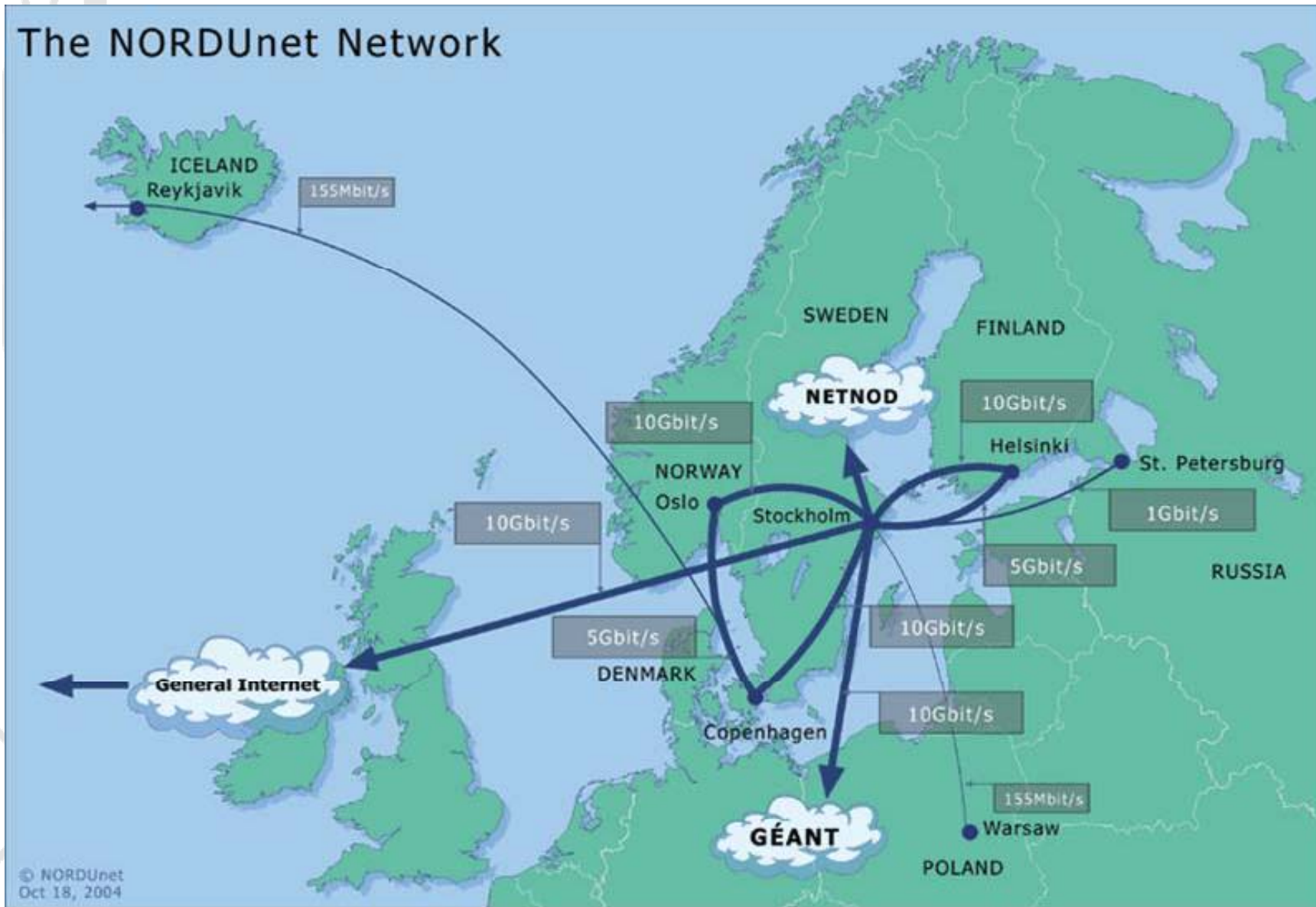
NORDIC Infrastructure for Research and Education

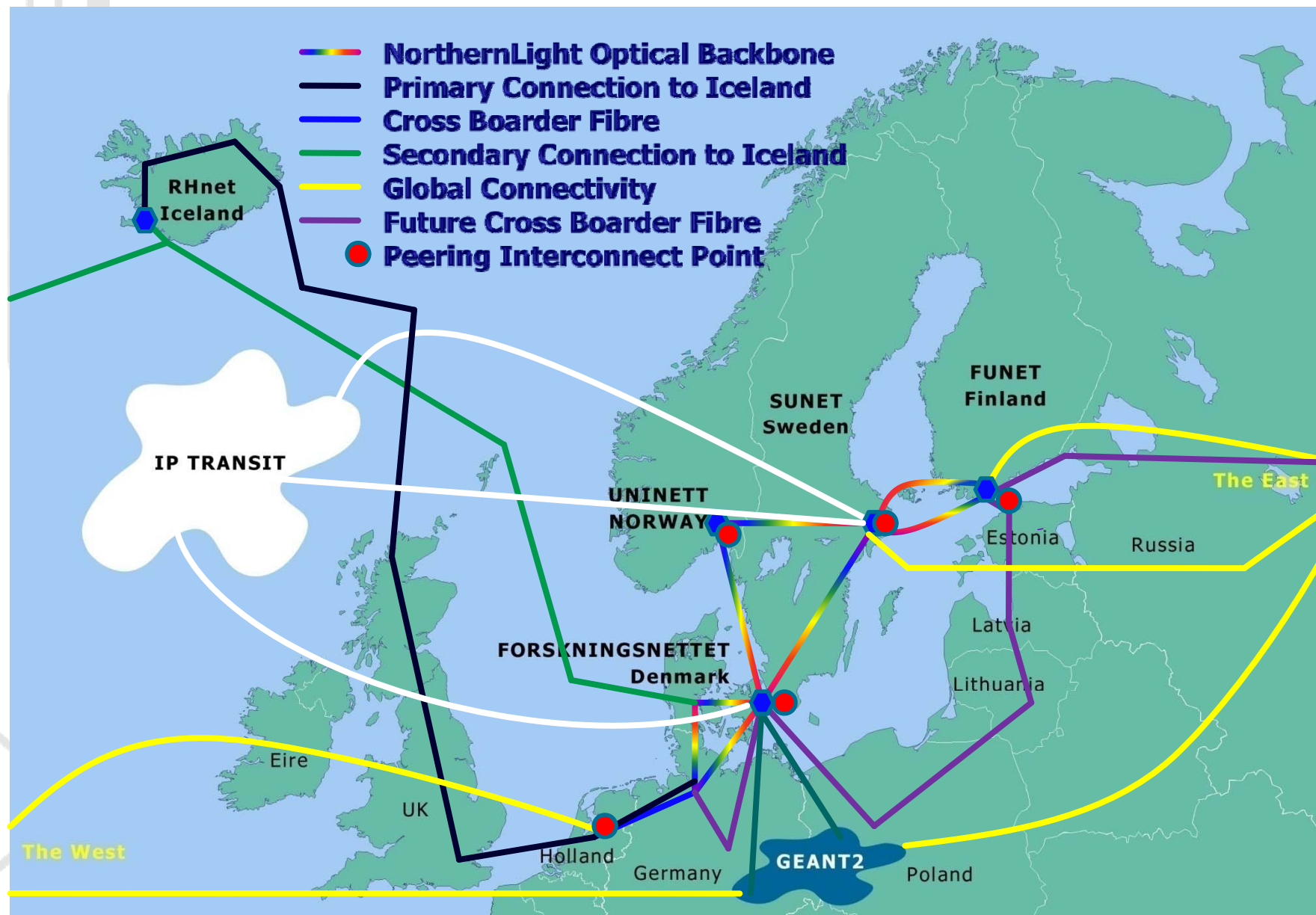


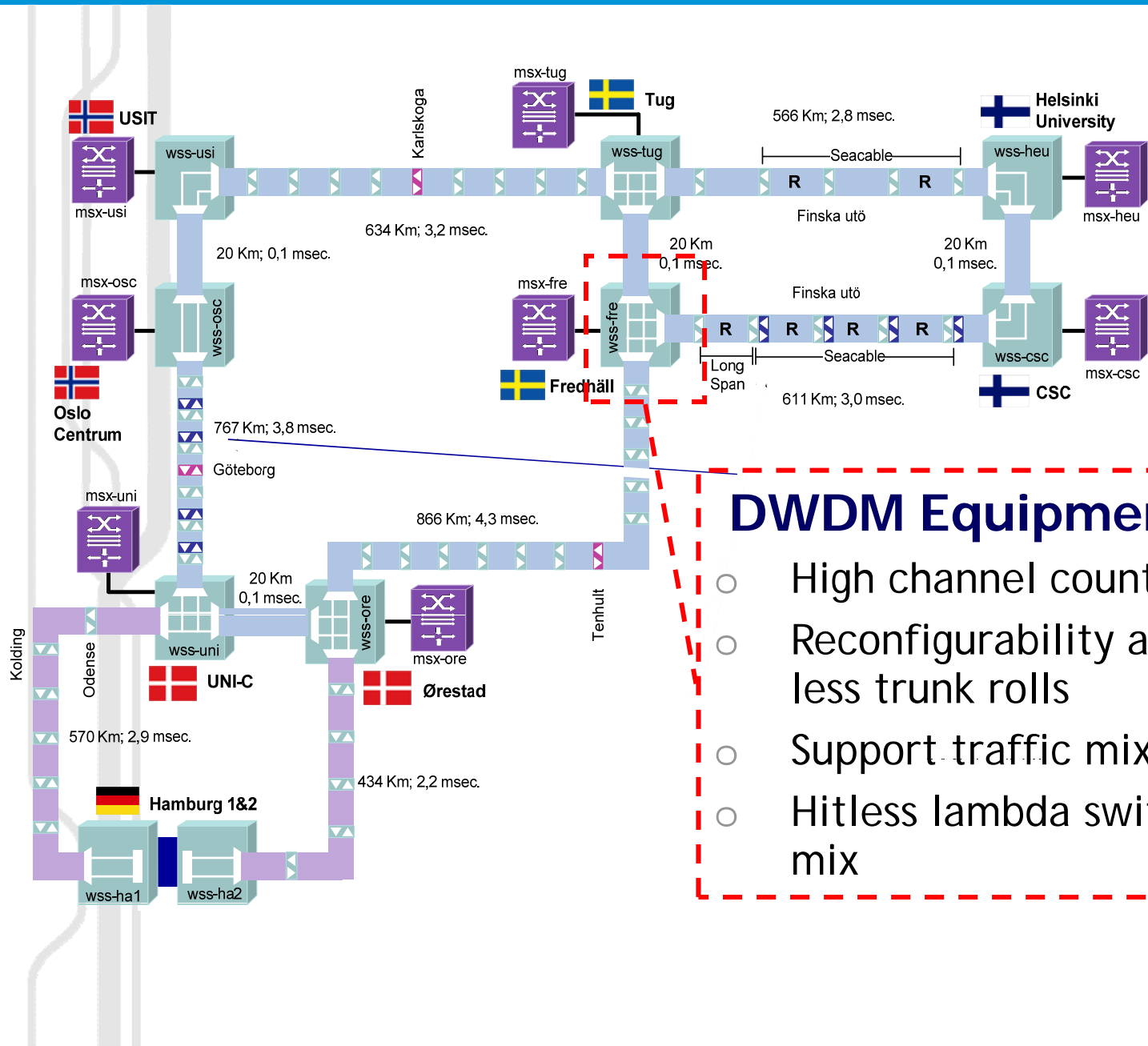
- Serve the Nordic NRENS
- Coordinate NORDIC NREN Development
- eInfrastructure Services
- International Dimension

- Fibre distances
 - NORDUnet ~4200 Km (Completed – NUNOC Managed)
 - SUNET ~7300 Km (Completed – NUNOC Managed)
 - FUNET ~4300 KM (Operational 2008)
 - Forskningsnettet ~1500 KM (Operational 2008)
 - UNINETT ~7000 KM (In Progress)
 - Rhnet 2,5 Gbit/s Lambda connection 2008
- Other Fibre Projects
 - Baltic Ring

The NORDUnet Network

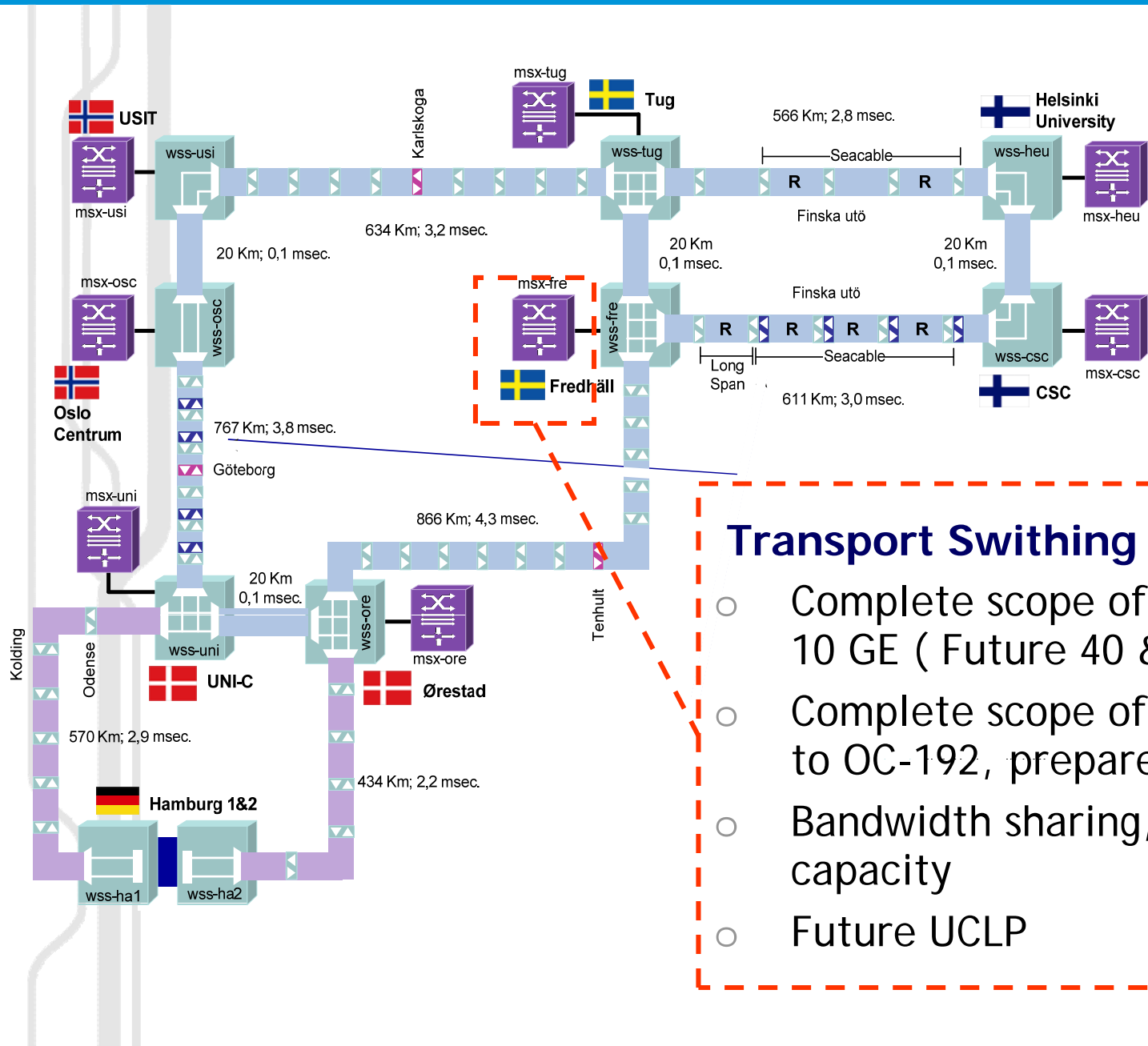






DWDM Equipment

- High channel count up to 88
- Reconfigurability and tunability for less trunk rolls
- Support traffic mix of 10G / 40G
- Hitless lambda switching of traffic mix



Transport Switching Equipment

- Complete scope of Ethernet 1 GE, 10 GE (Future 40 & 100G)
- Complete scope of SDH / SONET up to OC-192, prepared for OC-768
- Bandwidth sharing, dynamic use of capacity
- Future UCLP

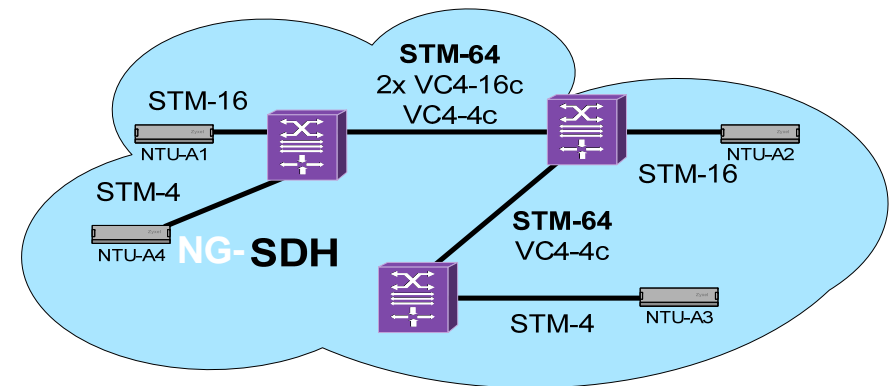
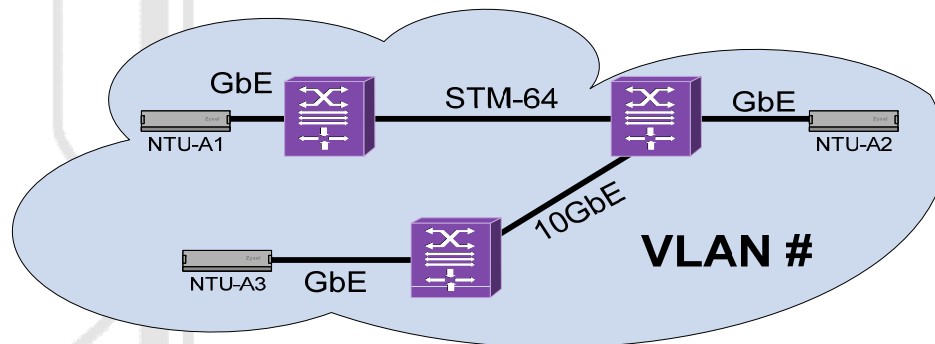


Unique Hybrid Architecture for Next-Generation Transport Switching

T-MPLS

TSS

- A Distributed Open Optical Exchange
 - Redundant nodes in Copenhagen, Helsinki, Oslo & Stockholm
 - Connect anywhere, switch connections anywhere
- A GLIF Open Lightpath Exchange
 - Part of GLIF network of GOLEs
- Open
 - To all collaborators, Nordic and international
 - To all types of services



Unique Hybrid Architecture for Next-Generation Transport Switching “Processing” decoupled from “Switching”

•Universal Switching

- Agnostic switching architecture (“quantum-switching”)
- Switching synch traffic (circuits) or asynch traffic (packets) in native format (technology-independent)
- Non-stop forwarding (not affected by traffic congestion)

100% TDM | Any Traffic Mix | 100% Packet

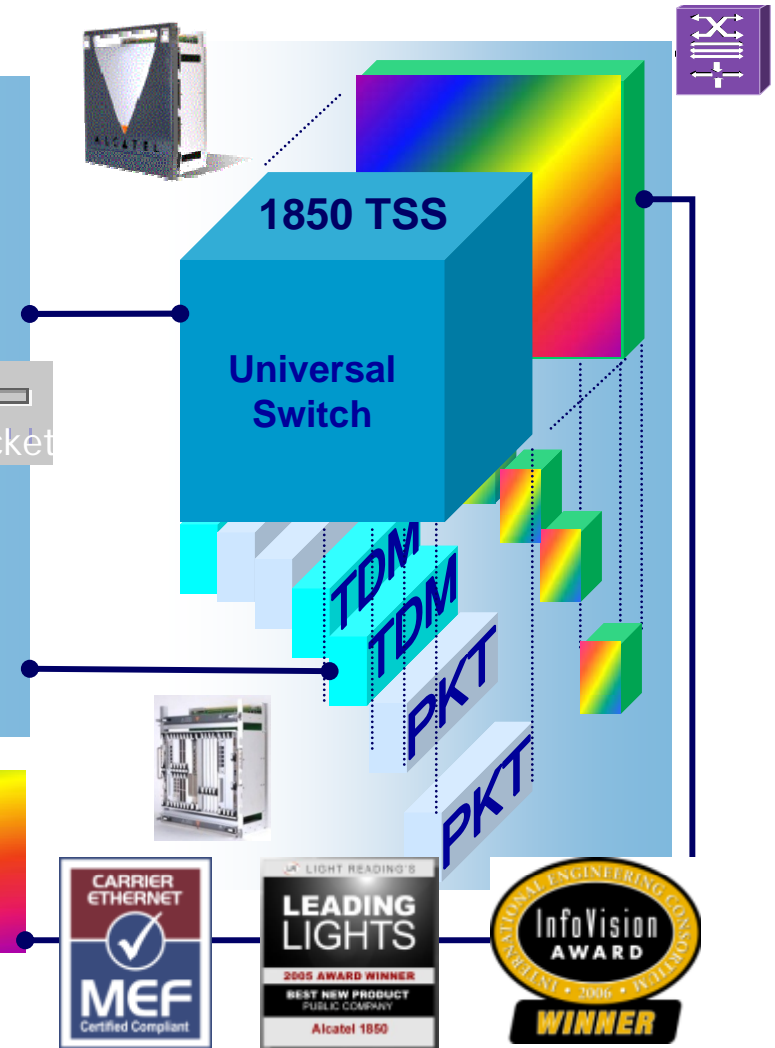
•Traffic Processing Line Cards

- Technology-dependent traffic line cards
- Host all specific traffic processing functions (classification, policing, perf monitoring, OAM, etc)
- Open to future packet-based protocols (T-MPLS)

Integrated WDM

- CWDM/DWDM, OADM, Mux/Demux, Transponders
- ROADM, OTH

- Cost-optimized network consolidation
- Freedom in planning network resources, reduced investment risk



- **NORDUnet NorthernLight**
 - Pan Nordic Redundant Dark Fibre Optical Infrastructure
- **NORDUnet IP**
 - Pan Nordic Redundant IPv4 & IPv6 Infrastructure
- **NORDUnet NOX** (NorthernLight Optical X-Change)
 - Distributed Open Optical Exchange
- **NORDUnet NUNOC**
 - 24x7 eInfrastructure operation centre.
- **NORDUnet PORTAL** (portal.nordu.net)
 - WIKI and WWW Community services for Research & Educational projects
- **NORDUnet Project**
 - Project and Administration services to Nordic Research Communities
- **NORDUnet Meeting**
 - Meeting & AV Conferencing host facilities in Copenhagen & Stockholm
- **NORDUnet Training**
 - Workshops and Training on Network & Computer Technologies.
- **NORDUnet3** (www.nordunet3.org)
 - Four year Internet Research Program – Nordic and the Baltic Countries
- **NDGF – Nordic Data Grid Facility** (www.ndgf.org)
 - Pan Nordic High Performance Computing GRID & Pentabyte Storage



Active Users

- Nordic Tier-1 for CERN LHC (permanent)
 - established: 10 GE Copenhagen - CERN
 - planned: 10 GE Copenhagen -> Amsterdam, Oslo, Stockholm, Helsinki
- DEISA (permanent)
 - established: 10GE Helsinki – Frankfurt
- Kyoto prize video streaming (Temporary, Oct,)
 - established: 10GE Stockholm – Kyoto
- RBnet – Russian Network Transit (Permanent)
 - Established: 10GE Stockholm-Amsterdam
- RUNnet – Russian Network Connectivity
 - Established: 10GE Helsinki
- GLORIAD (Permanent)
 - Established: 10GE Amsterdam-Stockholm

Nordic Astronomy OPN (for e-VLBI & LOFAR, permanent)

immediate requirement:

- 4 Gbps Onsala - Jodrell Bank (UK)

additional need:

- 1 GE Onsala – Jive
- 1 GE Helsinki – Jive
- 4 Gbps Helsinki – Onsala
- 4 Gbps Helsinki - Jodrell Bank
- 3 Gbps Onsala - Dutch LOFAR site
- Work is in progress on creating an integrated OPN for Nordic astronomy that can encompass all.

Trondheim - Seoul medical imaging

- requirement: 1 Gbps Trondheim - Seoul

Stockholm - Seattle HDTV video conferencing

- requirement: 1 x 1 GE Stockholm - Seattle

Umeå – Amsterdam – 40 Gbit trial

- Requirement: 1xAlien Lambda Stockholm-Amsterdam

GEANT Lambda – Copenhagen Helsinki

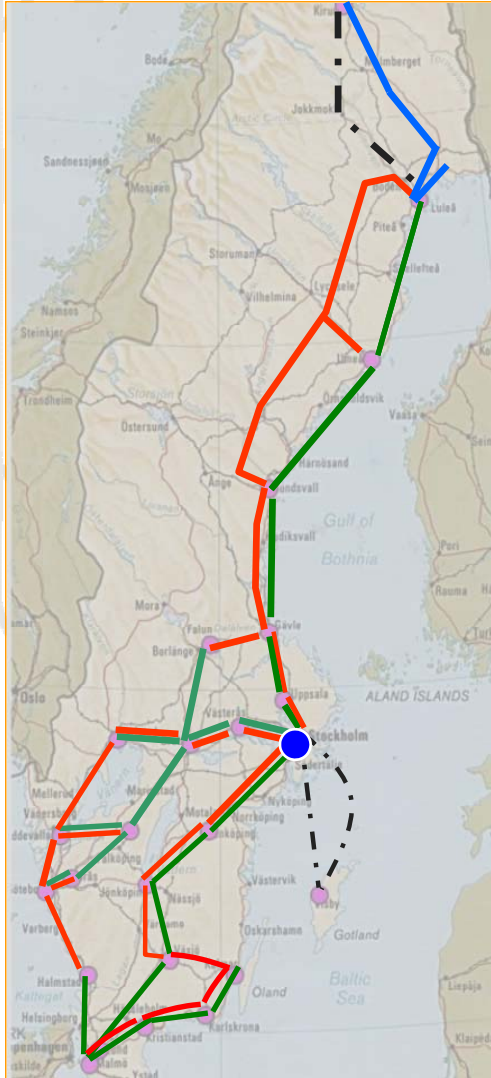
- Requirement: 10GB Lambda for GEANT2 Connectivity to Russia



SUNET

SWEDEN



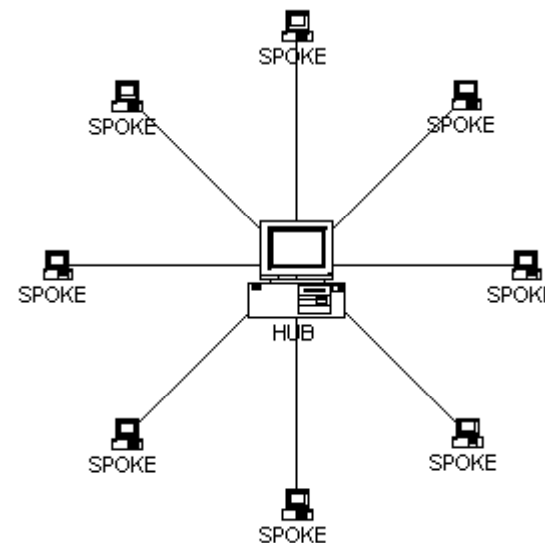


- 3 systems
 - North, West and South
- 2 networks per system
 - Red and Green
 - Redundancy on layer 3
- Fully Redundant Network
 - **Red – Green Separation**
- Desire for High Capacity Growth
- Support for Special Applications
- Support:
 - **Router Connectivity**
 - **Dedicated High BW Pt-Pt Connectivity**
- Cost Sensitive GE and 10GE
 - **But also need to be 40G Ready**

- SUNET has signed a contract for a 8 to 12 years lease of dark fiber from TDC Song, which is becoming our **only** supplier of fiber for the whole network
 - Using several subcontractors.
- Some details:
 - Wide area network – between PoPs
 - 7 663 km (4 763 miles) of dark fiber, in 46 sections
 - Local loops from PoPs to universities and colleges
 - 94 dark fiber connections
 - 3 x 2,5 Gbit/s leased connections (due to cost constraints)
 - 2 x Visby, 1 x Kiruna



- The network topology is a hub and spoke structure on leased dark fibers.
- Centralized routing solution



- The goal is to have a “long” lifetime of the fiber system (including amplifiers etc.) and a 5 to 8 year lifetime of the attached electronics (routers etc.)
- Hybrid network, having both traditional routed IP services as well as optical p2p connections.

- Pro

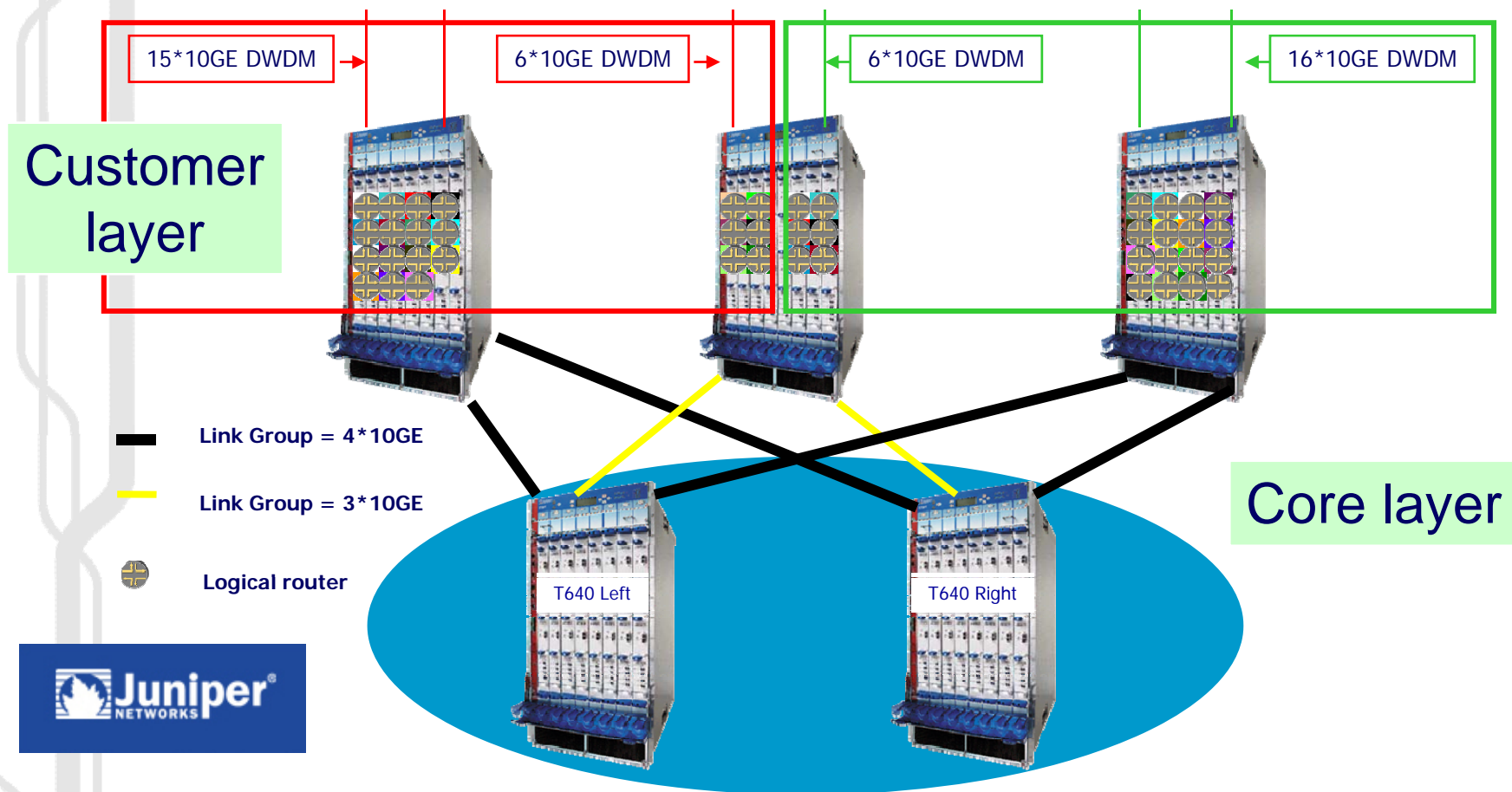
- Cost savings
- (much) Less routers to manage
- Everything at the same location

- Con

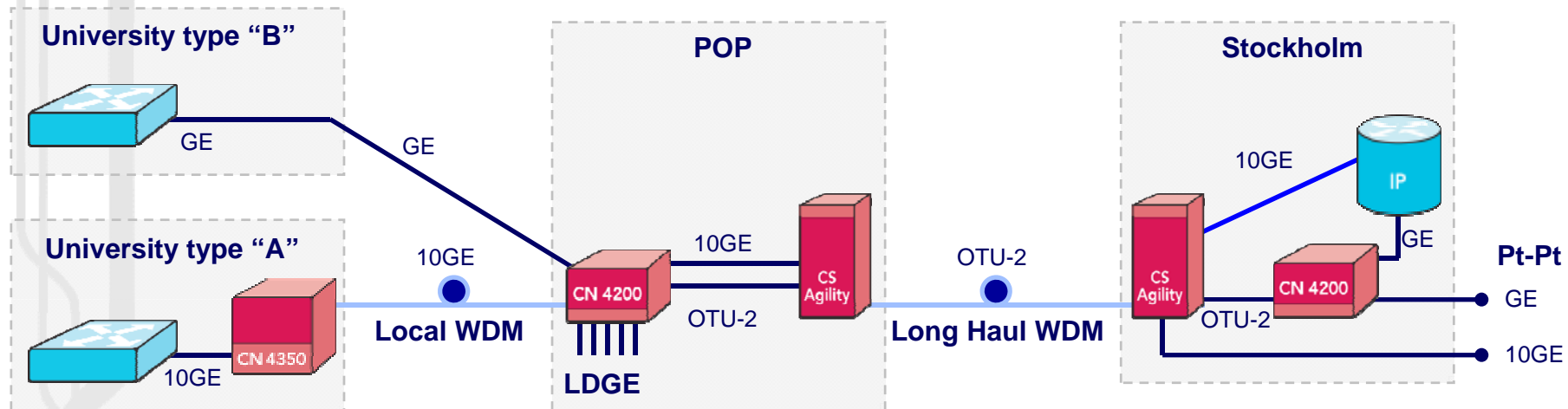
- All traffic has to pass Stockholm
 - Encourage local peering at the universities
- Peering “everywhere” is less straight-forward
- Logical routers are not the perfect solution
- Everything at the same location

- Customer (university) types:
 - A = Universities and larger colleges
 - 2* 10GE, with support for p2p
 - B = Colleges etc.
 - 2 * GE
- "LDGE" – Low Density Gigabit Ethernet
 - Possibility to provide GE connections "everywhere"
 - Student dorms, ISPs, local peering,
- p2p capabilities
 - 40G (later), 10GE, 2.5G, 1GE and possibly FC.

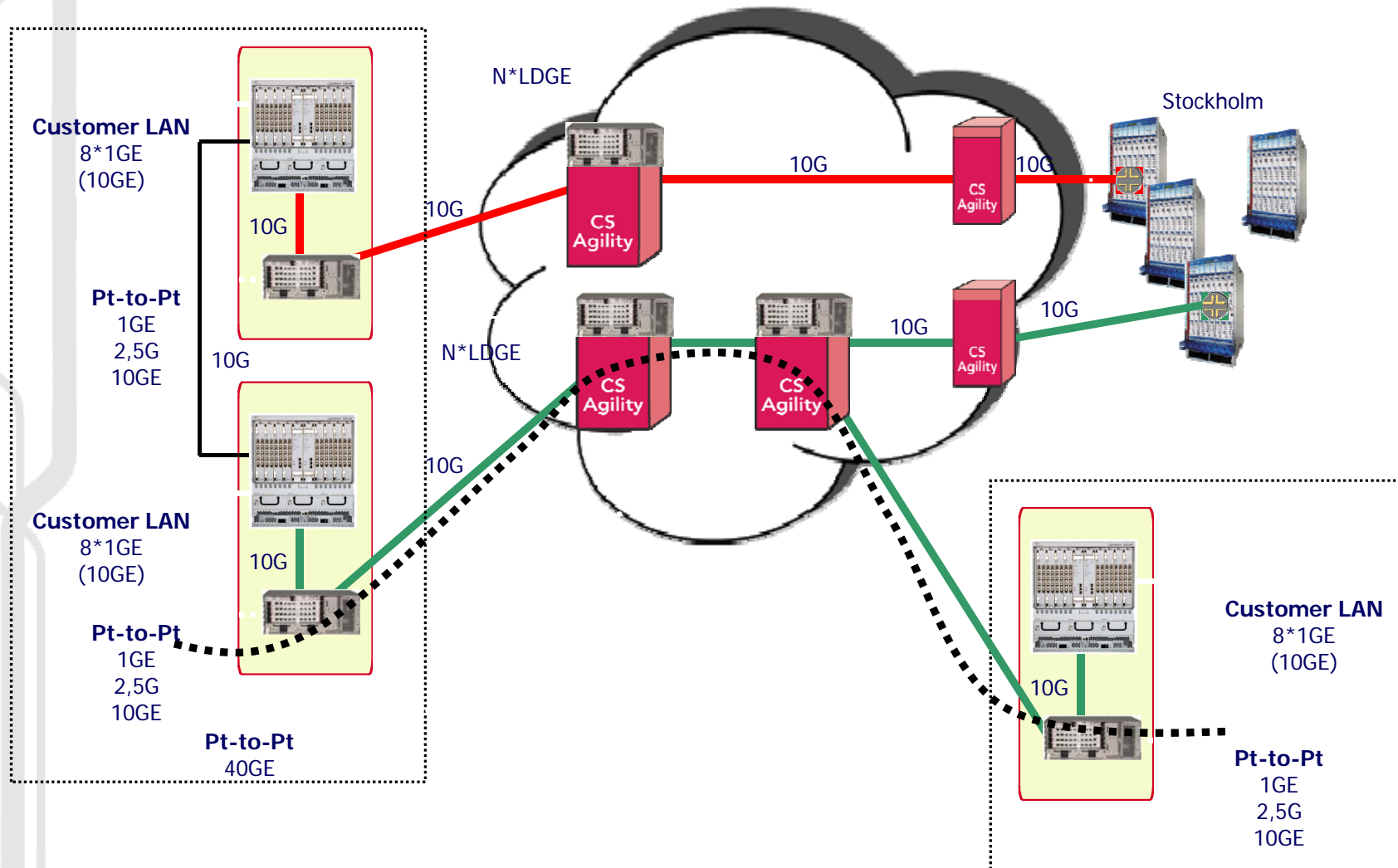




The “customer layer” of the centralized routing solution is used to provide the functions of the customer CPE routers, using “**logical router**” features



- 10GE or 1GE from University to Central router
- 10GE or 1GE Point-to-Point Connections

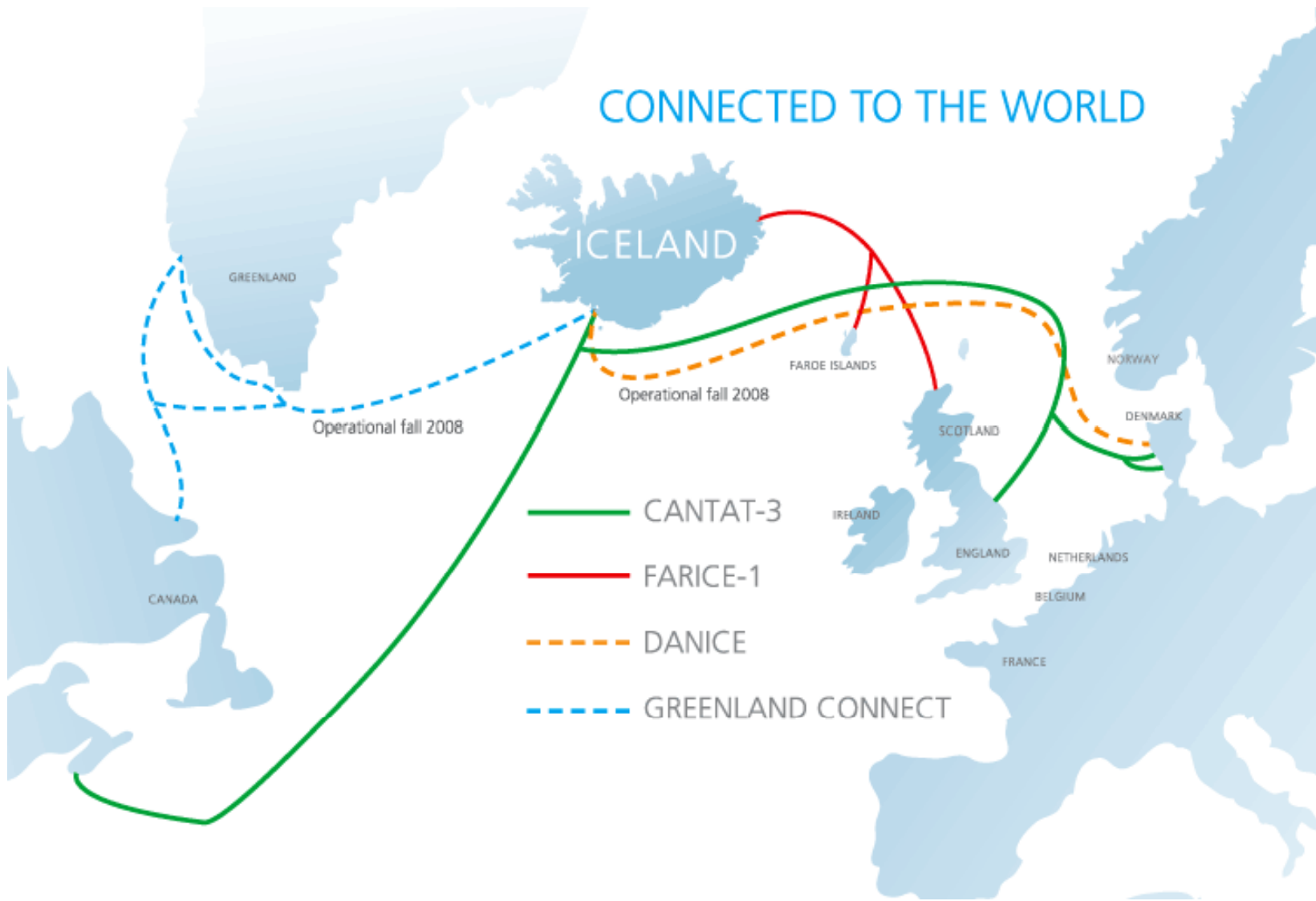


- Integrated management of routers and optical system
- Router integration with transponders with tunable lasers and FEC etc. in the routers
- 100 Gbit/s point-to-point connection
- 100 Gbit/s campus networks (100 GE?)
- Supporting the researchers yet unknown requirements

RHnet

ICELAND





FUNET

FINLAND



NORDUnet

Nordic infrastructure for Research & Education



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UNINETT

NORWAY

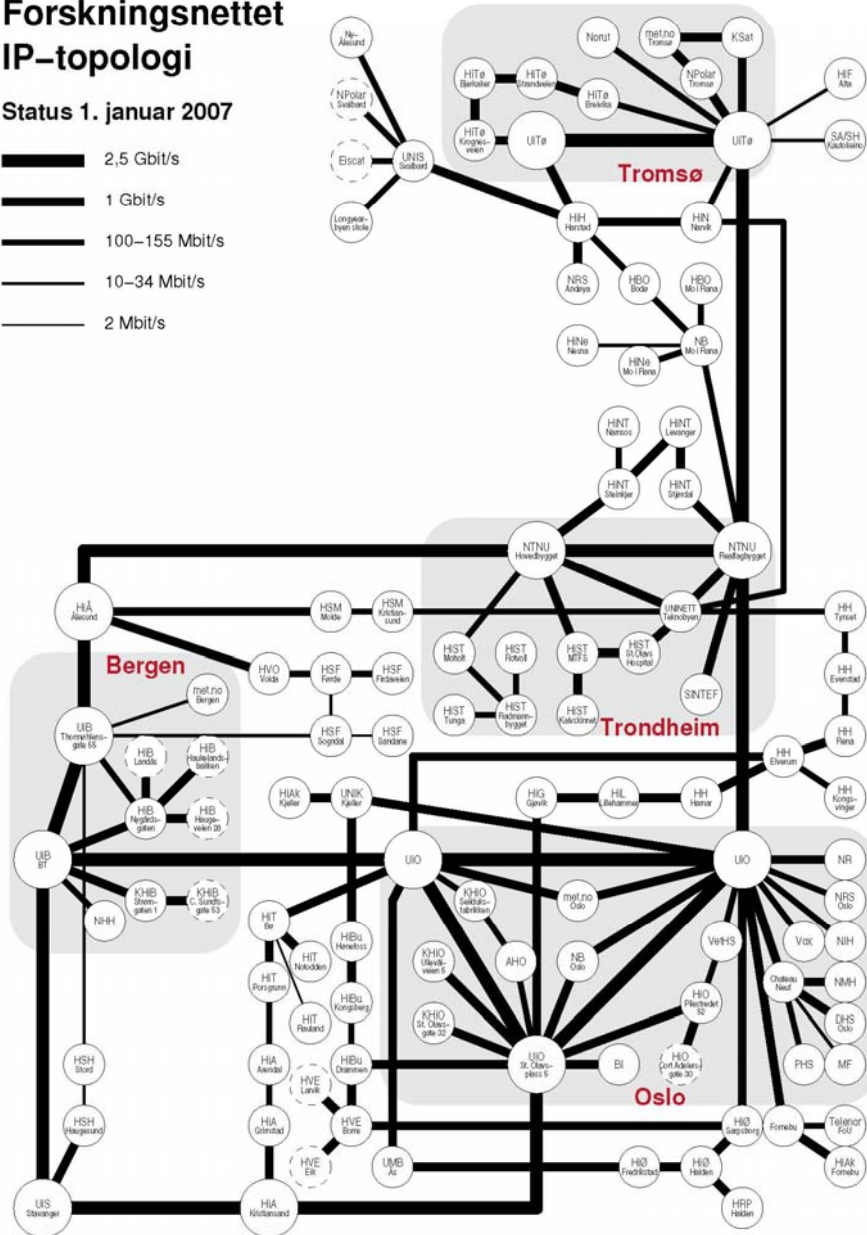
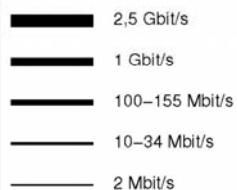


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Forskningsnettet IP-topologi

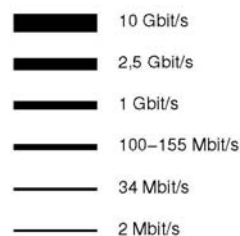
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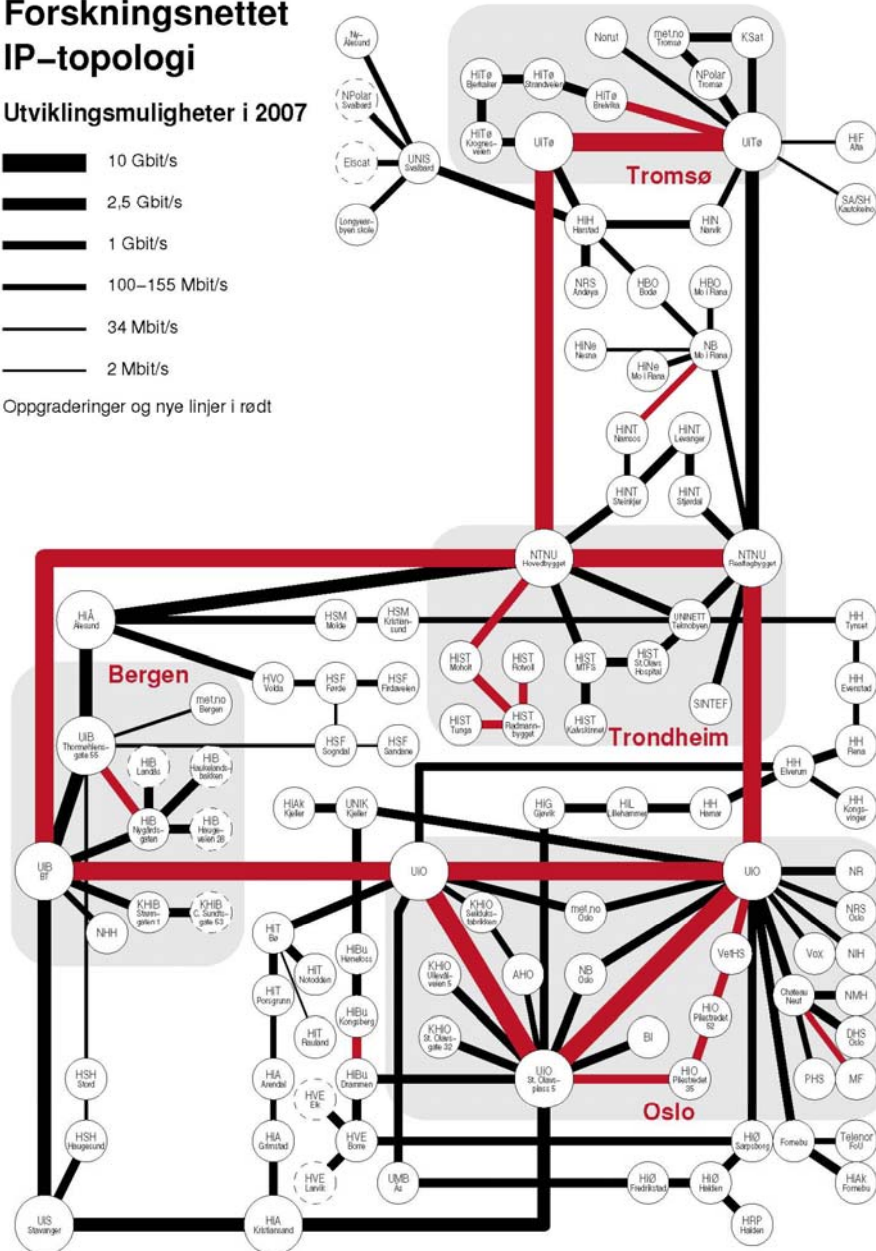
UNINETT

Forskningsnettet IP-topologi

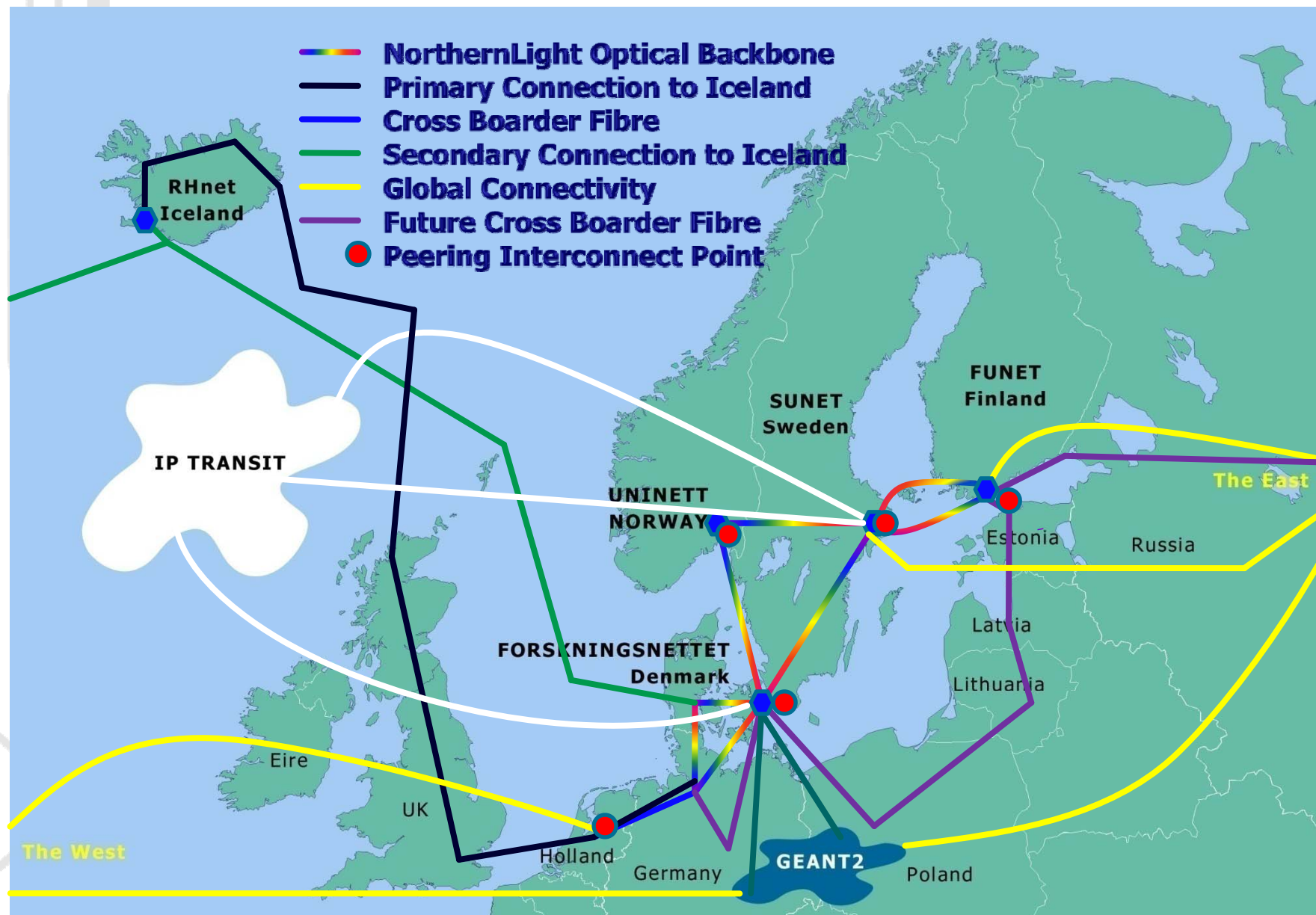
Utviklingsmuligheter i 2007



Oppgraderinger og nye linjer i rødt



Baltic Ring



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