NORDUnet

Nordic Infrastructure for Research & Education

NORDUnet Update
Forskningsnettet Konference 2008

René Buch

CEO

NORDUnet

Nordic Infrastructure for Research & Education

"NORDIC Infrastructure for Research and Education"

Mission:

➢ Serve the Nordic NRENS

The NORDUnet method of facilitating and coordinating Nordic & Global activities has proven very successful placing the Nordic NRENS in Line with major international players that would otherwise be unreachable at a cost efficiency level unobtainable on individual basis.

➢ Coordinate NORDIC NREN Development

- o Nordic Projects
- o GEANT Projects
- o Global Projects

➢ eInfrastructure Services

- ➢ Nordunet3
- ➢ NDGF
- ➢ ...

➢ International Dimension

Facilitating and Coordinating Local-Global-Local contacts and project opportunities.

Key strategy drivers

- ### Globalization and International Competition

  To push the scientific borders further Global Collaboration is necessary and to pool global resources and knowledge fx. CERN, eVLBI GLEON, GENI, CINEGRID etc. This raises the competition between international scientists and institutions.

- ### Cross Boarder Collaboration

  To be a recognized as participant in Global Research Projects it requires that national and regional institutions collaborate and pool resources. The Nordic NREN experience is that a coordinating and facilitating interregional coordination body add significant value to the national efforts as a common level play ground.

- ### Network Paradigm shift

  In addition to the general usage of the network the requirements for specialized high capacity E2E connections are rapidly increasing. This requires a new approach to inter network and inter organizational provisioning and coordination.
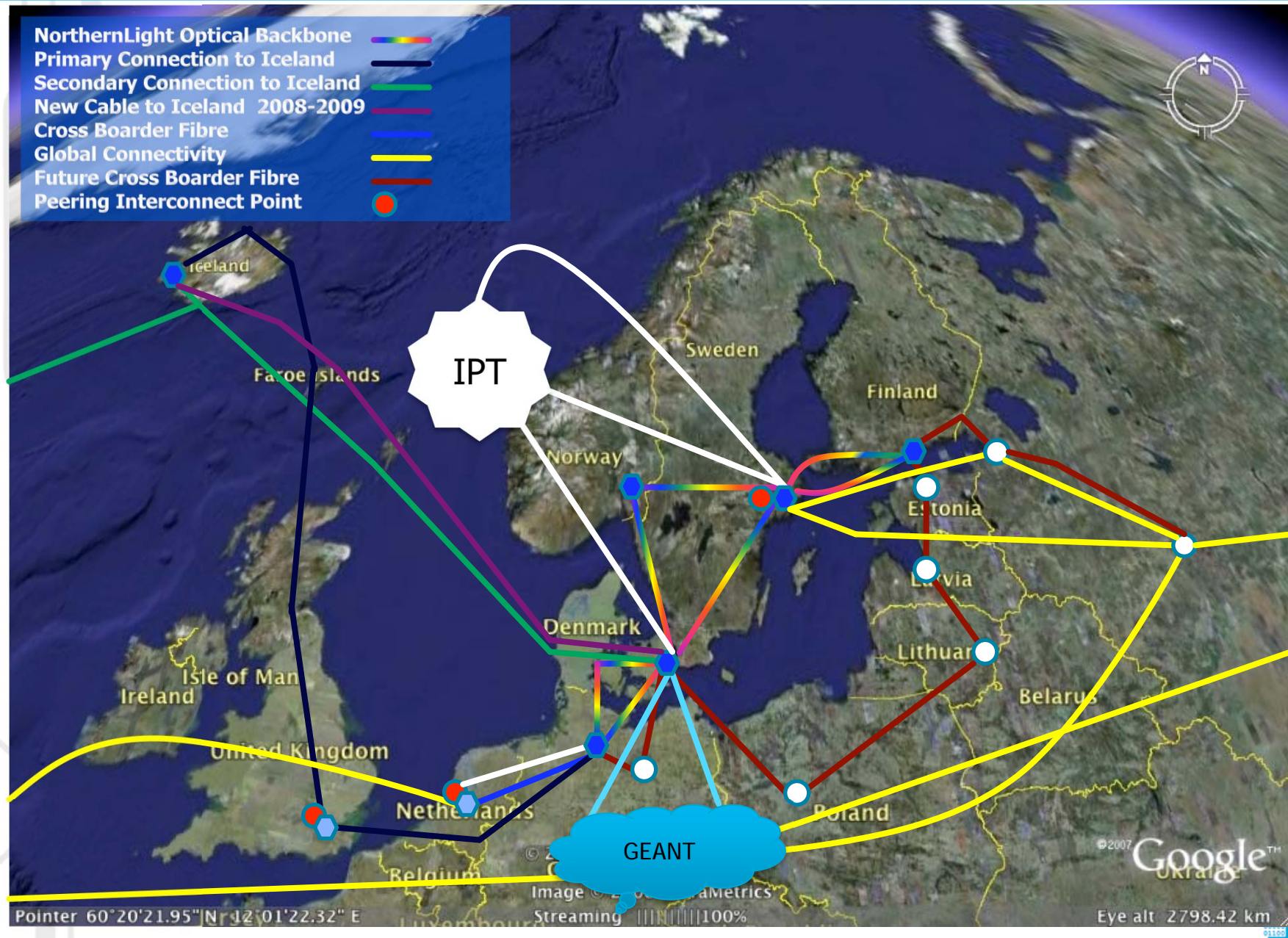
- ### Interdependencies of various disciplines

  In addition to the paradigm shift in networking the interdependencies between multiple disciplines like Networking, Storage, GRID, AAI etc. raises the international and inter regional coordination challenges to a new complexity level.
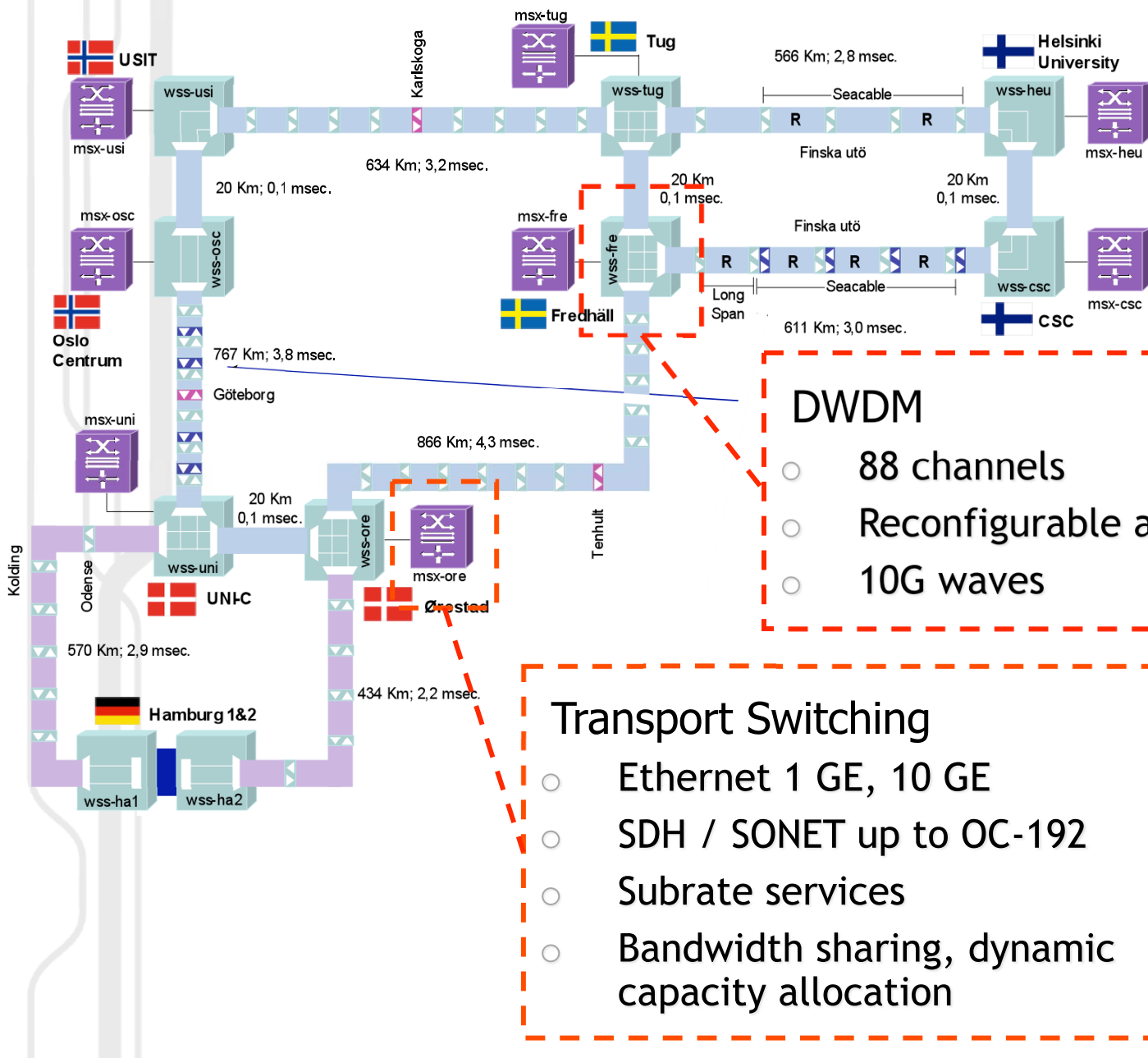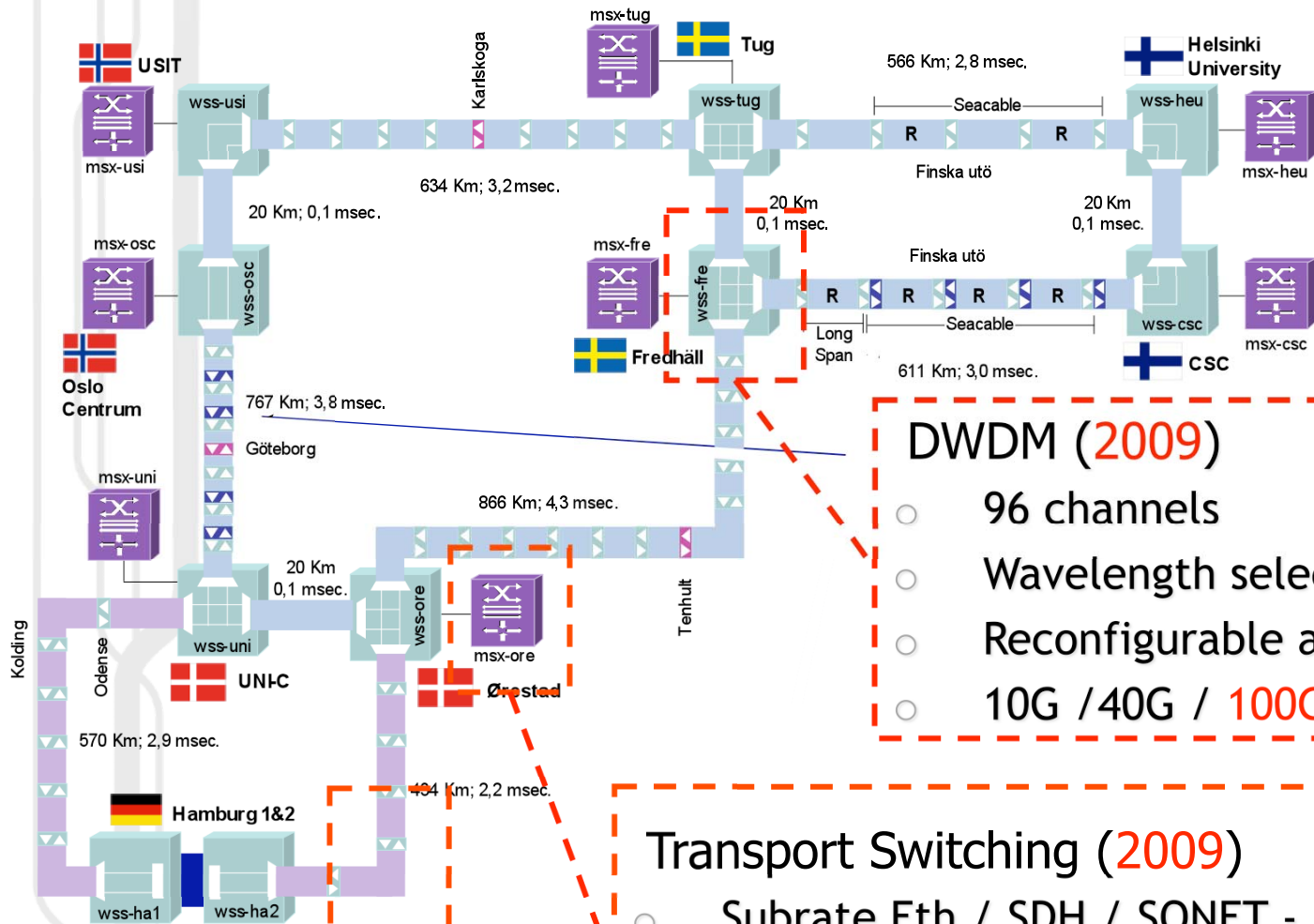
NORDUnet Status

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- 1st 40 Gbit Connection (Sunet)
- Upgrade of Core Optical Backbone to WSS (80% Equipment replacement)
- AMSIX Peering Online
- Google Private Peering Online
- Hosting
  - Ørestad & Tulegatan

2nd Generation: Hybrid (2007)

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DWDM
- 88 channels
- Reconfigurable and tunable
- 10G waves

Transport Switching
- Ethernet 1 GE, 10 GE
- SDH / SONET up to OC-192
- Subrate services
- Bandwidth sharing, dynamic capacity allocation

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3rd Generation: WSS (2008+)

DWDM (2009)
- 96 channels
- Wavelength selector switches
- Reconfigurable and tunable
- 10G / 40G / 100G waves

Transport Switching (2009)
- Subrate Eth / SDH / SONET - partial 10G / 40G / 100G waves
- Next-generation Ethernet
- T-MPLS

Cross-Border Fibre
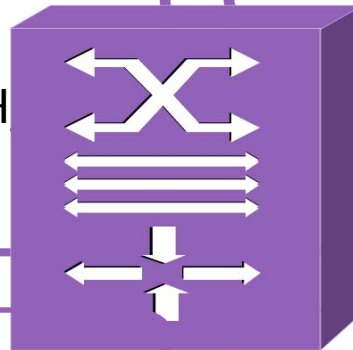
ALU 1850 TSS-320

SDH/SONET

- STM-1, 4, 16 & 64
- Cross-Connection
- Termination
- ETH Mapping over SDH
- Complete Scope of SDH SONET Features

Ethernet

- 10GE LAN/WAN - Optical
- GE - Optical
- 10/100/1000 - Electrical
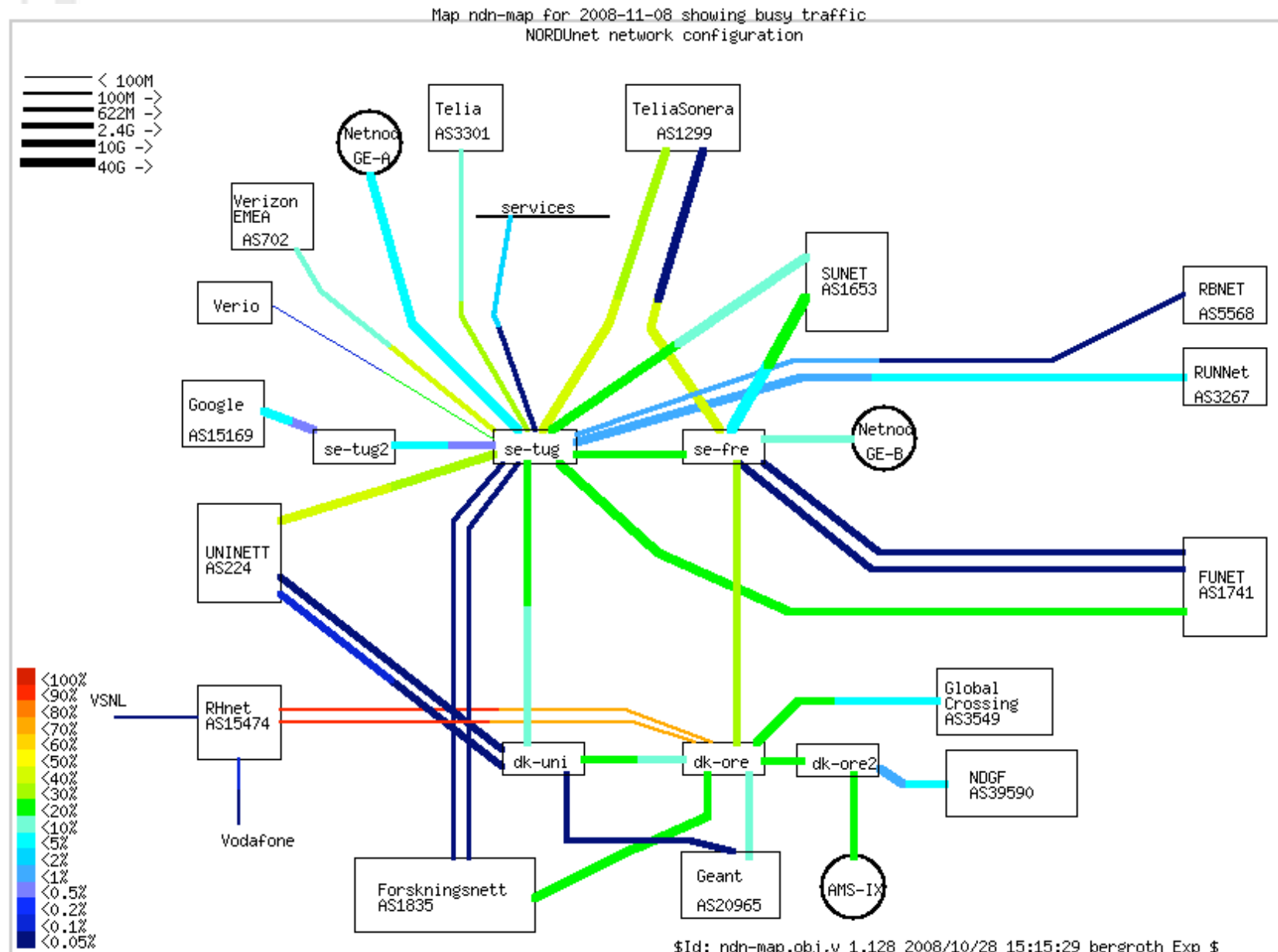- ETH Traffic Classification
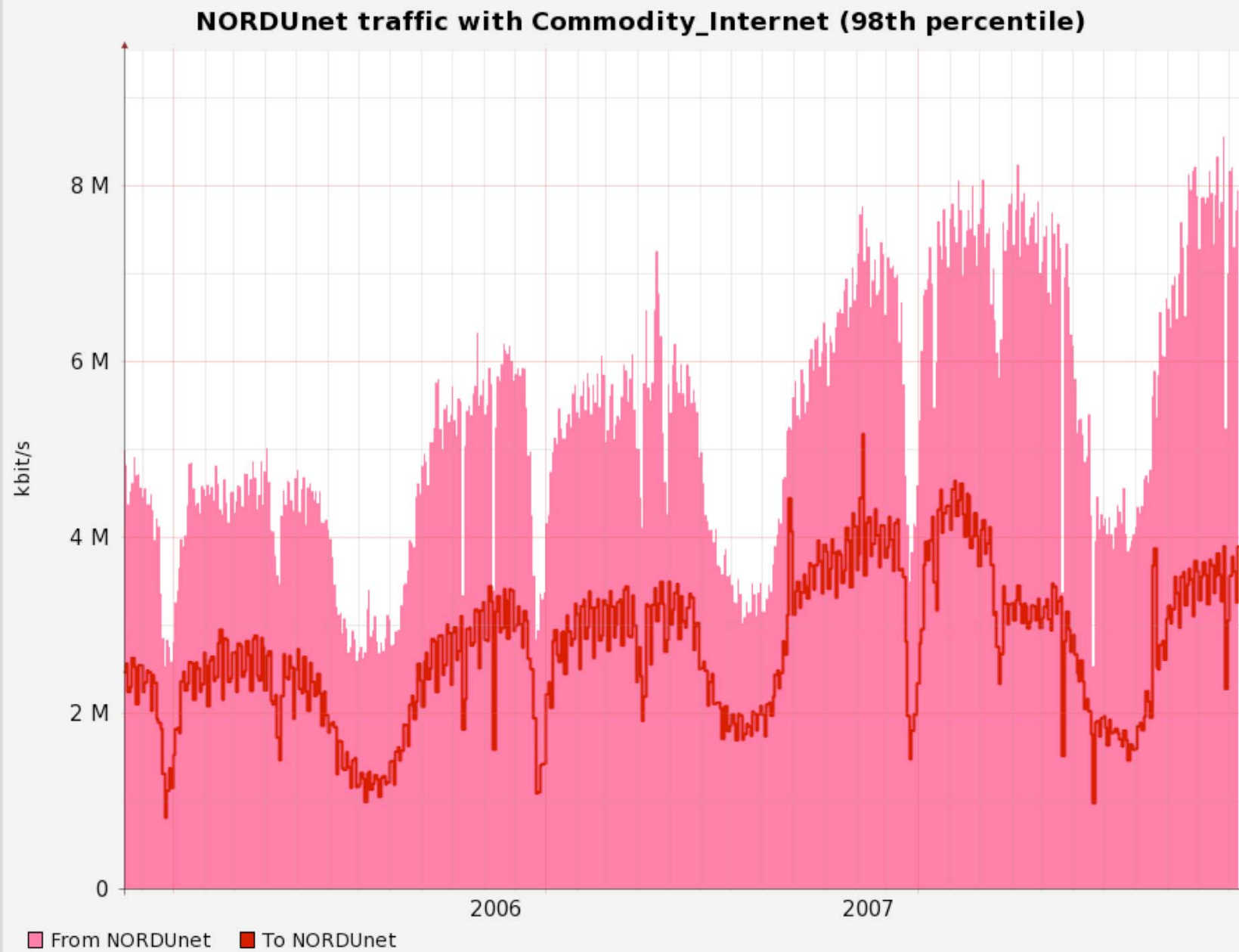- Complete Scope of Ethernet Features

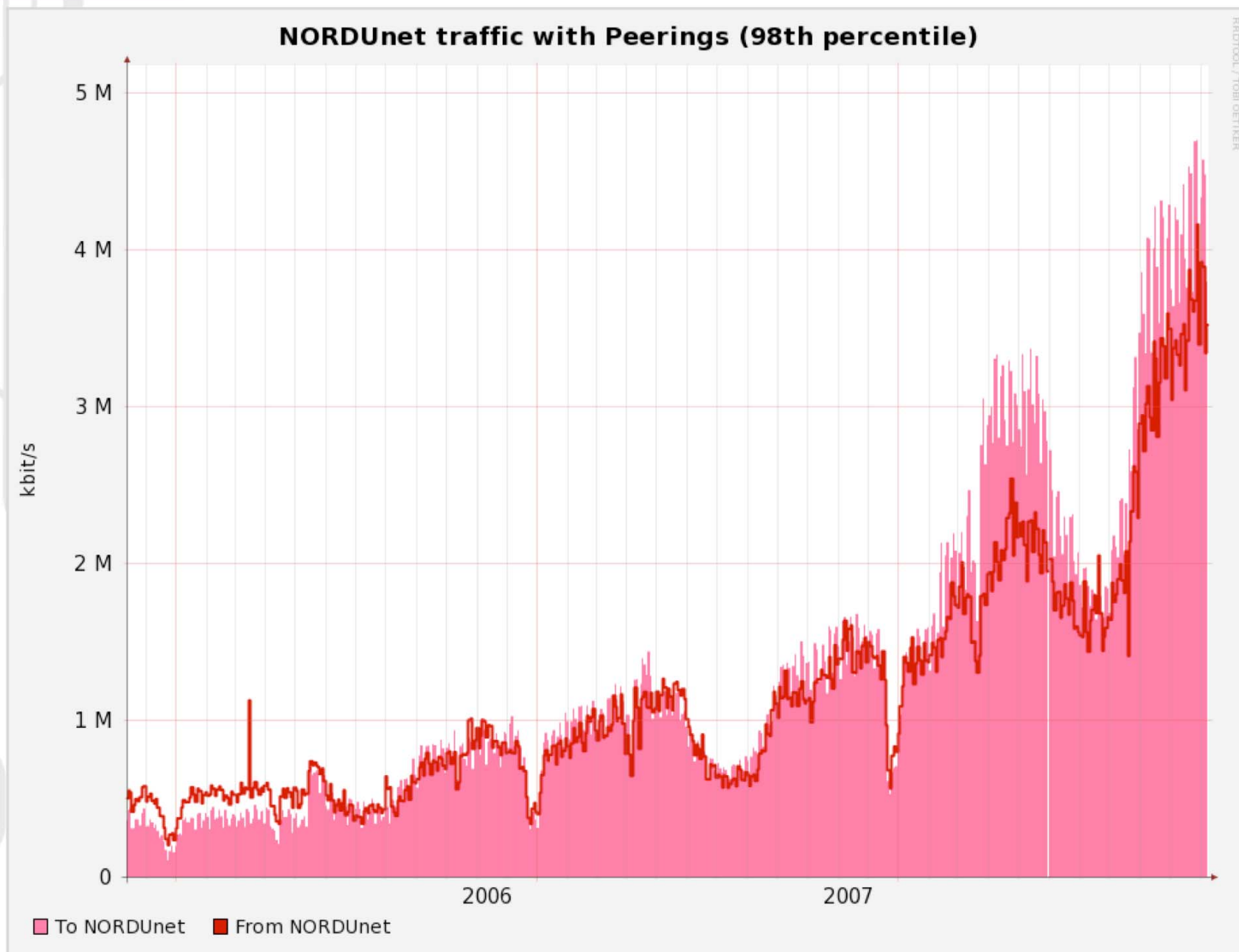## CWDM

- Terminal, Hub, OADM Ring
- Stacked C-WDM Rings

MSPP

- CLI, SNMP and TL1
- 2008 GMPLS feature set

1850 TSS-320

NORDUnet
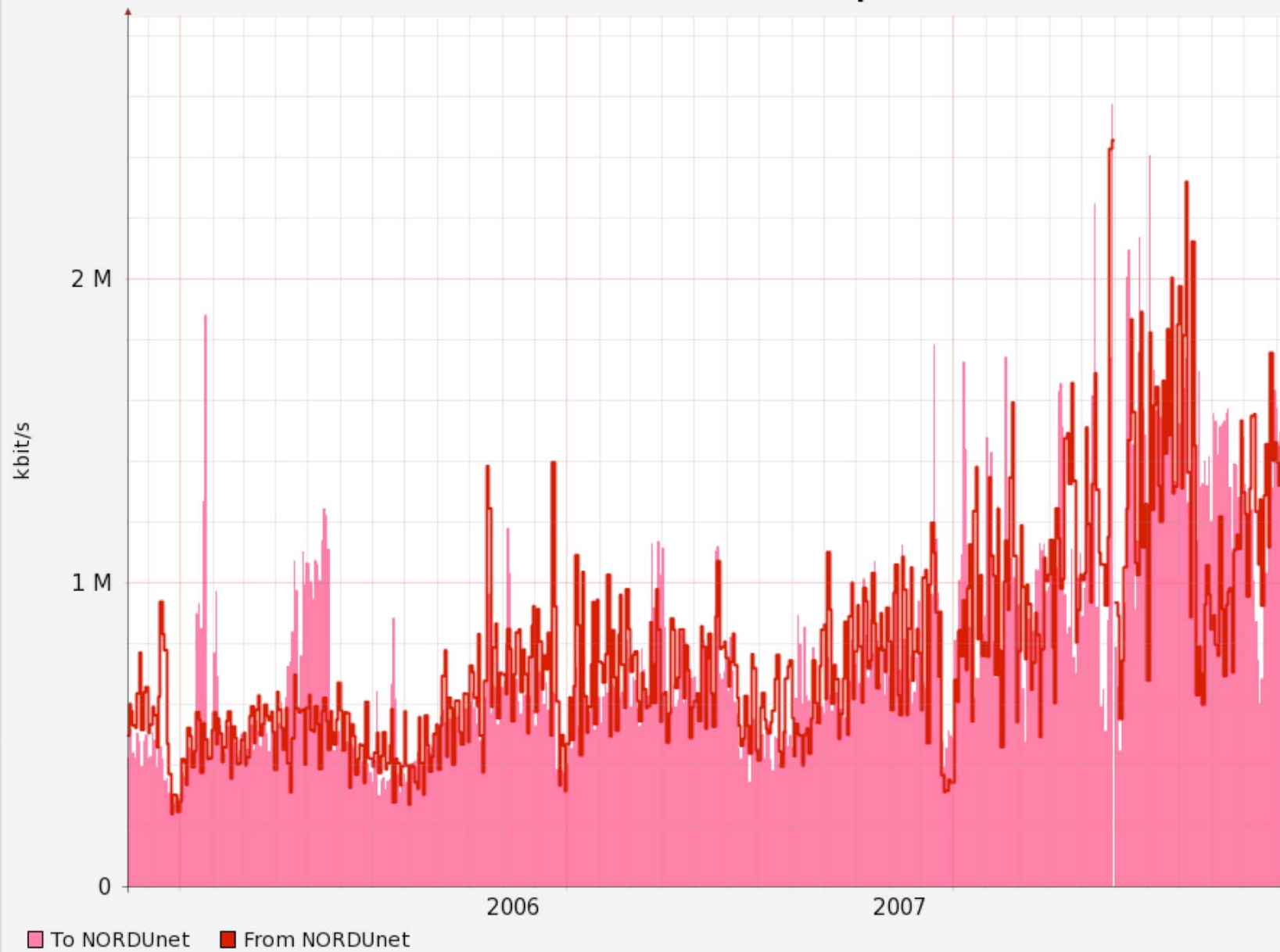**Nordic infrastructure for Research & Education**

NORDUnet IP Network

Map ndn-map for 2008-11-08 showing busy traffic
NORDUnet network configuration

< 100M
100M ->
622M ->
2.4G ->
10G ->
40G ->

Telia
AS3301

Netnod
GE-A

TeliaSonera
AS1299

services

Verizon
EMEA
AS702

Verio

SUNET
AS1653

RBNET
AS5568

RUNNet
AS3267

Google
AS15169

se-tug2

se-tug

se-fre

Netnod
GE-B

UNINETT
AS224

FUNET
AS1741

<100%
<90%
<80%
<70%
<60%
<50%
<40%
<30%
<20%
<10%
<5%
<2%
<1%
<0.5%
<0.2%
<0.1%
<0.05%

VSNL

RHnet
AS15474

Global
Crossing
AS3549

dk-uni

dk-ore

dk-ore2

NDGF
AS39590

Vodafone

Forskningsnett
AS1835

Geant
AS20965

AMS-IX

$Id: ndn-map.obj,v 1.128 2008/10/28 15:15:29 bergroth Exp $

NORDUnet IP Transit

NORDUnet traffic with Commodity_Internet (98th percentile)

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NORDUnet traffic with Peerings (98th percentile)

□ To NORDUnet   ■ From NORDUnet

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Peering Versus IP Transit

In Gbit/sec	2004	2005	2006	2007	2008
IP Transit	3,50	5,00	6,00	7,50	9,00
Peering	0,30	0,50	1,00	1,50	5,00
Total	3,80	5,50	7,00	9,00	14,00
Peering %	7,89%	9,09%	14,29%	16,67%	35,71%

NORDUnet GEANT

NORDUnet traffic with GEANT (98th percentile)

Legend: ▢ To NORDUnet ▢ From NORDUnet

y-axis: kbit/s (0, 1 M, 2 M)
x-axis: 2006, 2007

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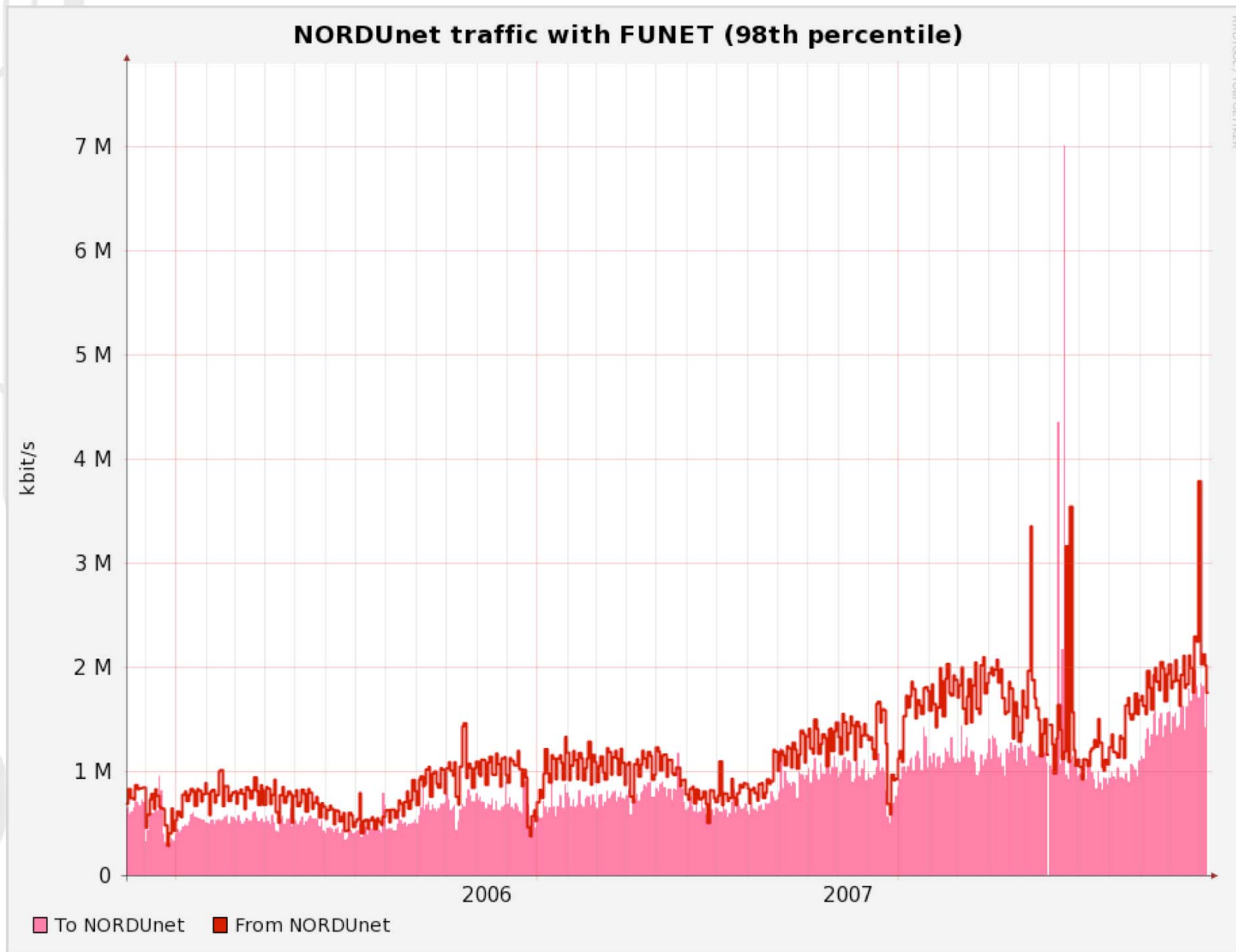

NORDUnet traffic with FUNET (98th percentile)
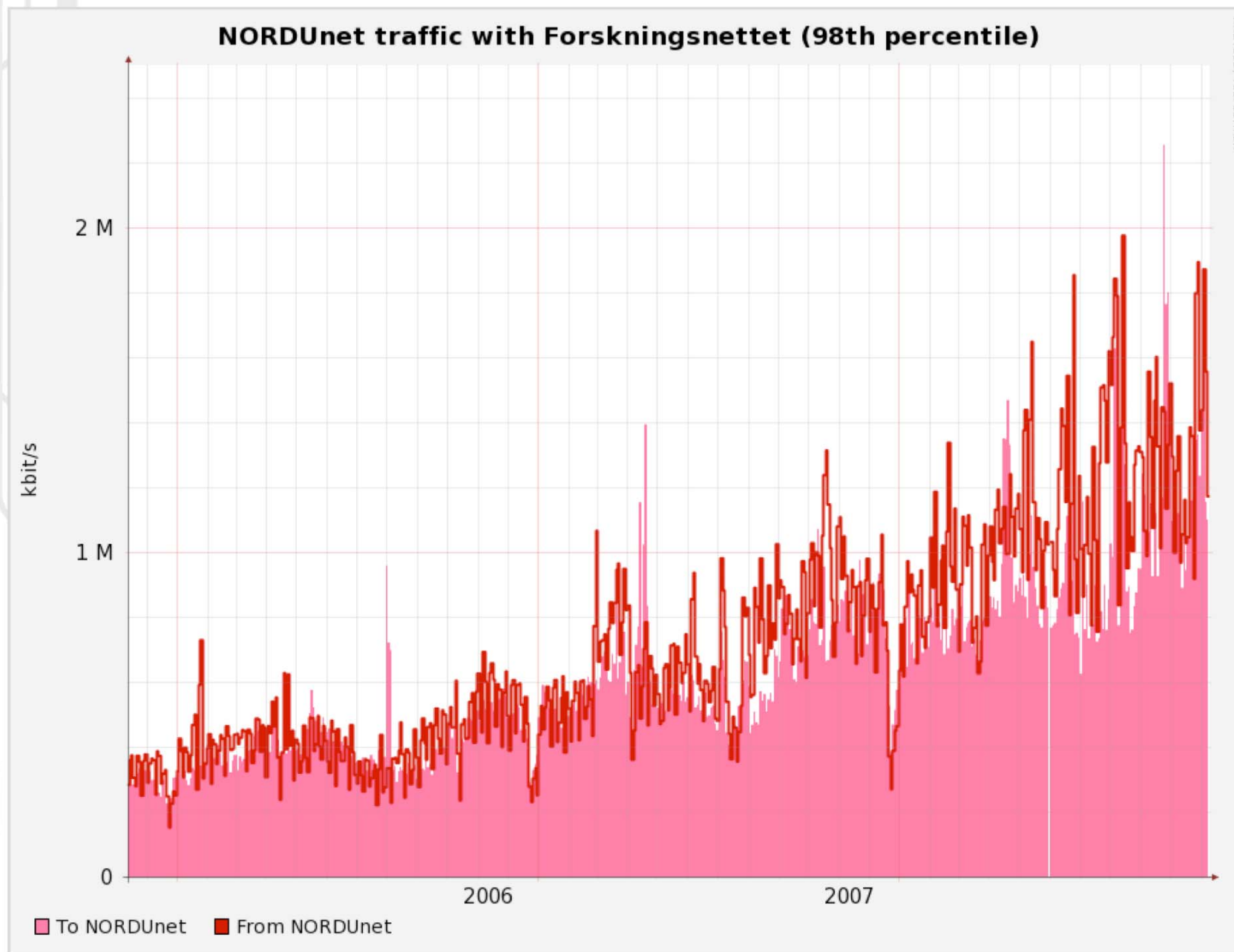
# NORDUnet Status
A couple of examples

- Medical Media HD Live Transmission
  - From Seoul, Korea to Trondheim, Norway
  - Test technologies for HD live medical surgery transmission
  - Viewing laparoscopy surgery in High Definition Video enable doctors to collaborate, learn, and see details normally not available
- Video Streaming
  - 800 Mbps, low jitter required
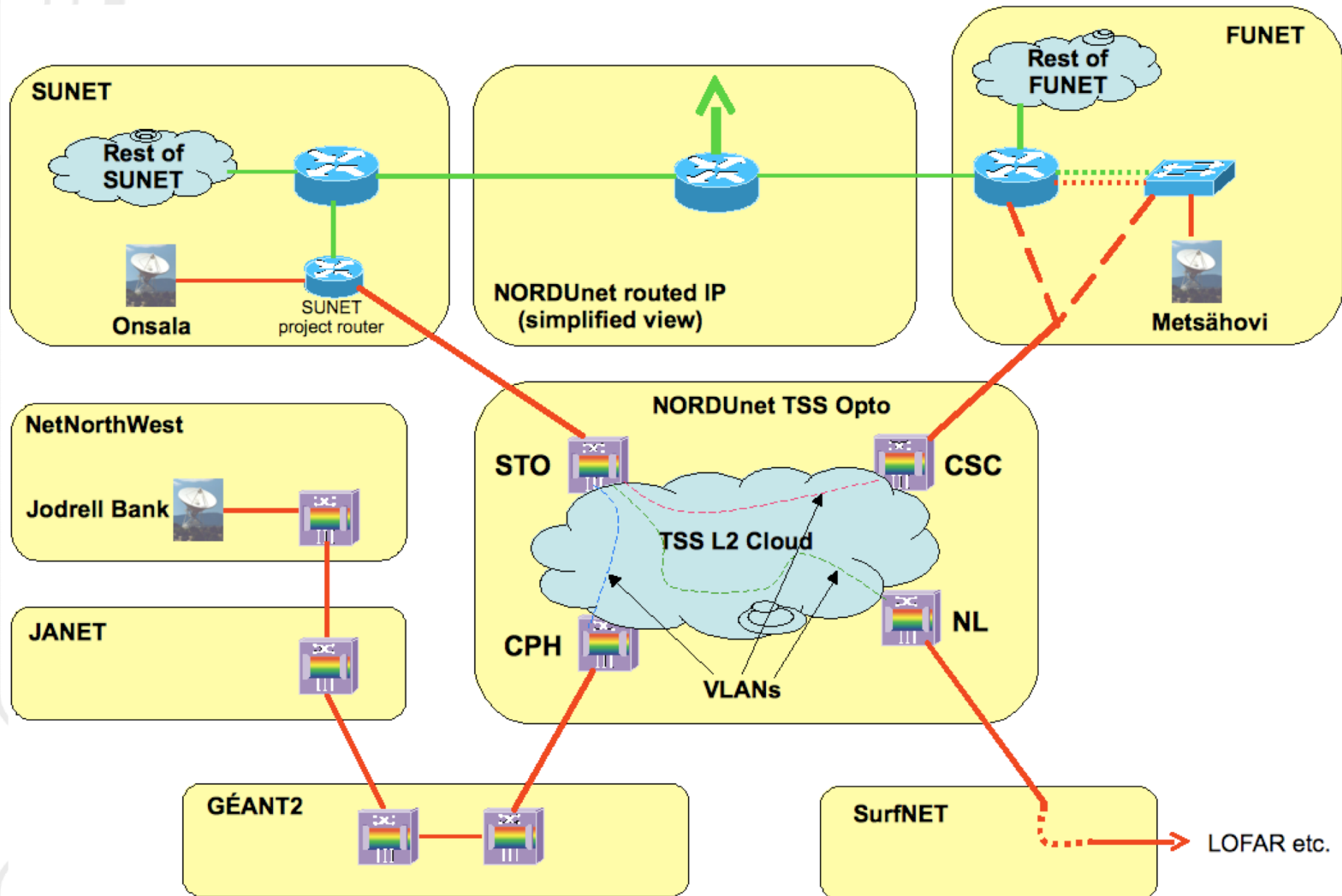 - Dedicated 1 GE link Norway – Korea provide by collaboration in GLIF

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The Results

HD Output
GW→NE

1GE Network Port

BNC cable
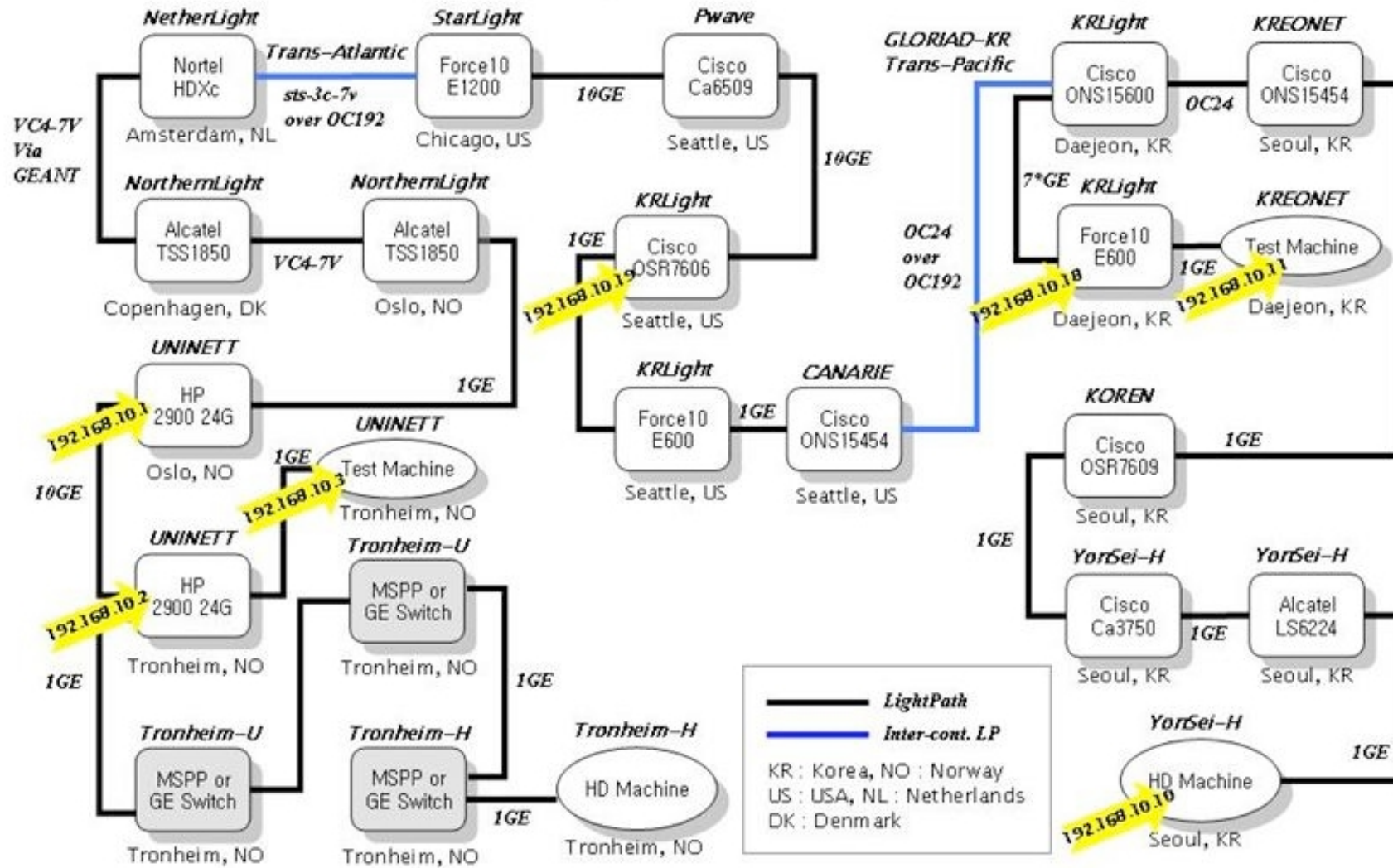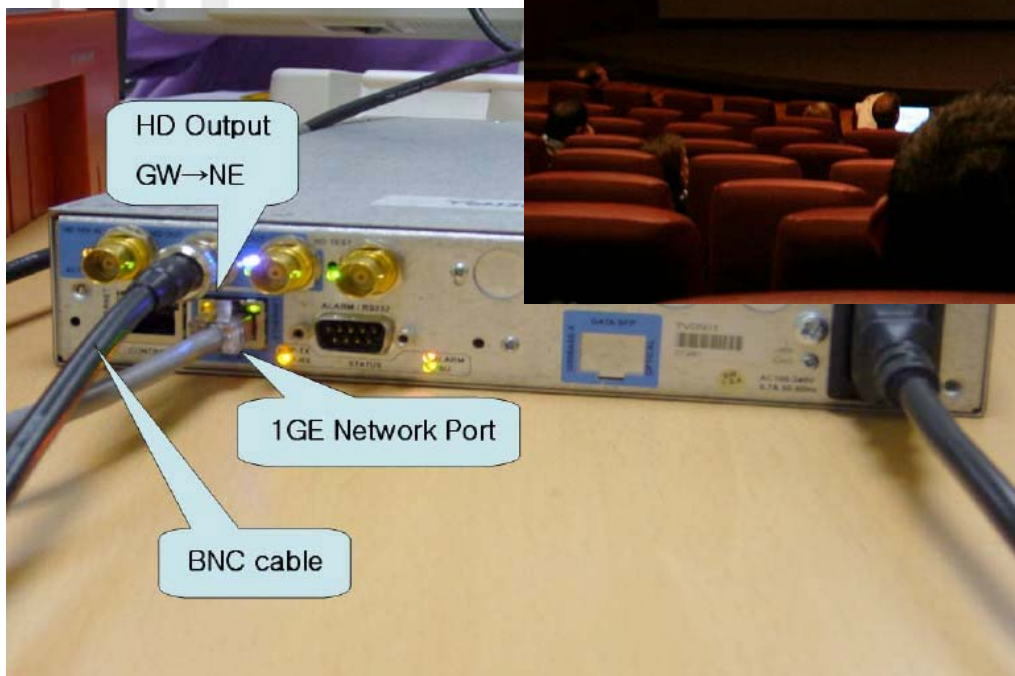
Network status as per 2007-08-21. Image created by Paul Boven <boven@jive.nl>. Satellite image: Blue Marble Next Generation, courtesy of Nasa Visible Earth (visibleearth.nasa.gov).

- Collaboration between KTH and Keio University, Japan
- Challenge
  - Stream the Kyoto price ceremony, live, from Kyoto to Stockholm, using 4k video (Nov. 2007)
  - Use Sony projector, NTT encoder / decoder
- 4k video – cinema quality
  - 4096 x 2160 pixels – 4x HDTV 1080p
  - Uncompressed 4k = 8.6 Gbps
- 10G circuit provisioned in two weeks
  - GLIF resources, GOLE-to-GOLE
  - Across Pacific, North America, Atlantic, N. Europe

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NORDUnet IPTV Trial

- Analogue and is discontinued on many places.

- Customers looking for alternatives, Sat & IPTV

- Utilize NORDIC Wide distribution network for TV / Content Distribution

  - Step one: IPTV

  - Step two: Content on demand

- Gain Experience with respect to technical & political issues relating to TV / Content distribution.

- Test NORDUnet Multicast Capabilities

- Project Start Q1 – 2008 Was intended for local NORDUnet experience gathering but significant Nordic Interest.

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- Geographical Rights paradigm

- Vendor used to small Neighbor networks

- Many vendors have base in TV not in Networks.

- Limited vendor skill set on large Public IP based networks.

- Multiple Network paradigms

- HW versus SW Client

- Encryption

- JANET, Canarie & US in Front
  - http://www.inuknetworks.com/janet.html
  - http://www.freewire.co.uk

Network Expansion 2009

Icelandic Connectivity

- Upgrade of Core IP Backbone to 40 Gbit
- Upgrade all NREN connections to 10 Gbit
- New Network Projects:
  - CPH – LON
  - Iceland – Greenland – US
  - CPH – US
  - CERN Redundancy
  - CBF:
    - Hamburg – Poznan
    - Helsinki – Sct. Petersburg (Moscow)
- Peering:
  - LINX
  - Ashburn

Network Evolution Trends

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- Federated networks built from NREN facilities:
  - Cross Border Fibers
  - Lightpath Exchanges
- Collapsed backbone topology
- Dynamic Circuit Networking
  - From static configurations to tunable lasers and filters
  - Wavelength Selector Switches for flexible routing of entire lambdas in the optical domain
  - Alien waves – for inter-domain lambdas
  - Dynamic configuration that allows control plane systems to alter lambda routes "on the fly"
- Transmission:
  - Multi-domain WSS 40G,
  - 100G trials
- Virtualization (logical routers, service oriented middleware, cloud computing ..)

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NORDUnet Projects

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GEANT 2

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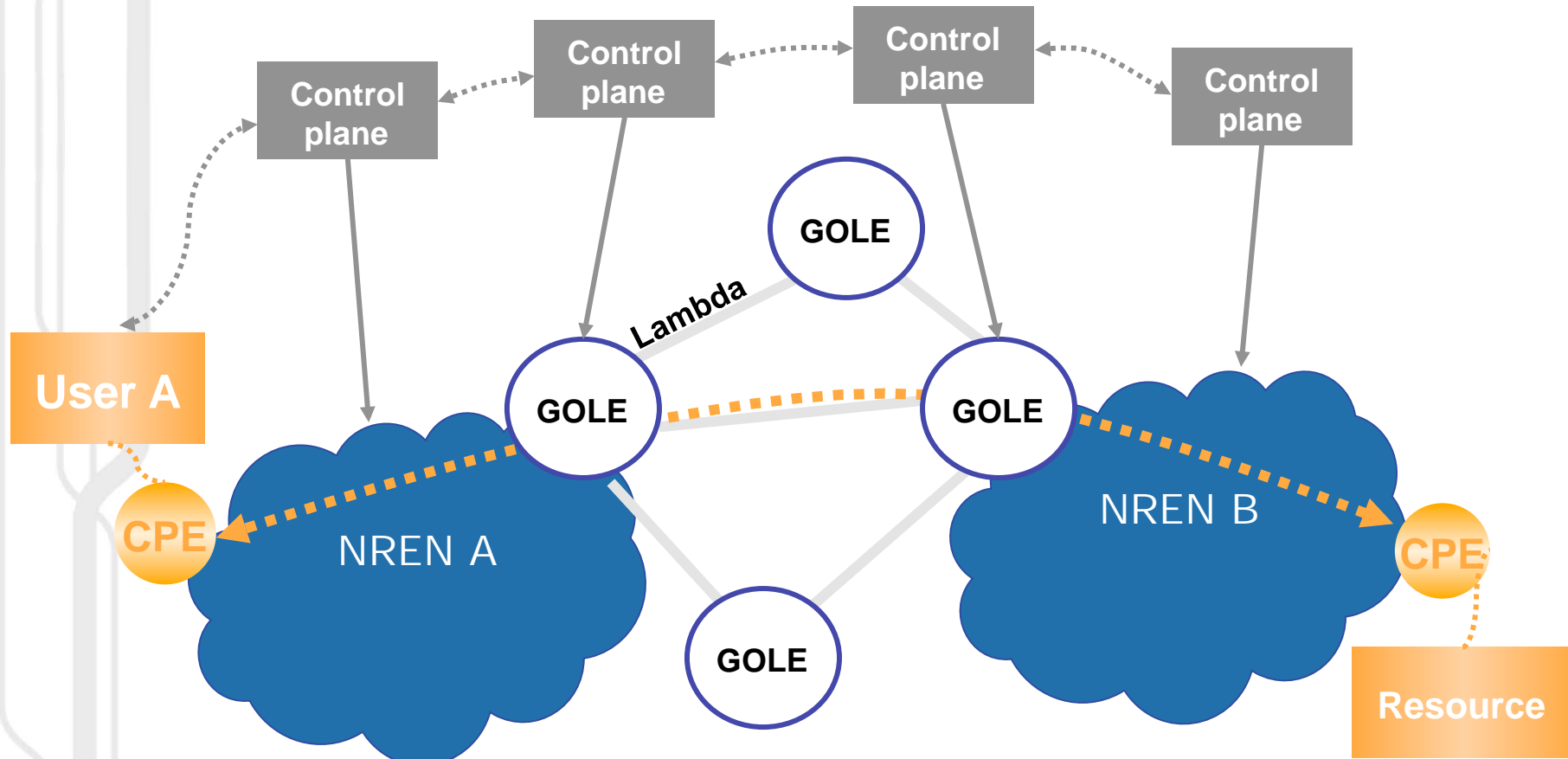
- Introduction of hybrid networking
  - NORDUnet, national networks
- Nordic contributions to
  - PerfSONAR - UNINETT
  - Eduroam – SUNET, Forskningsnet
  - EduGAIN – SUNET, UNINETT, CSC UNINETT award for simpleSAMLphp
  - Participation by NRENs, coordination through NORDUnet
- 8,5 Mann Year Equivalent
- Funded by NRENS and EU (APPROX 45%)

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- 30+ countries collaborating
- The centralists vs. the collaborators:
  - Different priorities,
  - Different ambitions,
  - Different economies,
  - Different strategies,
  - Different tradition,
- Resulting in constant conflict and compromises
- Substantial funding from the EC:
  - To entice collaboration and bridge to the digital divide
  - But for how long ?

- NREN Paradigm shift
  - European NREN's Switched form Leased capacity to NREN owned dark fibre in many European countries
  - NREN owned cross-border fibre
  - NREN owned international connections
- GN2 is now a parallel infrastructure in many regions.

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GEANT 3

- Initiated September 2007 with two task forces
- GN3 Membership Committee
  - Artur Binczewski (*PSNC.PL*), Thomas Brunner (*SWITCH.CH*), Dai Davies (*DANTE*), Jan Gruntorad (*CESNET.CZ, Chair*), SabineJaume-Rajaonia (*RENATER.FR*), Karel Vietsch (*TERENA*)
- GN3 High Level Technical Strategy
  - Erik-Jan Bos (*SURFNet.NL*), Mauro Campanella (*GARR.IT*), Hans Döbbeling (*DANTE*), Lars Fischer (*NORDUNet*), David Foster (*CERN*), Vasilis Maglaris (*NREN PC, Chair*), Dorte Olesen (*TERENA*), Roberto Sabatino (*DANTE*), Afrodite Sevasti (*GRNET.GR*)
- Rules of membership, categories (December 2007)
- Green Paper (March 2008)
- White Paper (July 2008)

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Project Members
New Project Members
Associate Partners

Russia

Belarus

Ukraine

Moldova

Serbia

Montenegro

FYR of Macedonia

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- To create an innovative multi-domain hybrid networking environment, using advanced transmission & switching technologies

- To enable R&E users through their Organizations with flexible and scalable production quality services via their constituent NRENs

- To be an enabler for Global R&E networking supporting international e-Science initiatives, creating a Global Virtual Village to house researchers & educators around the world

- To contribute to standards as a key participant in European & Global efforts towards the Network of the Future

White paper highlights

- Innovative multi-domain hybrid networking infrastructure

- Coordinated user services: seamless access to services, computing, storage across multiple domains, identity management, mobility.

- Multi-domain nature: services must be established across confederate (loosely couple) domains: Campuses, NRENs, and International.

- Collaboration and Federation: use of NREN resources, work closely with GLIF, open exchange points international peers

- Networks of the future: facilitate development and experimentation, testbeds, testing transmission and switching technology, novel multi-domain services and protocols.

- Strong NREN involvement: lead by NRENs, executed by NRENs

- Bridging the digital divide, advanced and affordable services for all of Europe

See the entire document at wiki.nordu.net

GN3 Proposal Structure

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Promote, Liaise & Study

Explore & Develop

Create & Operate Services

NA2 Promote

Coordinate Administrate
NA1 Manage

NA4 Liaise

NA3 Study

Control & Mgmt Provisioning
JRA1
Control & Mgmt Provisioning

Control & Mgmt Provisioning
JRA2
Security Network Factory

Access Control Identity
JRA3
Composable Services

Backbone & Global Links
SA1
Cost Shared Common NREN Network

Multi Domain Connectivity
SA2
Services to Institutions

Roaming & Identity
SA3
Services to Individual End Users

Software Governance
SA4
Development Environment

NA's: Networking Activities

SA's: Service Activities

JRA's: Joint Research Activities

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GN3 Network Architecture

- GN3 will initially use GEANT2 while developing a new network architecture

- GN3 network architecture workgroup to be formed in late October 2008, and deliver first report in February 2008.

- Work to take into account experience from GN2, international experiences, recent technology developments

- Architecture to stress cost efficiency, use of NREN resources, collaboration, federation

Nordic contributions

- Stronger role than for GN2
  - NRENs and NORDUnet

- Contributions to:
  - Optical networking, technology trials
  - Hybrid networking, development and deployment of provisioning platform, inter-domain facilities
  - Roaming, Identity management
  - Network monitoring & measurement
  - Campus best practice initiative
  - Environmental Impact initiative

- A total of 46 man-years over 4 years
  - One of the largest partner contributions

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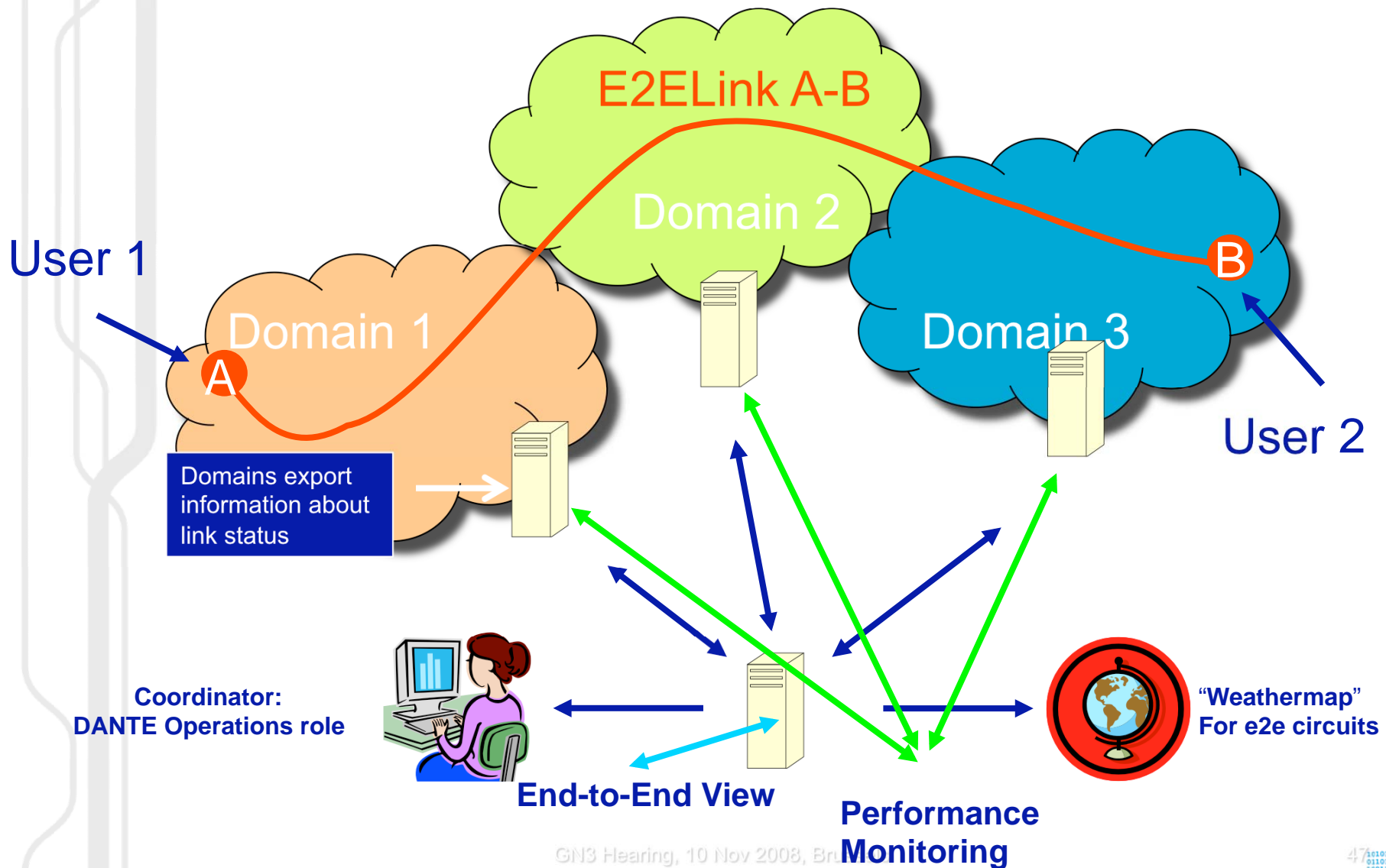
- Extend the NREN & GÉANT service model to provisioning of e-Infratructure for R&E:
  - Multi-domain hybrid networking services
  - Virtualization of computing and network resources
  - Storage & computing services
- Converging e-Infrastructures
  - Relationship with Grid, HPC, Cloud computing
  - We may have different technologies and multiple organizations, but users are expecting a single, coherent, European infrastructure
  - Provide foundations: connectivity, network management, network provisioning, mobile access, identity management

NORDUnet Outreach

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- # International Research Initiatives
  - GENI – http://www.geni.net/
  - CINEGRID – http://www.cinegrid.org/
  - DCN (Internet2)
  - 40 Gbit Long Distance trials

- # Workshops:
  - DCN – For Management
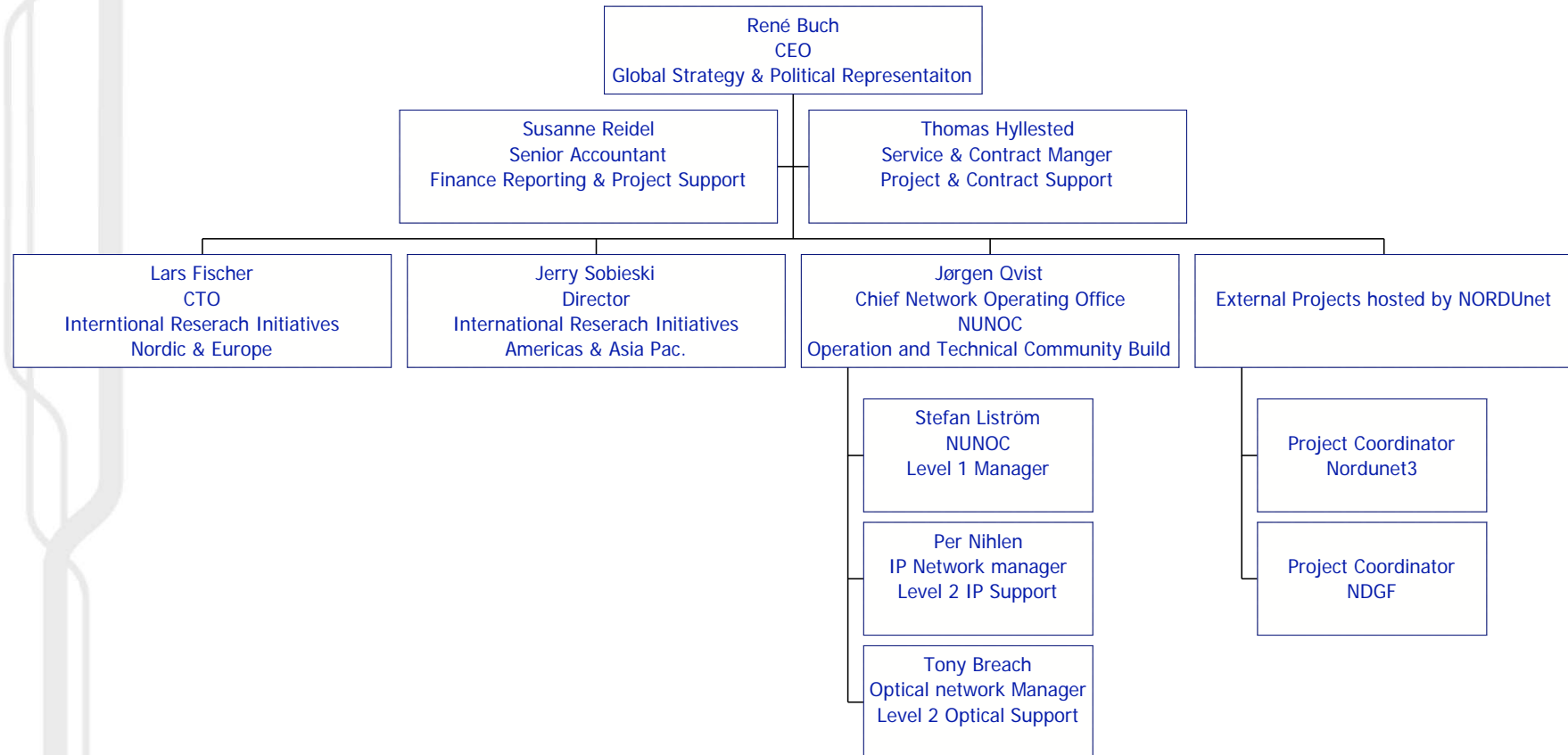 - DCN – For Techies
  - Autobahn

International Research Initiatives is focusing on:

- Being the main driving force in expanding the International Research Collaboration between the Nordic Countries and global key Research Initiatives and evangelizing the achievements of the Nordic NREN Community and the benefit of working with NORDIC Scientists.

- Knowledge Transfer

- Working with global partners facilitating potential projects, contacts and research initiatives to the Nordic NREN community within:
    - eInfrastucture
    - Global Network integration and Network Provisioning Research
    - GRID
    - AAI
    - eScience
    - Astronomy
    - High Energy Physics
    - Environmental Research

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NORDUnet Key Contact Point

NORDUnet
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Thomas Hyllested
Service & Contract Manger
Project & Contract Support

Lars Fischer
CTO
Interntional Reserach Initiatives
Nordic & Europe

Jerry Sobieski
Director
International Reserach Initiatives
Americas & Asia Pac.

Jørgen Qvist
Chief Network Operating Office
NUNOC
Operation and Technical Community Build

External Projects hosted by NORDUnet

Stefan Liström
NUNOC
Level 1 Manager

Per Nihlen
IP Network manager
Level 2 IP Support

Tony Breach
Optical network Manager
Level 2 Optical Support

Project Coordinator
Nordunet3

Project Coordinator
NDGF

http://www.nordu.net/ndnweb/the_nordunet_team.html

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