The Weakest Links in the Fastest Nets...
...Need Fixing First

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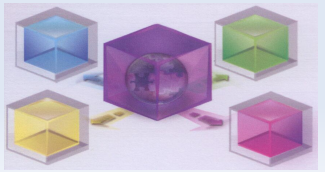
NORDUnet
Nordic Infrastructure for Research & Education



Erik-Jan Bos

- Datacoms consultant with a few years of experience in the NREN world
- First foot on Iceland: NORDUnet2003 and GLIF in August 2003

- Thankful to Eyjafjallajökull

  (more later)

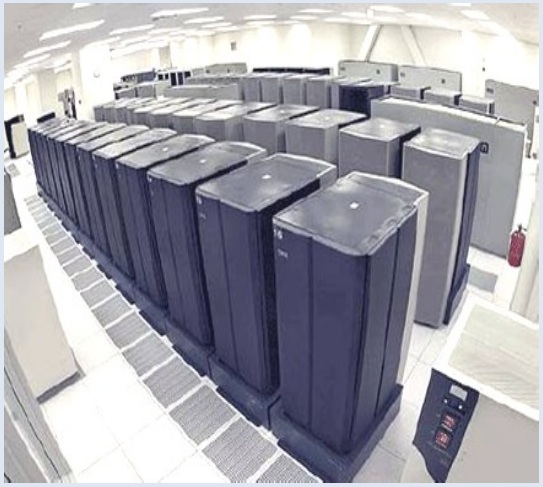
- The opinions and errors in this presentation are mine, and not necessarily those of one or more of the organisations mentioned on the previous page.

Introduction

- (N)RENs have come a long way, 20+ years
- Strong networks on continents
- Weak interconnection between continents
- How does this landscape look?
- And what are our challenges?

New research → New Network Requirements

- Explosion in the amount of data from experiments and simulations (Challenge #5 from Rene Buch)
- Need for near real-time processing of very large datasets
- Increase in remote collaboration:
  - Distributed sensors
  - Shared computing and storage grids
  - Virtual teams, virtual organisations
  - Accessing cloud services in a seamless way



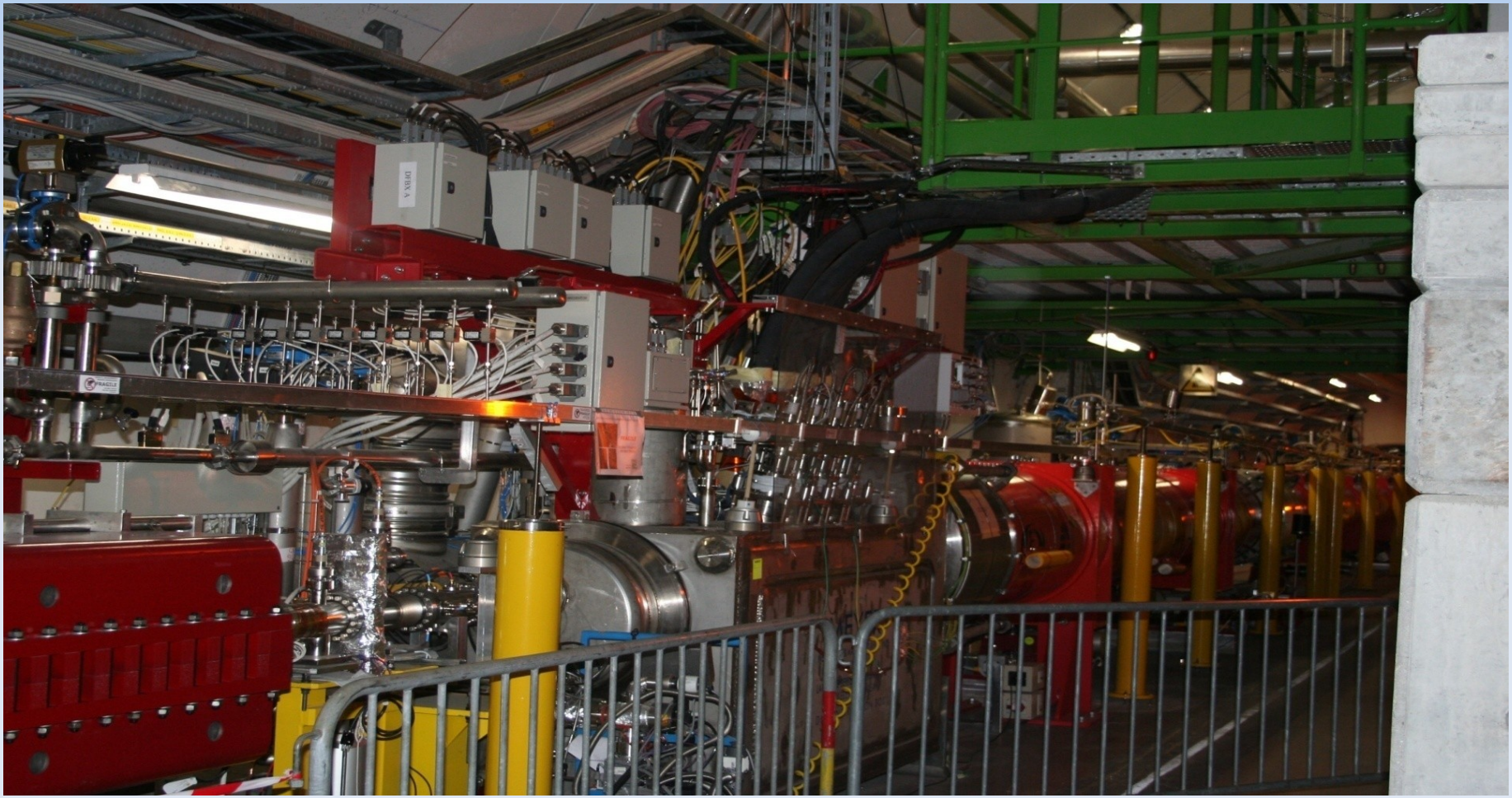
Example of Data Intensive Science: IJkdijk, Sensors in Dikes

- First controlled dike breach in September 2008
- 30.000 sensors (microphones) needed for the Dutch dikes

Example of Data Intensive Science: e-VLBI, a radiotelescope the size of the earth

Image by Paul Boven (boven@jive.nl). Satellite image: Blue Marble Next Generation, courtesy of Nasa Visible Earth (visibleearth.nasa.gov).

Example of Data Intensive Science: Large Hadron Collider: ~20 Pbyte/year

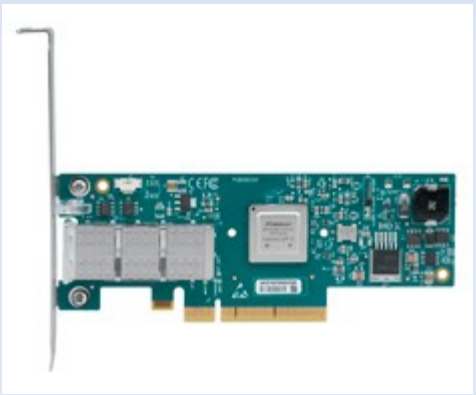


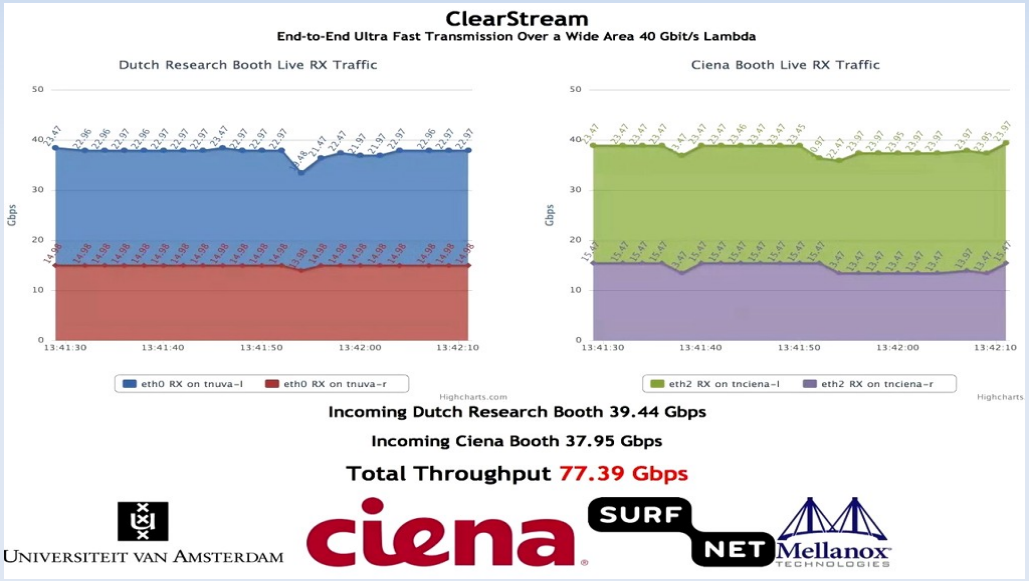
Example of Data Intensive Work: Academy of Motion Picture

- More than 2 Pbytes for one entirely digital movie production
- Expected: 5 Pbyte/week = 250 Pbyte/year

Example of Data Intensive Experiment: ClearStream: 40G data transport over 1600+ km

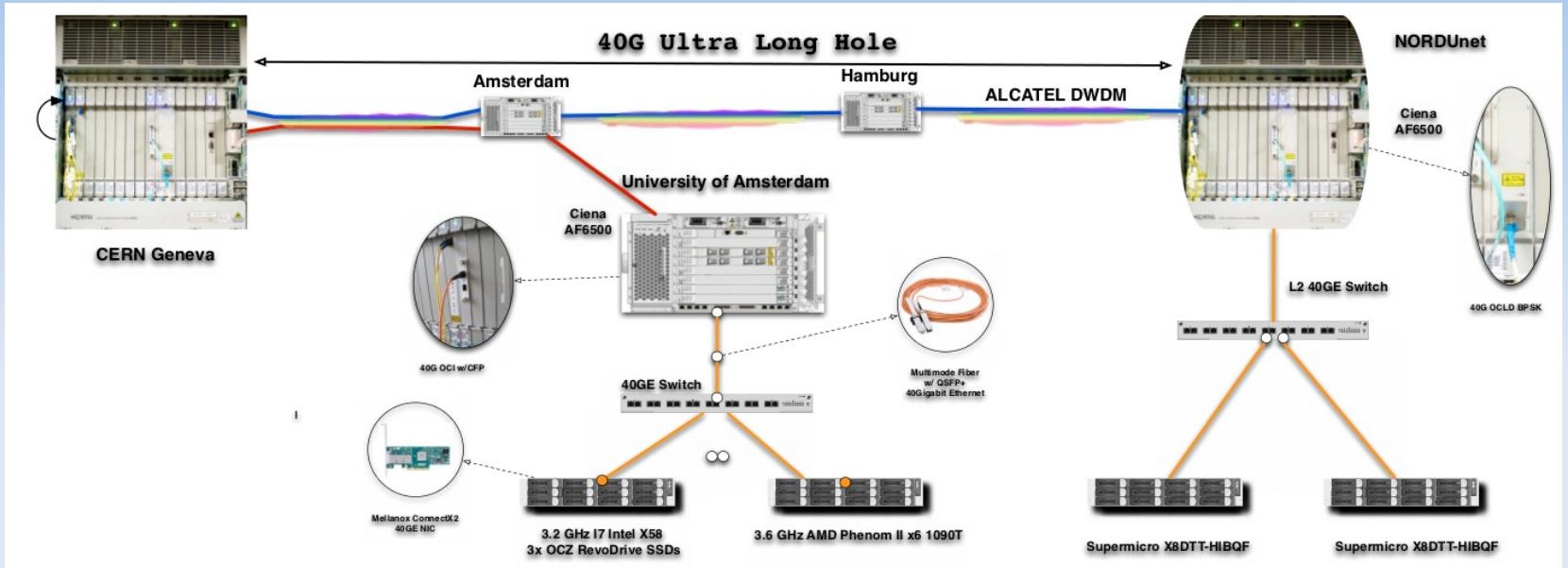
- 1600 km dark fiber, Ciena 40G optics, Mellanox PCI cards: http://ext.delaat.net/posters/2010-11-11-ClearStream-sc.pdf





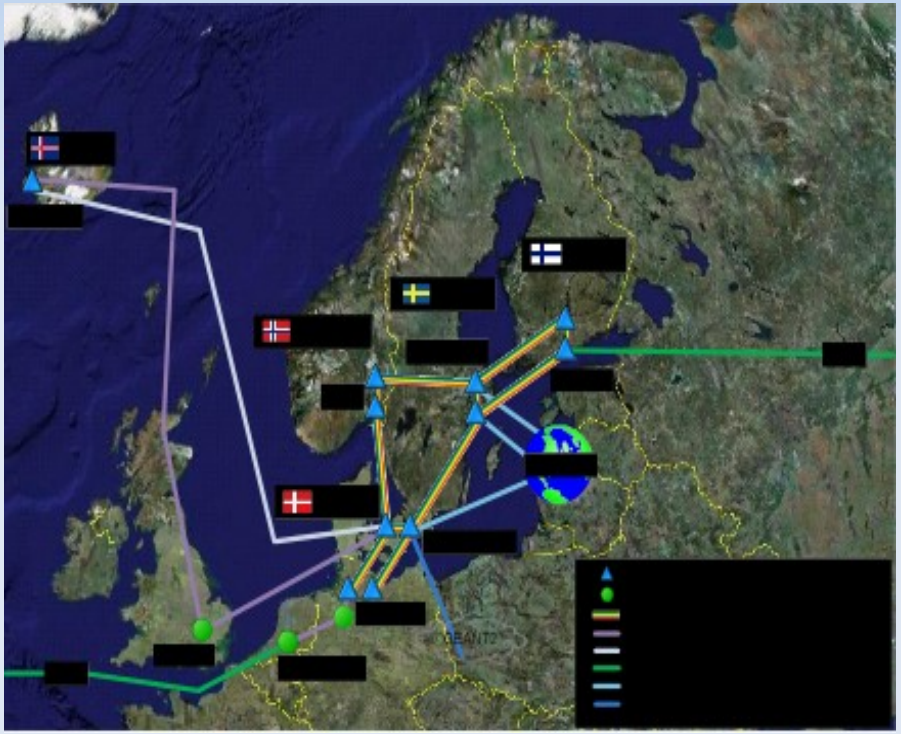
- Thank you, Eyjafjallajökull, for locking up CdL and EJB

ClearStream: 10G long-haul boundary gone (@TNC2011)



- Cross-border fiber, lit with 40G SURFnet Ciena and NORDUnet Alcatel-Lucent photonics gear
- 40 Gbit/s lambda, 4400 km, partly as alien wave
- Pushing data at 25+ Gbit/s core to core
- http://tnc11.delaat.net/

NORDUnet: Serving the 5 Nordic countries

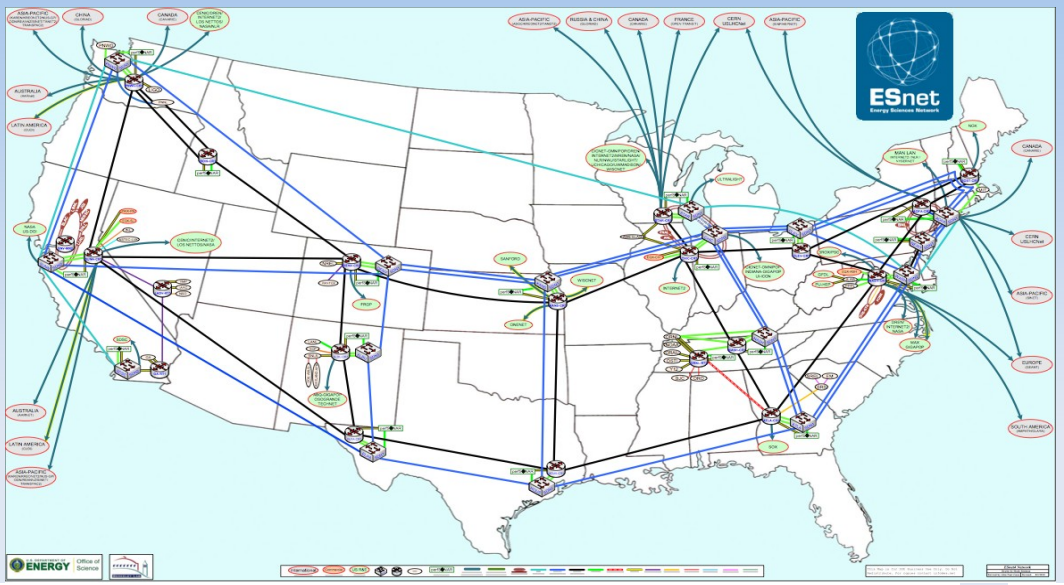


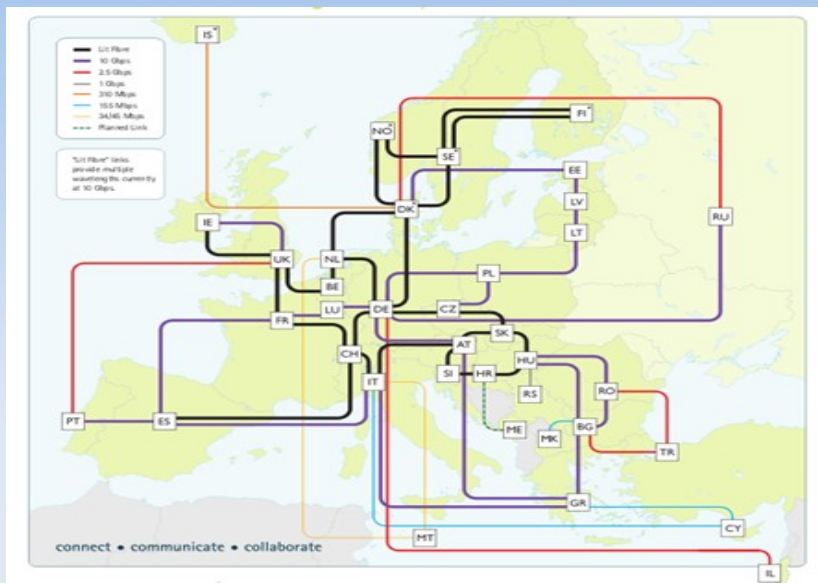
- Fully resilient photonic network
- Based on dark fiber
- Delivering IPv4, IPv6 and lightpath services
- Well connected to other regions

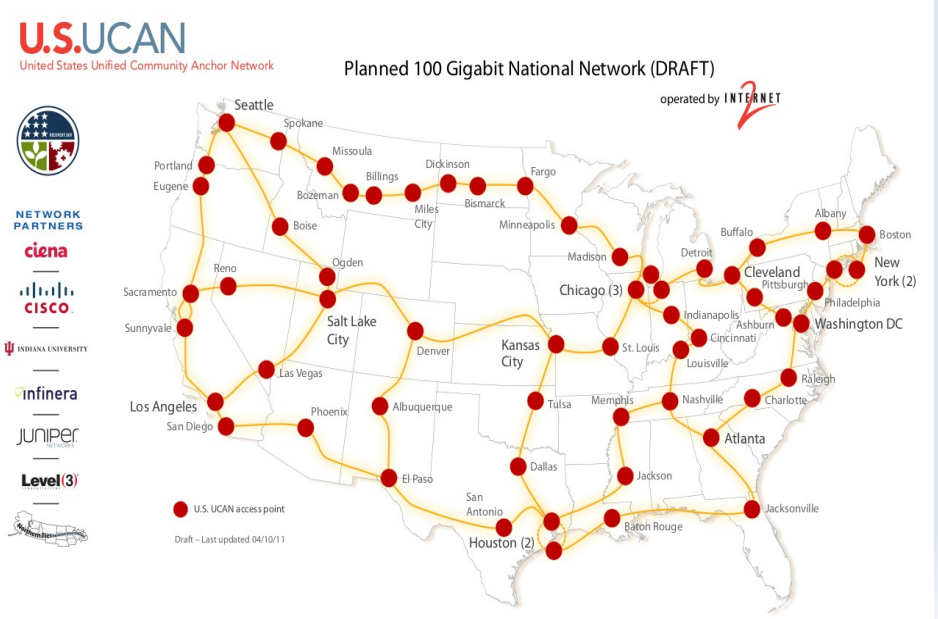
SURFnet: End-to-end hybrid network

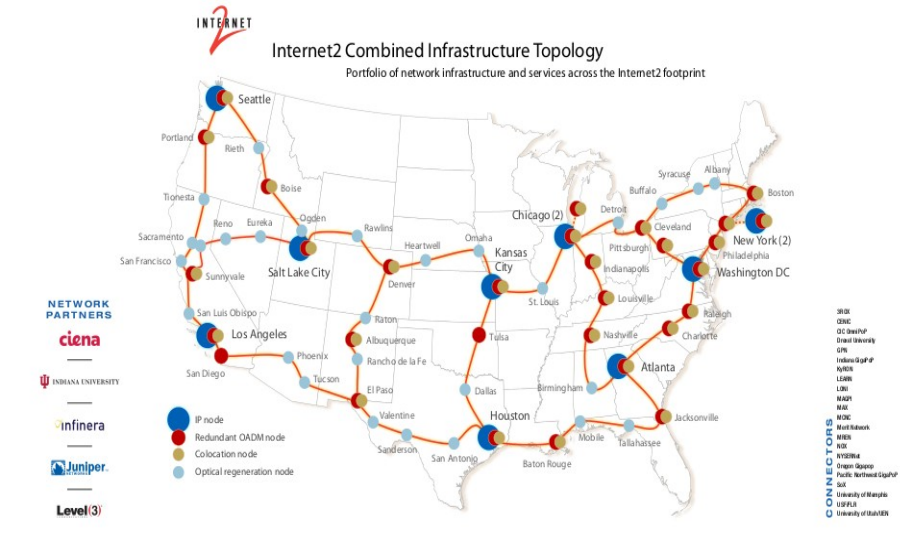
- 11.000+ km managed dark fiber
- Own photonic network
- Network Services:
  - IPv4 and IPv6
  - Fixed and dynamic lightpaths
- Collapsed IP backbone with routers at only 2 location

ESnet, GÉANT, Internet2's Combined and US UCAN Planned networks







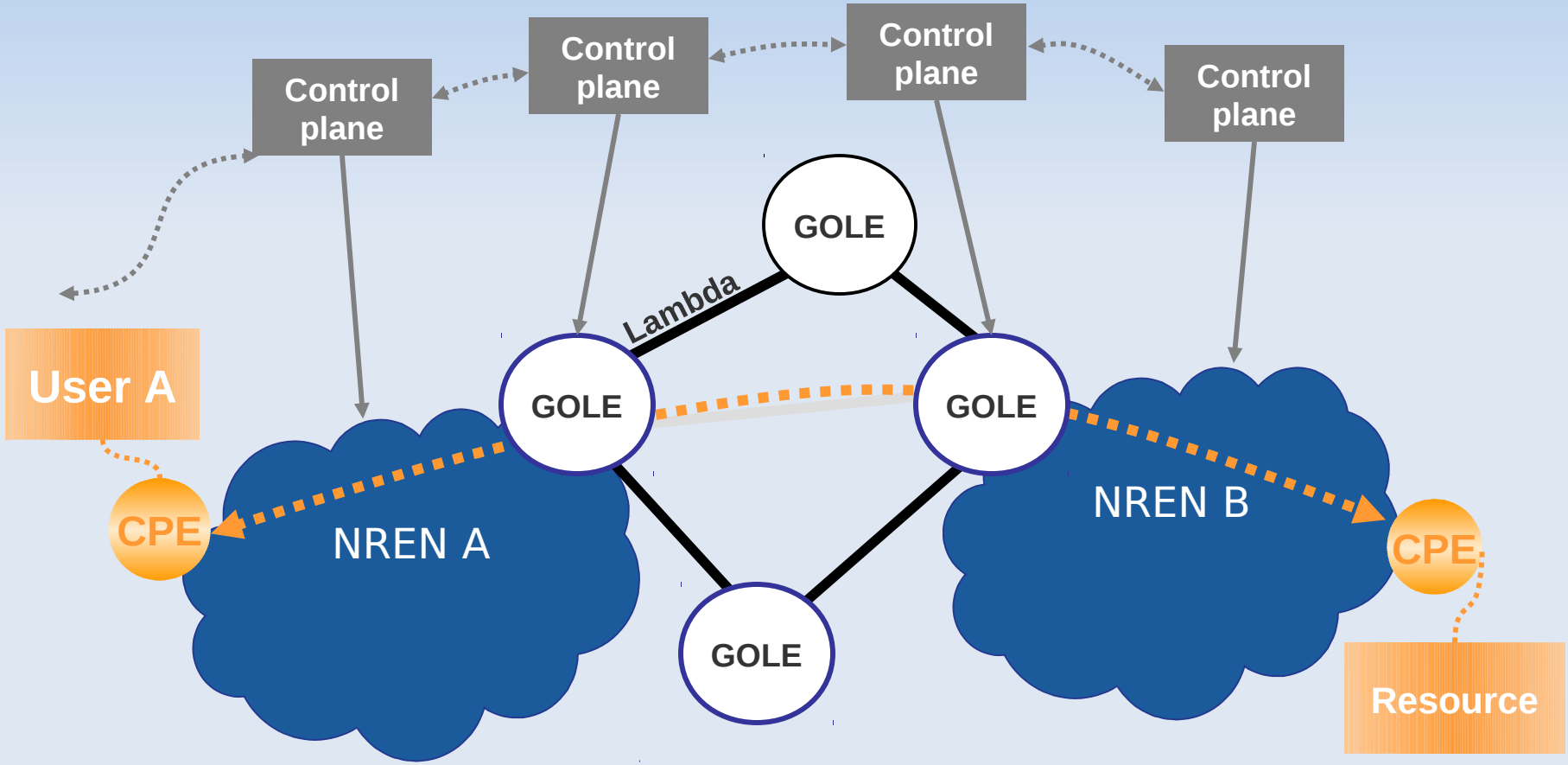


Hybrid end-to-end network: Lightpaths

- Dark Fiber is the basis for building research infrastructures
- Lambdas form the building block for high capacity research networks
- Lightpaths are full lambdas or a dedicated part, for end-to-end, high bandwidth data transport with fixed characteristics

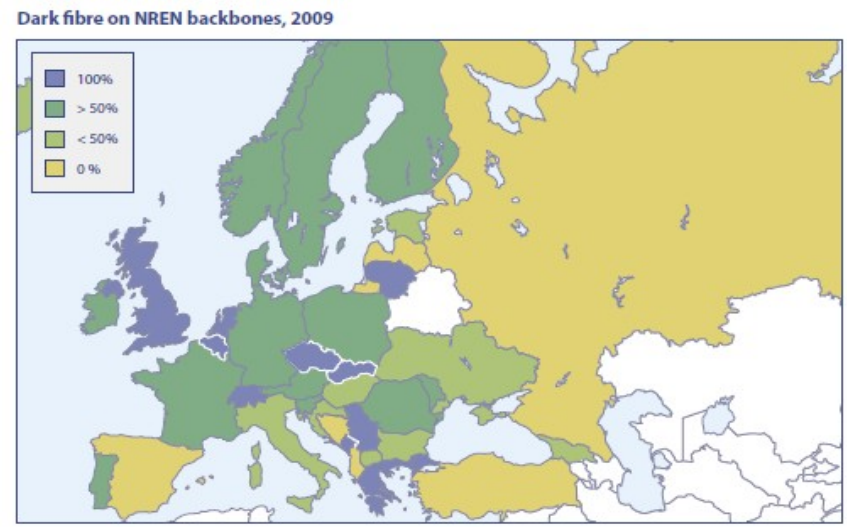
- Fixed lightpath: always on
- Dynamic lightpath: under control of users and their applications

Advanced approach to lambda networking



NREN owned and operated dark fibers

NREN backbones
on dark fiber



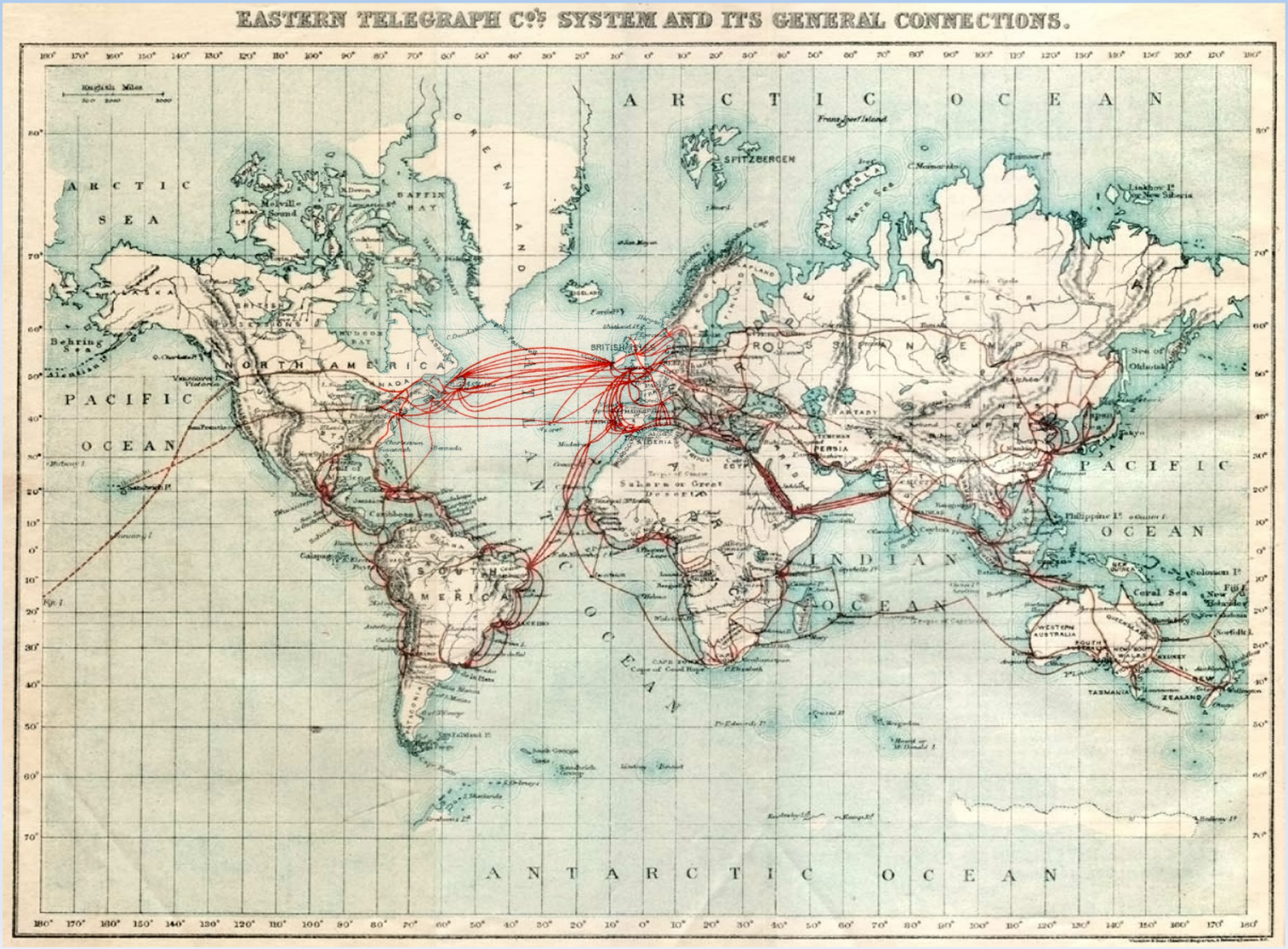
Source:
TERENA
Compendium
2009

NREN
owned and operated
Cross Border Fiber

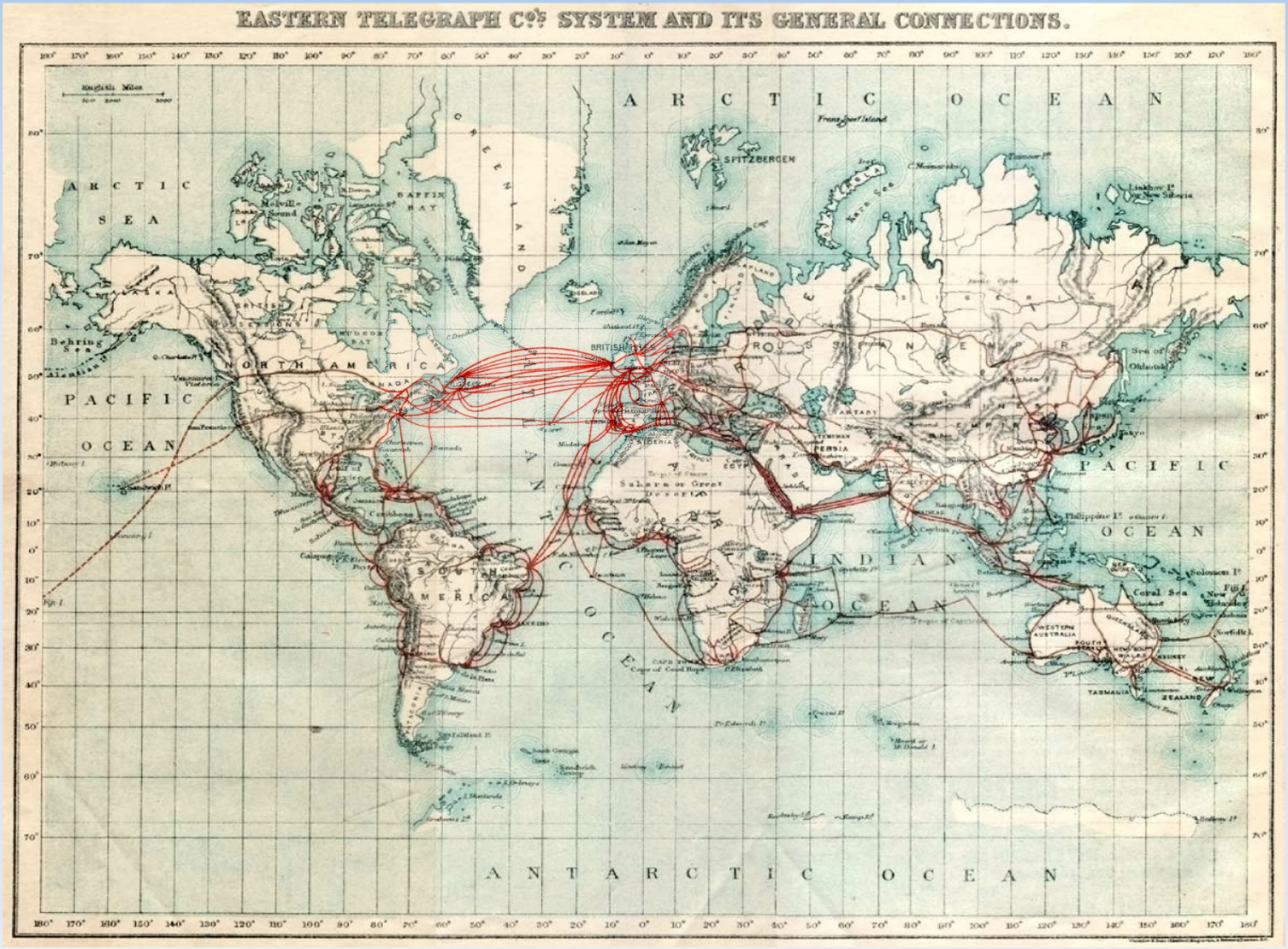
Strong and Weak links

- Strong:
  - Photonics developments
  - Processing power
  - R&E Networks' infrastructures
  - Open Exchanges gaining momentum

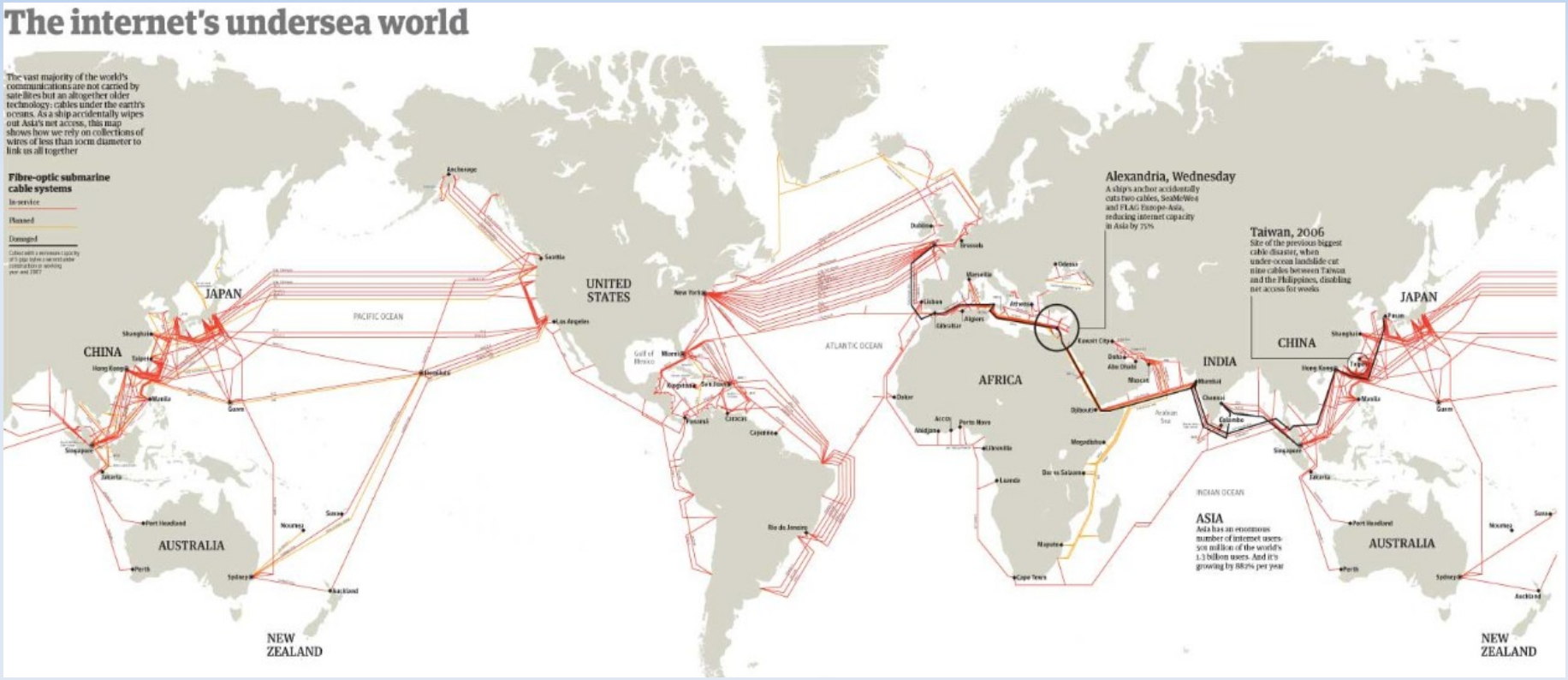
- Weak:
  - The last mile (towards labs/showfloors)
  - Trans-Oceanic and inter-continental


EASTERN TELEGRAPH Co.'s SYSTEM AND ITS GENERAL CONNECTIONS.
ARCTIC OCEAN
ARCTIC SEA
SPITZBERGEN
GREENLAND
BAFFIN BAY
Melville Sound
Behring Sea
NORTH AMERICA
PACIFIC OCEAN
BRITISH ISLES
RUSSIAN EMPIRE
Sea of Okhotsk
Sahara or Great Desert
PERSIA
INDIAN OCEAN
PACIFIC OCEAN
Philippine Is
Solomon Is
Coral Sea
Fiji Is
New Zealand
WESTERN AUSTRALIA
SOUTH AUSTRALIA
NEW SOUTH WALES
SYDNEY
TASMANIA
SOUTH AMERICA
Caribbean Sea
Cape of Good Hope
ANTARCTIC OCEAN

Eastern Telegraph Company network in 1901

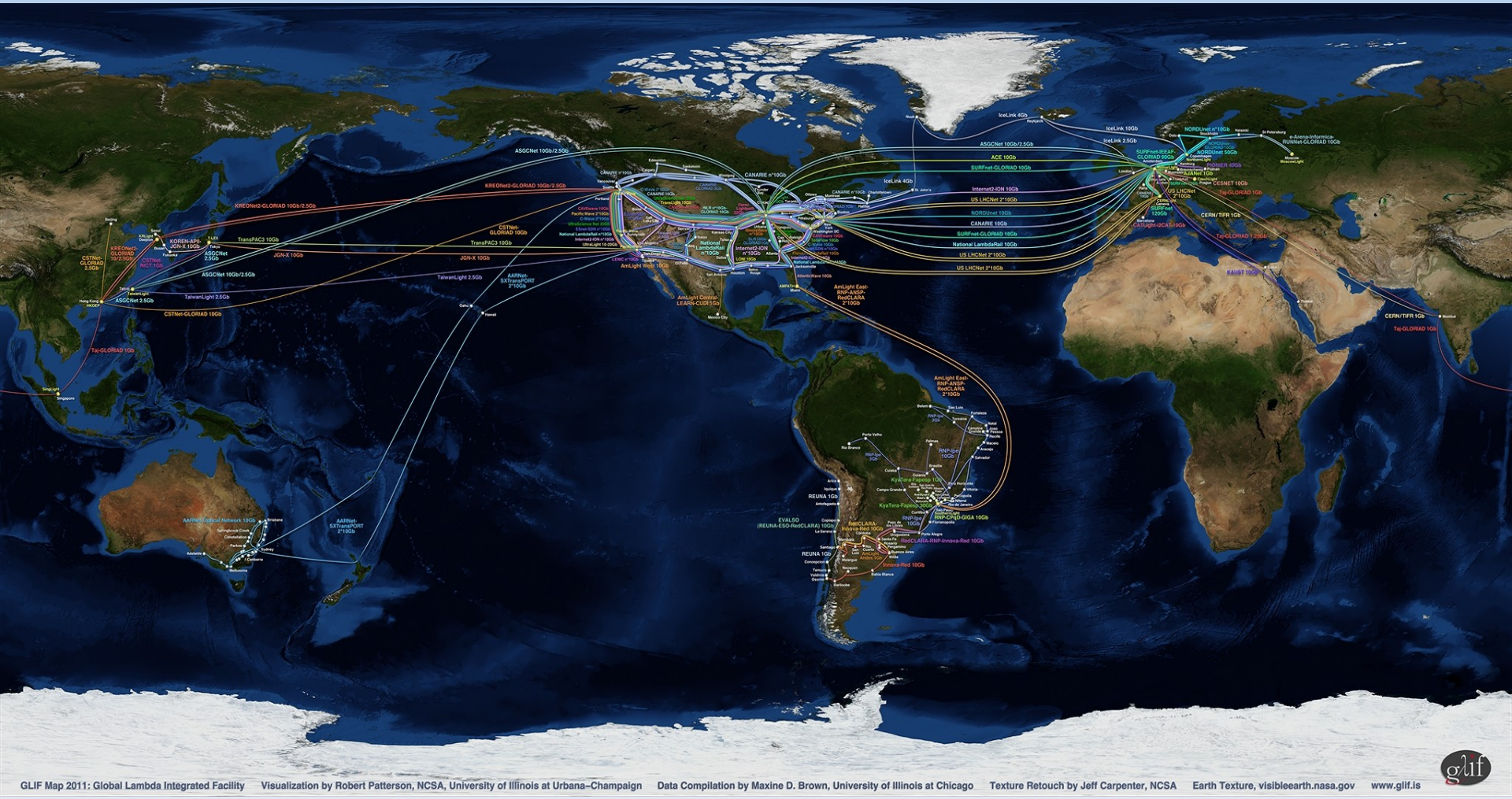


Intercontinental Cable Systems (recent)



Source: http://image.guardian.co.uk/sys-images/Technology/Pix/pictures/2008/02/01/SeaCableHi.jpg

GLIF (Global Lambda Integrated Facility) Map 2011



Conclusions

- The demands from research users are still (way) ahead of what the market can provide:
  - Data tsunami, Many users, Real time
- Many NRENs on continents such as Europe and North-America have fixed the bandwidth problem for their constituency
- Now we need efficient methods of handling this bandwidth:
  - Alien Light, Open Exchanges, E2E agile photonics
- The final frontier of (N)REN's network infrastructures: Intercontinental dark (dim) fiber

Thank you. Questions?

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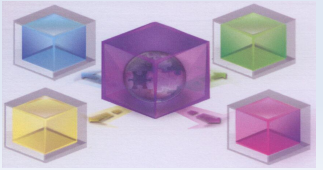
  - Phone: +31 65 313 1879

- “The NREN as a Global Service Provider”
- Betra er að standa á eigin fótum en annarra – Icelandic Proverb

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