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SURFnet and the LHC

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Contents

- Intro to lambda services and lightpaths
- Global Lambda Integrated Facility (GLIF)
- SURFnet6, a hybrid optical and packet switching network
- NetherLight, the Open Optical Exchange in Amsterdam

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Why Lambda Services?

- Lambdas form an excellent basis for IP networking
- Researchers are interested in lambdas

- Provides excellent quality on point-to-point connections at very high speed
- Protects the routed network
- Enables demanding applications to make use of the infrastructure in an economically sound way

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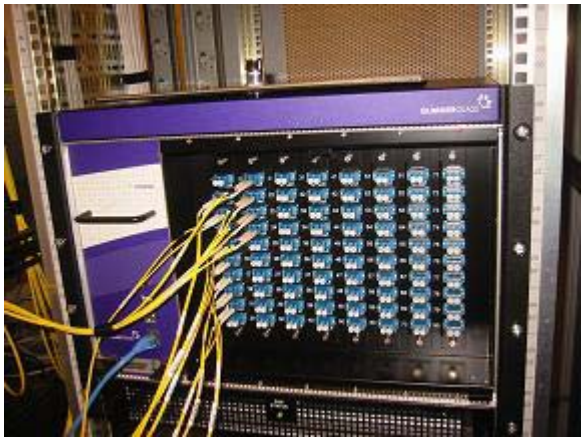
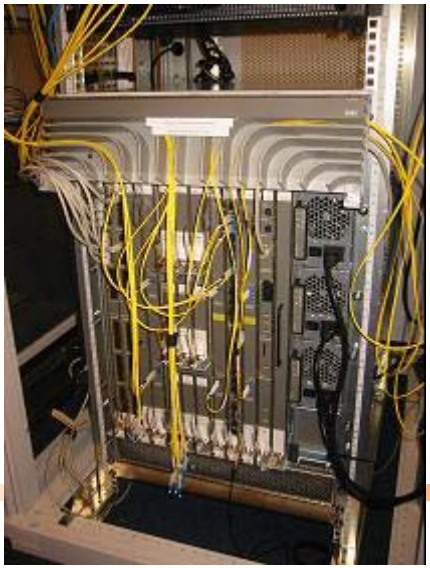
Lightpath technology

- Grooming of Ethernet packets into SONET/SDH containers:
  - Framing in the GLIF: ITU-T Recommendation G.7041/Y.1303 Generic Framing Procedure
  - STS-1 is smallest unit (51.84 Mbit/s)
- Now: Full GE needs 24 STS-1s, i.e. 8 GEs in a 10G λ
- Soon: 21 STS-1s using VCAT, i.e. 9 GEs in a 10G λ
- LCAS will introduce flexibility:
  - Physical interface 10GE
  - Actual lightpath any speed up to 10G, e.g. 5.5 Gbit/s
  - Remaining capacity for additional GE lightpaths

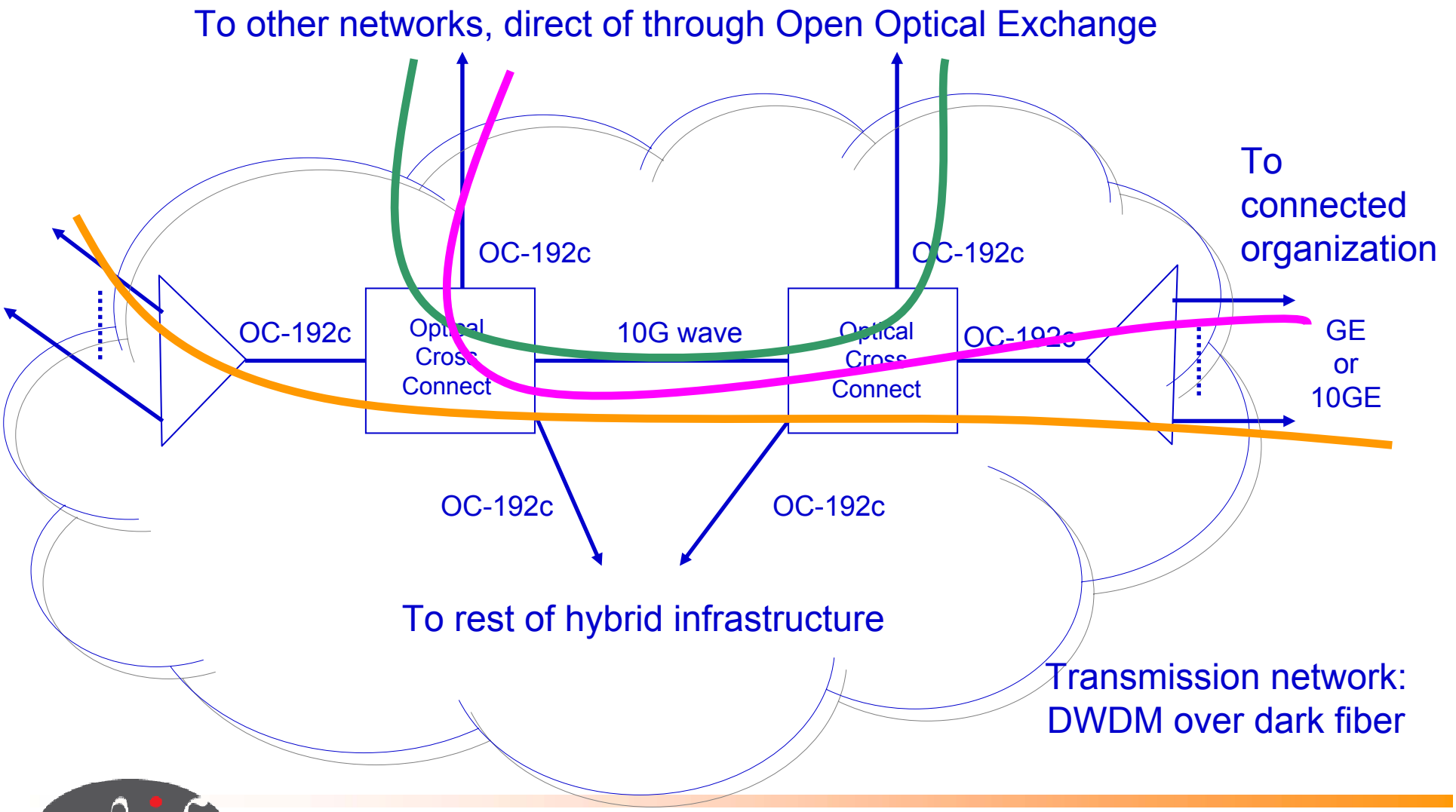
A word on networking costs

- Costs of optical port is 10% of switching port is 10% of router port of same “type” (speed, power budget)
  - 10G router port ≈ 100-500 kUSD, 10G switch port ≈ 10-20 kUSD, MEMS port ≈ 0.7 kUSD
- Give each packet in the network the service it needs, but no more





Lambda services over the hybrid network



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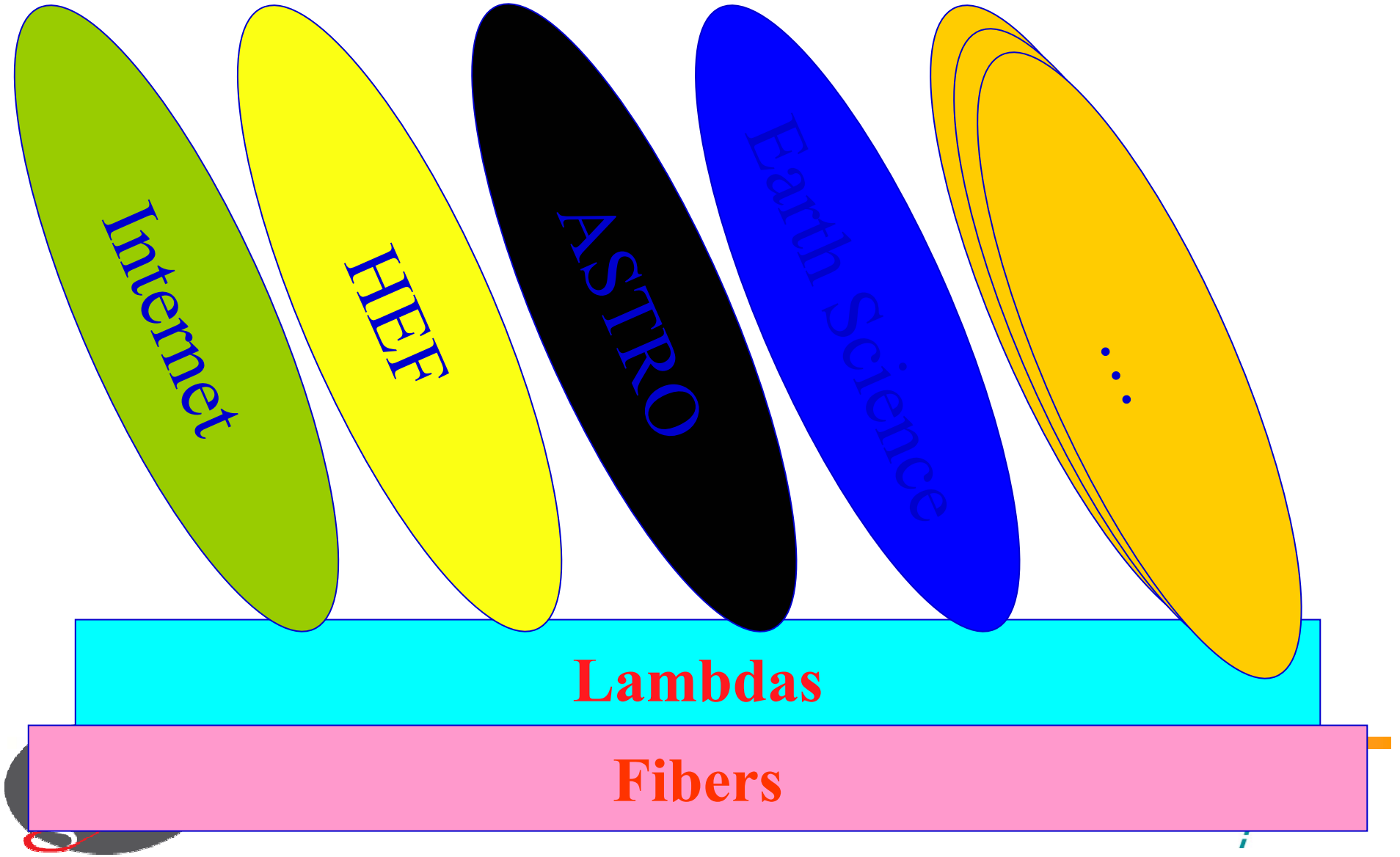
The Internet and Global high-performance instruments



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What is GLIF?

- Consortium of institutions, organizations, consortia and country NRENs, sharing optical networking resources and expertise
- Develop the Global LambdaGrid for the advancement of scientific collaboration and discovery
- GLIF “glues” together the networks and resources of its participants
- GLIF is not a new network and GLIF will not compete with its participants

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GLIF Mission

- To create and sustain a Global Facility supporting leading-edge capabilities that enable high-performance applications and services, especially those based on new and emerging technologies and paradigms related to advanced optical networking

- GLIF provides leadership in advanced technologies and services on behalf of National Research & Education Networks (NRENs), creating new models that they can implement

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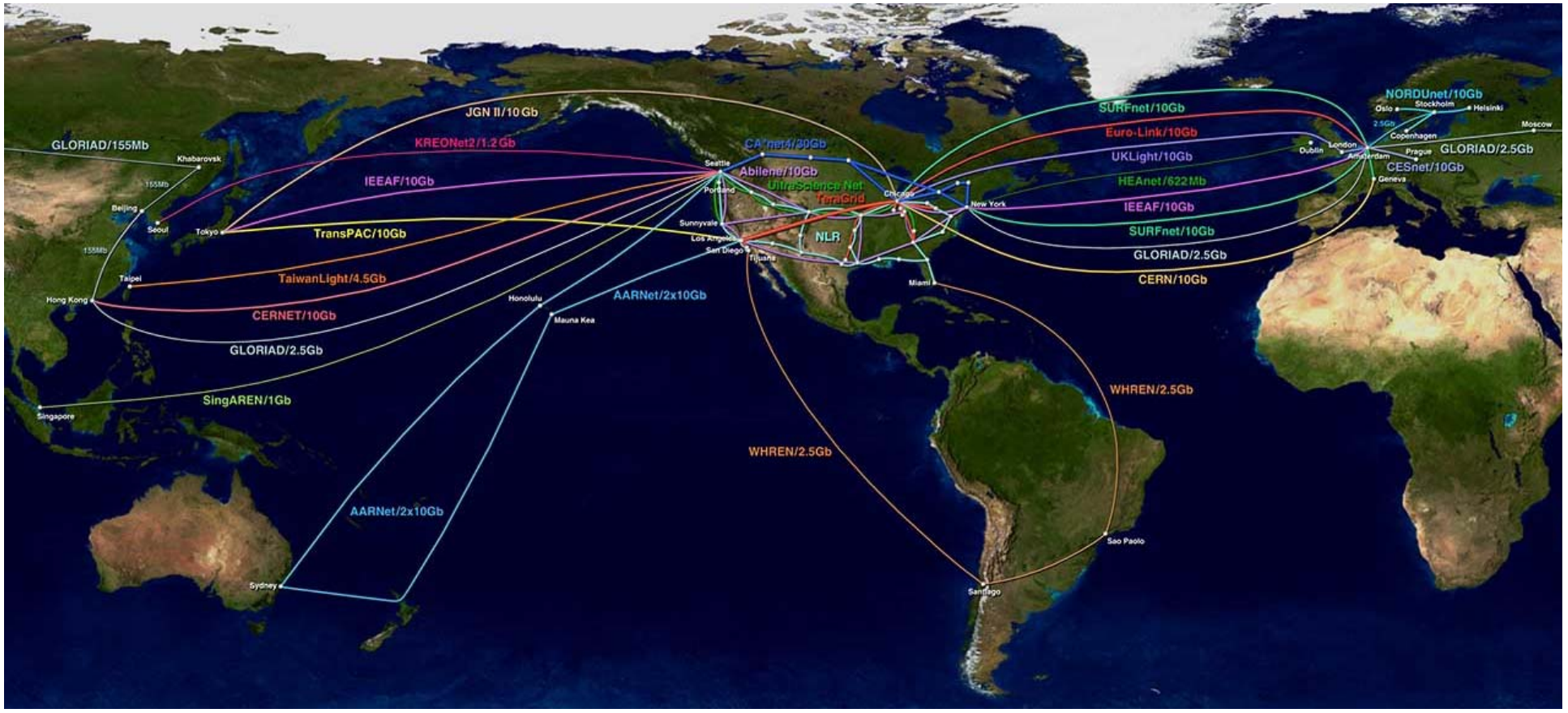
History of GLIF

- Brainstorming in Antalya, TR at TERENA Conf 2001
- 1th meeting at TERENA offices Sep 11 & 12, 2001
  - On invitation only (15) + public part
  - Thinking, SURFnet test lambda Starlight-NetherLight
- 2nd meeting appended to iGrid2002 in Amsterdam, NL
  - Public part in track, on invitation only day (22)
  - Core testbed brainstorming, idea checks, seeds for TransLight
- 3rd meeting Reykjavik, IS, hosted by NORDUnet
  - Grid/Lambda track in conference + this meeting (35)
  - Brainstorm applications and showcases, technology roadmap
  - GLIF established

GLIF TEC: Nottingham output

- Identify procedures and building blocks:
  - Optical Exchanges (with assorted services)
  - Links
- Create an international network map of participant resources
- Understand application requirements for high performance venues such as SC and iGrid
- What does it mean to connect to GLIF? What does it mean to bring equipment to GLIF?

GLIF World Map – December 2004



Visualization courtesy of Bob Patterson, NCSA.

GLIF Next Steps

- Best Current practice documents:
  - Interoperability and interconnectivity
  - Definition of optical exchange
- Register of GLIF Resources

- Feb 13, 2005: GLIF TEC in Salt Lake City, UT, USA
- 2005 at UCSD, hosted by Cal-(IT)2 in conjunction with iGrid2005
- 2006 in Japan, hosted by the WIDE Project (Jun Murai) and JGN-II (Tomonori Aoyama)

Open Optical Exchanges, production or planned

- One physical location, examples:
  - Europe:
    - CzechLight, in CZ
    - NetherLight, in NL
  - North America:
    - MAN LAN, in US
  - AP-region:
    - T-Lex, in JP
- Distributed, examples:
  - CA*net 4, in Canada
  - NorthernLight, spanning DK, NO, SE, FI
  - UKLight, in the UK
  - GEANT2 soon, in Europe

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SURFnet6 overview

- A hybrid optical and packet switching infrastructure
- Based on customer-owned managed dark fiber
- Native IPv4, IPv6 and Light Path Provisioning over a single transmission infrastructure
  - Managed via a single control plane
  - Network nodes reduced from 20 routed locations to 2 routed locations

Paving the way to a ubiquitous and scalable Services Grid

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SURFnet6 on dark fiber

- SURFnet6 will be entirely based on SURFnet owned managed dark fiber via the customer premises
- Approx. 6000 km fiber pairs available today; average price paid for 15 year IRUs:
  < 6 €/meter per pair
- Managed dark fiber infrastructure is being extended with new routes, to be ready for SURFnet6

SURFnet6: Light Path Provisioning

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Lambdas:

- enable layer 1/2 end-to-end Light Paths

Light paths:

- provide excellent quality on point-to-point connections at high speed (1G to 10G)
- not constrained by traditional framing, routing, and transport protocols
- are becoming integral part of scientific instruments
- enable creation of Optical Private Networks (OPN)

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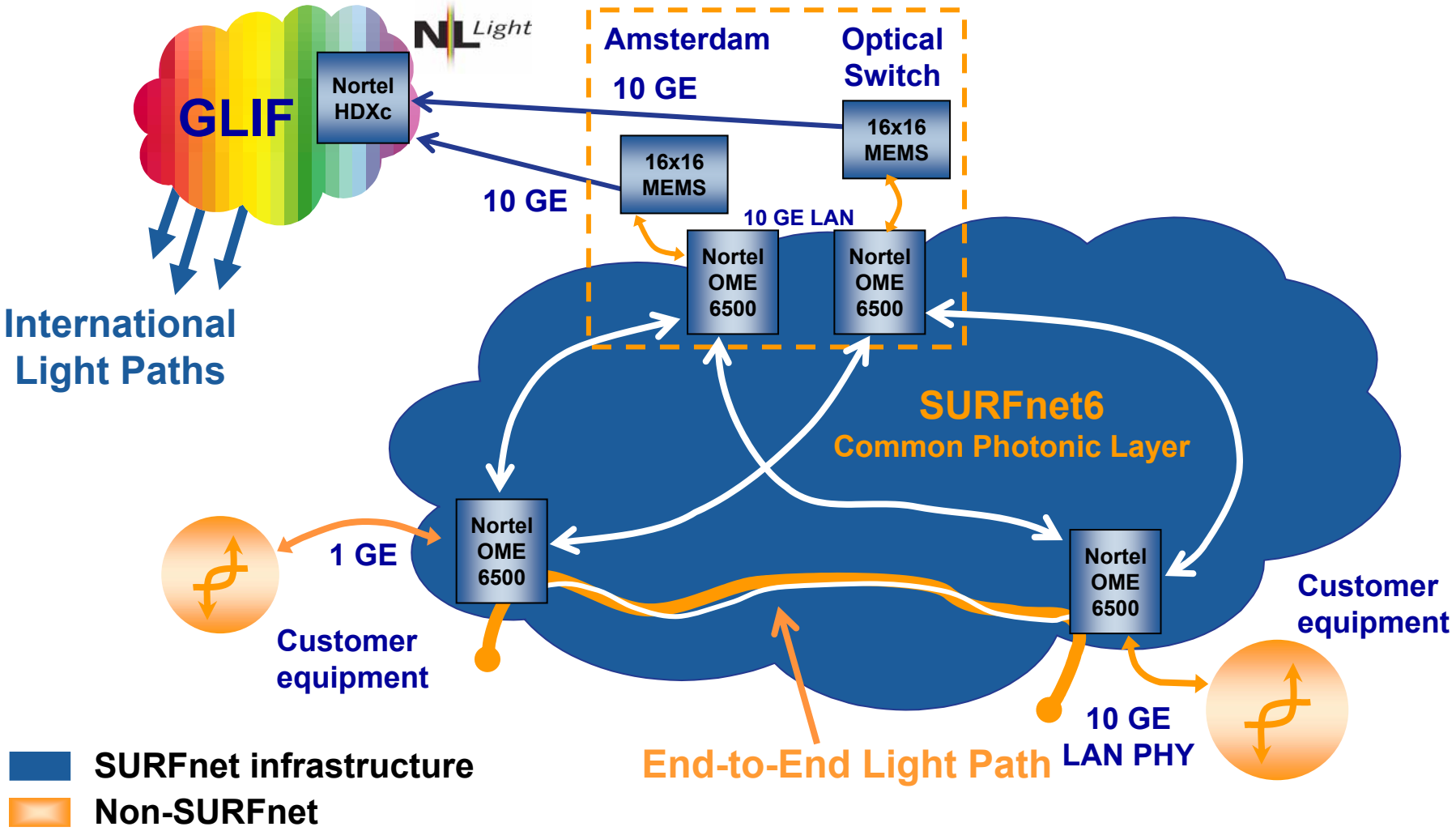
SURFnet6: Light Path Provisioning implementation



SARA/NIKHEF's Tier 1 envisioned connection

- Connected to SURFnet6
- T0 -> T1 data transport: One or more 10GE LAN PHY physical connections for Lightpath usage between CERN and SARA/NIKHEF
- T1 -> T2 data transport: One or more GE physical connections for Lightpath usage between SARA/NIKHEF and various Tier 2 sites

- Need a plan a.s.a.p. with projected data flows, bandwidth needed, timing yielding a basic architecture for the LHC instrument

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Open Optical Exchange example: NetherLight

- Operational since January 2002
- Now centered around Nortel Networks HDXc, a full duplex 640G non-blocking cross-connect capability, running production since September 1, 2004
- Nortel Networks OME6500 and Cisco Systems 15454 for GE grooming; GE switch for access to clusters

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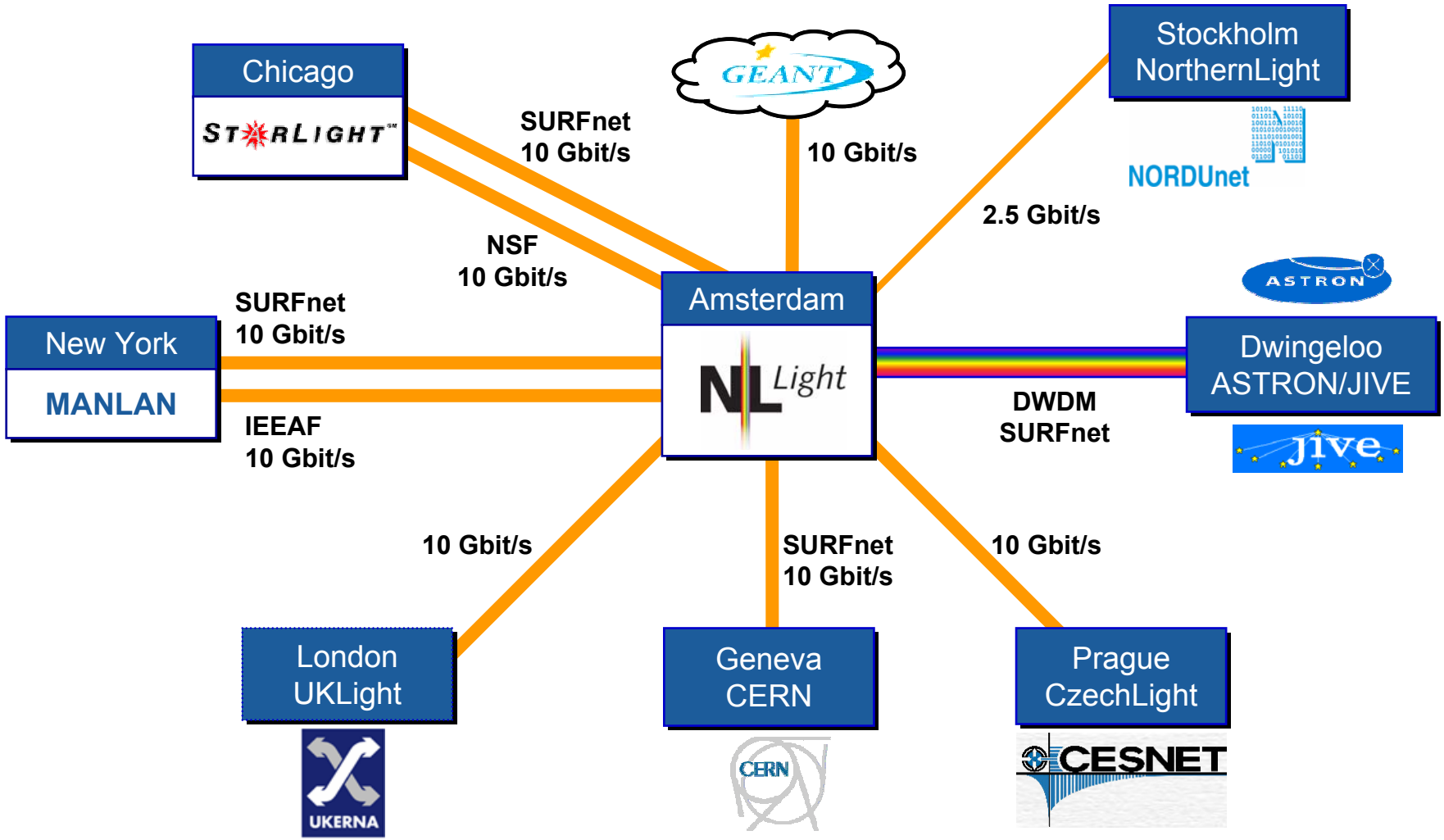
NetherLight 2004



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Conclusion & recommendations

- A lightpath is a 1 Gbit/s or 10 Gbit/s Ethernet framed point to point link; by use of VCAT and LCAS more granular flavors possible
- Hybrid networks delivering IP and Lambda Services can meet user demand within budget constraints
- For end to end data flows, lightpaths form the excellent basis for no loss constant andlatency data transfer
- This group should draft a high level architecture for the “LHC network infra” as soon as possible

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Thank you

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http://www.glif.is/

http://www.netherlight.net/

http://www.surfnet.nl/