NetherLight

The experimental optical internet exchange in Amsterdam

2nd *e*VLBI workshop

Dwingeloo, May 15-16, 2003

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Outline

- SURFnet

- NetherLight
  - What is it
  - Why: the rationale

- From OC48 test bed to lambda grid
  - Lambda networking since 2001
  - National & International lambda connectivity
  - Research activities

- Conclusion

SURFnet

- Provides the Dutch National Research Network
- Not for profit company
- 200 connected organisations, 500.000 users
- Turnover (2002): 30 M Euro
- Infrastructure services:
  - innovation paid for by government
  - exploitation paid for by users
  - partnership with industry

SURFnet5: world leading research network

Legenda
- Managed dark fiber
- ■ Hoofdaansluitpunten (PoP)
- ■ Aansluitpunten

Uitbreidingen Drenthe

Testnetwerk

SURFnet5-netwerk
Dubbel uitgevoerd

Leeuwarden · Groningen · Dwingeloo · Alkmaar · Zwolle · Haarlem · Amsterdam · Deventer · Enschede · Oegstgeest · Lisse · Hilversum · Leiden · Utrecht · Den Haag · Wageningen · Arnhem · Delft · Nieuwegein · Houten · Rotterdam · Dordrecht · Den Bosch · Nijmegen · Breda · Tilburg · Eindhoven · Maastricht · Heerlen

- 15 PoPs connected by thirty 10 Gbit/s lambdas

- Dual stack IPv4 and IPv6

- 500,000 users

- 84 institutes connected at Gbit/s level
  - using dark fiber (shown in previous talk by Cees de Laat)

What is NetherLight?

- NetherLight is the optical Internet exchange in Amsterdam
    - Built and maintained by SURFnet
    - Inspired by StarLight in Chicago

- A test facility to get acquainted with <u>light path provisioning</u> concepts for high-bandwidth IP traffic

- "Bring us your lambdas"

NetherLight: the rationale I

- ## Scientists point-of-view
  - Need for high-bandwidth, point-to-point, up to 1 Gb/s connectivity (10Gb/s in near future)
  - Need for low jitter, low latency
  - Only during certain time-frames

- ## Provider (NREN) point-of-view
  - Avoid performance impact on routed IP layer
  - Lot of bandwidth will become available
  - Uncertain if backbone routers can scale
 - Partially split off traffic from expensive IP layer

NetherLight: the rationale II

- Challenge is in how to integrate (into the network) the large amounts of bandwidth that will become available

- Bottom line: create a hybrid architecture that serves all users in one consistent cost effective way

- International co-operation is essential
  - StarLight, CANARIE, CERN, CESnet, …

- International lambda networking!

The NetherLight network: 2001

- ## How it started late 2001
  - One 2.5Gbit/s lambda between StarLight, Chicago, USA and SARA, Amsterdam, NL

  - Lambda terminated on Cisco ONS15454 muxes
    - WAN side: SONET framed: OC48c
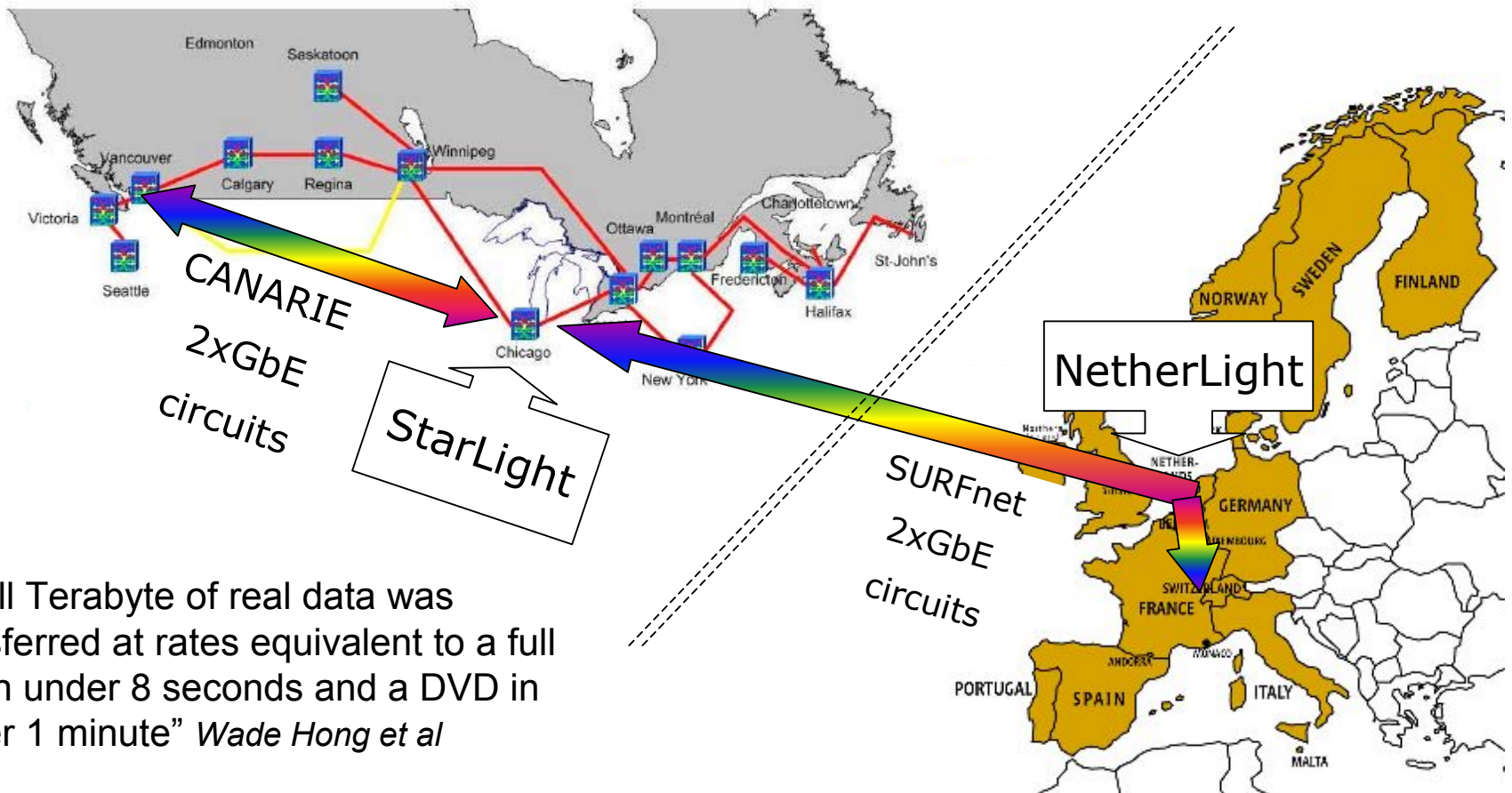   - LAN side: GbE interfaces to computer clusters

StarLight   SARA

GbE   2.5G lambda   GbE

GbE   GbE
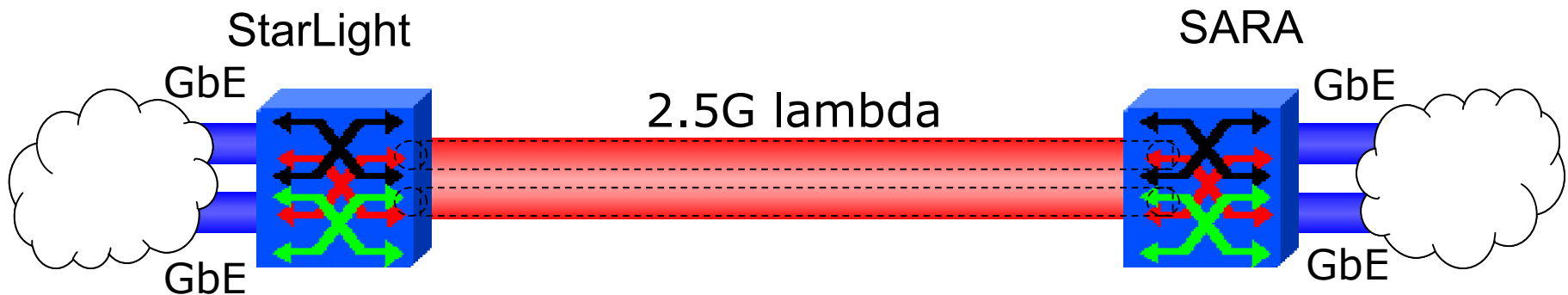
NetherLight Network: 2002

- The iGrid2002 event brought many lambdas to Amsterdam
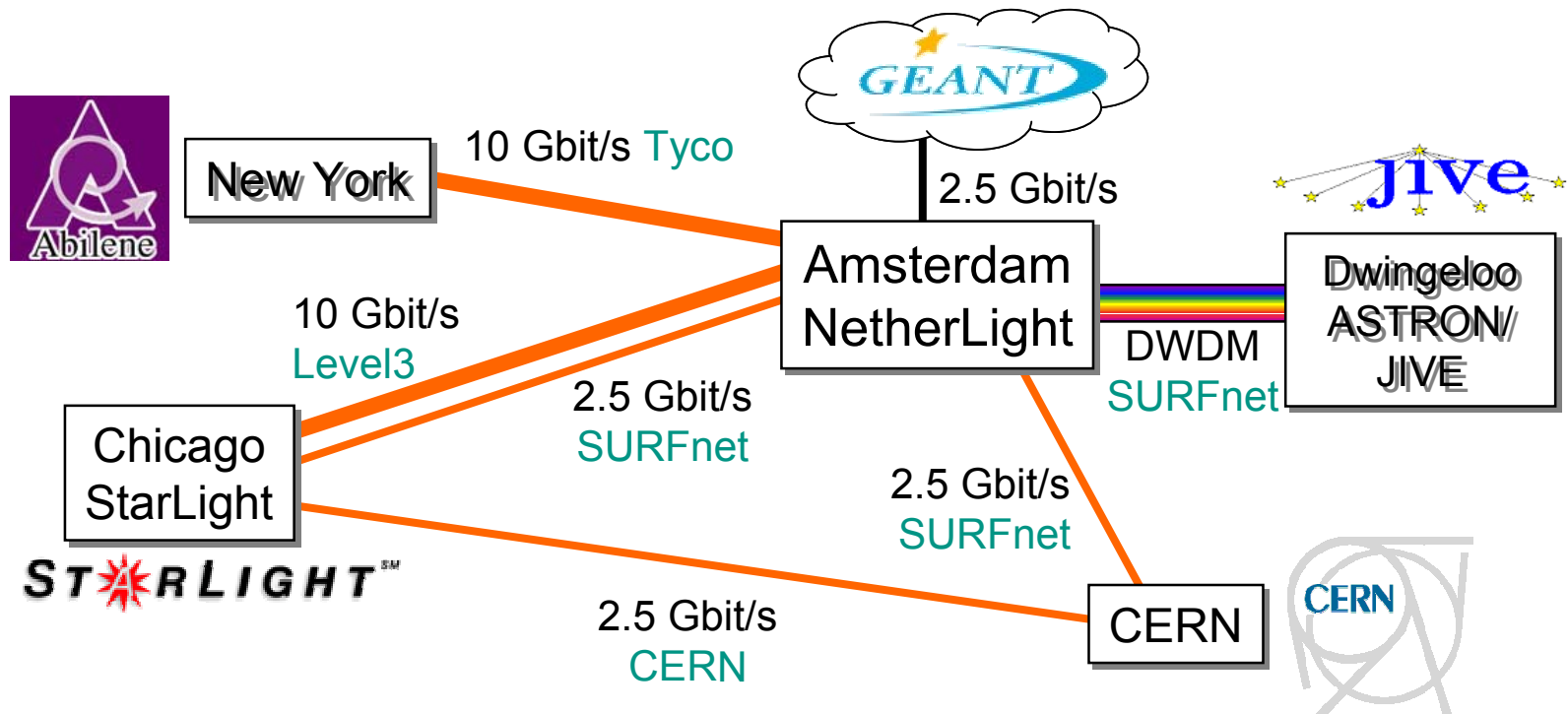
ATLAS Canada Lightpath trial
TRIUMF Vancouver ⟺ CERN Geneva

CANARIE
2xGbE
circuits

StarLight
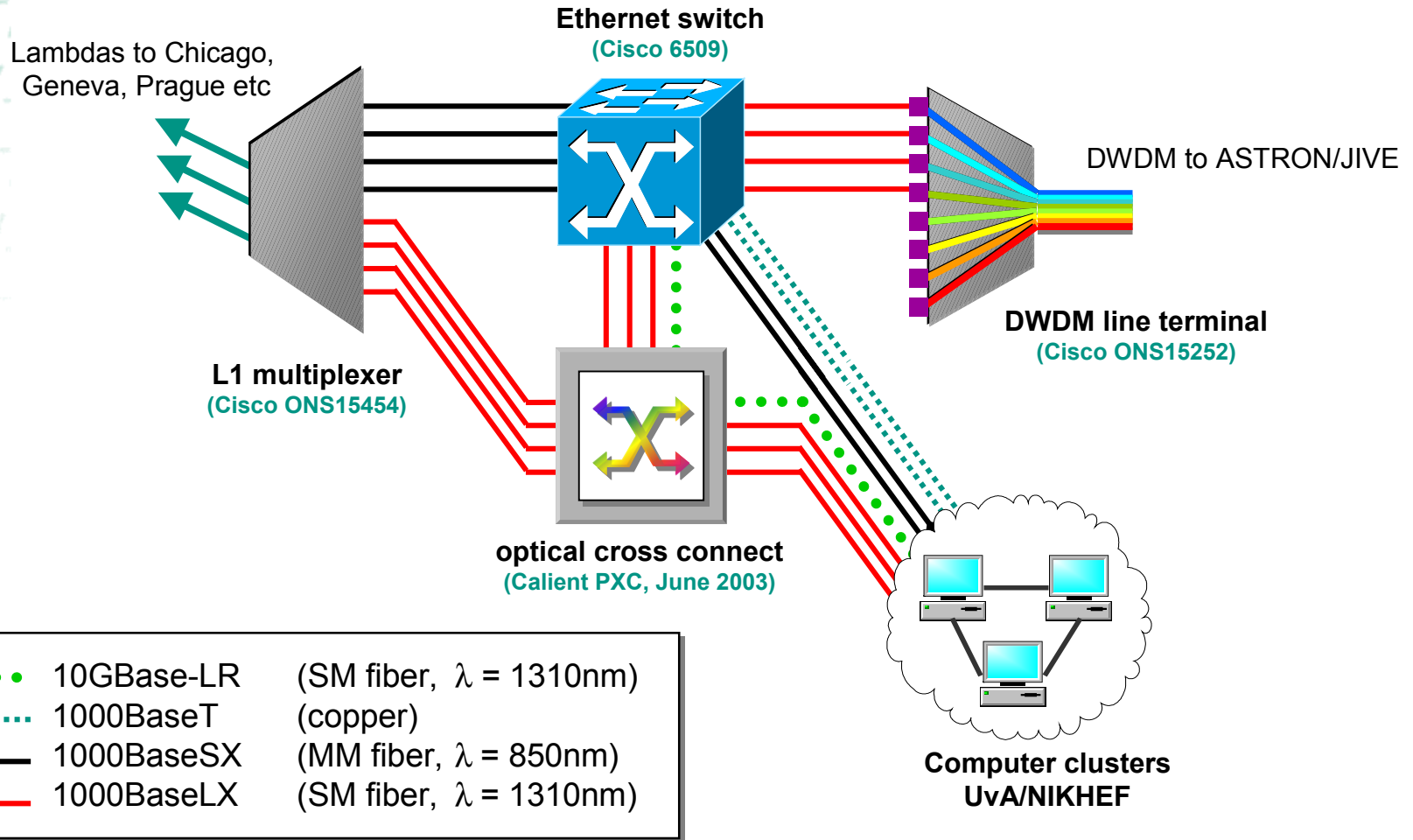
NetherLight

SURFnet
2xGbE
circuits

"A full Terabyte of real data was transferred at rates equivalent to a full CD in under 8 seconds and a DVD in under 1 minute" *Wade Hong et al*

Lambdas connected to NetherLight

- ## National lambdas:
  - DWDM line system to ASTRON/JIVE (Joint Institute for VLBI in Europe)
    - Up to 32 lambdas (3 installed today @ 1GE)

- ## International lambdas now:
  - 10Gb/s to StarLight, Chicago, IL, USA
  - 10Gb/s to CERN, Geneva, CH
  - 10Gb/s to New York (IEEAF/Tyco)
  - 2.5Gb/s from CzechLight, Prague, Czech rep.

- ## Soon:
  - 10Gb/s to StarLight (NSF-funded)
  - 2.5Gb/s from Stockholm (Nordunet)
  - 10Gb/s from UKLight (London)

NetherLight setup at SARA

Lambdas to Chicago,
Geneva, Prague etc

Ethernet switch
(Cisco 6509)

DWDM to ASTRON/JIVE

DWDM line terminal
(Cisco ONS15252)

L1 multiplexer
(Cisco ONS15454)

optical cross connect
(Calient PXC, June 2003)

Computer clusters
UvA/NIKHEF

• • • •	10GBase-LR	(SM fiber, λ = 1310nm)
·········	1000BaseT	(copper)
——	1000BaseSX	(MM fiber, λ = 850nm)
——	1000BaseLX	(SM fiber, λ = 1310nm)

NetherLight Network: 2003
Emerging international lambda grid

New York City

Stockholm
Northern Light

GEANT

JIVE

10 Gbit/s
Tyco/IEEAF

Abilene

10 Gbit/s
NSF

Amsterdam
NetherLight

Dwingeloo
ASTRON/JIVE

10 Gbit/s
SURFnet

DWDM
SURFnet

10 Gbit/s
NSF

Chicago
StarLight

2.5 Gbit/s
CESNET

STARLIGHT

10 Gbit/s
SURFnet

London
UKLight

Prague
CzechLight

Geneva
CERN

CERN

	Operational 1H03
••••	Expected 2H03
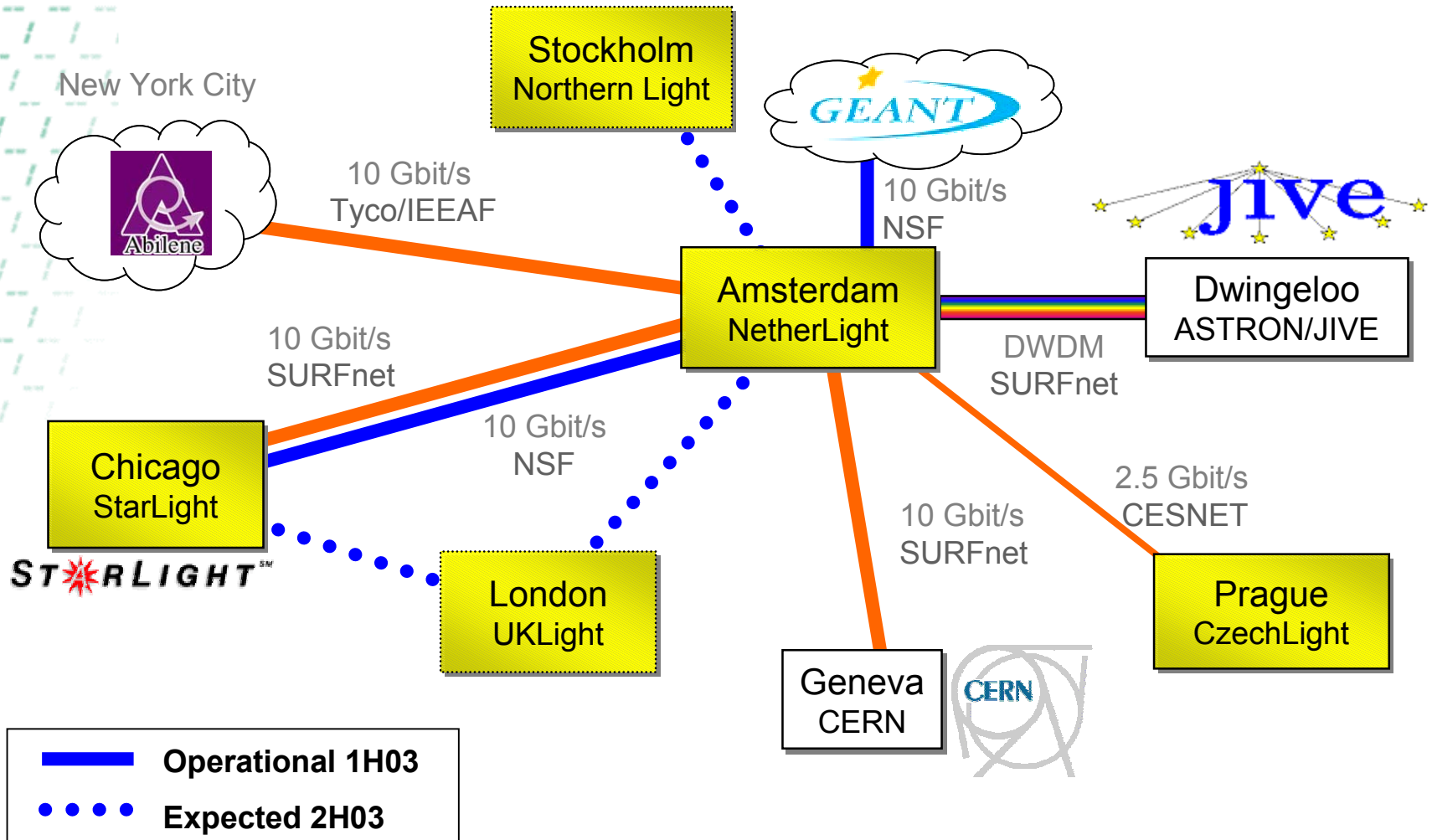
Research activities

- Definition of architectures for integration of IP and optical networks

- Control of (optical) switch matrix at NetherLight
  - Experimental work by the Grid community
    - e.g. UvA: Cees de Laat c.s.
  - Middleware for lambda provisioning

- Data transport tests with high bandwidth user groups, e.g.:
  - high-energy physicists in Europe and US
  - Astronomers: eVLBI network in Europe

Conclusion

- Network paradigm shift looks unavoidable

- Further research on architectures for seamless integration of IP and optical networks necessary

- Just start doing it

Thank you for your attention

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Extra slide

NetherLight switching components at SARA, Amsterdam

- Layer2: VLAN flexibility
  - Cisco 6509 with 1GbE and 10GbE interfaces

- Layer1: ONS15454 for semi-permanent circuit provisioning/grooming
  - 10G lambdas are carved into sublambdas
    - SONET: STS-24 for tunneling 1 GbE

- Layer1/0: Calient PXC (june 2003)
  - All-optical circuit switching (MEMS-based)