Optical Networking Activities in NetherLight

TERENA Networking Conference 2003

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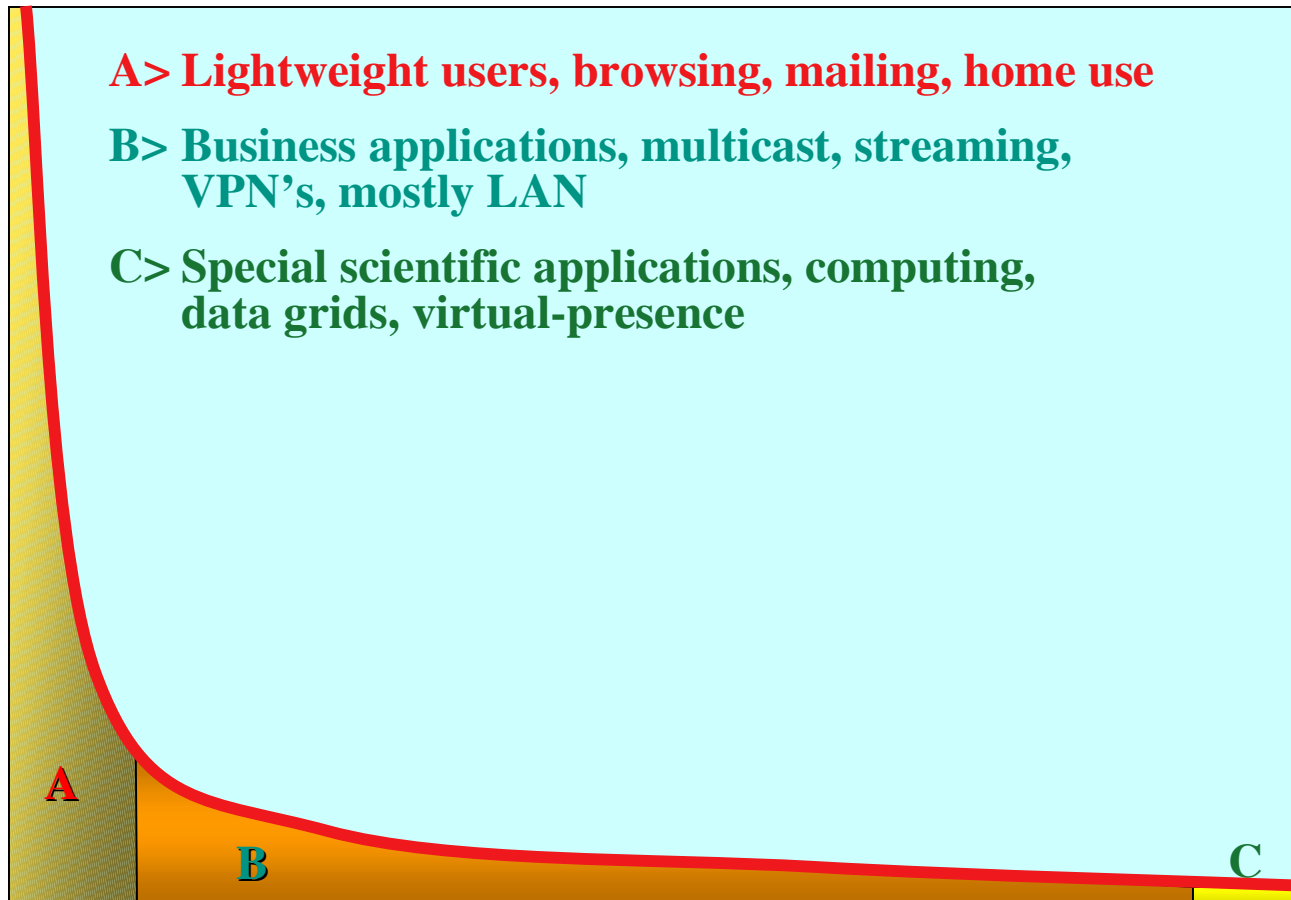SURFnet High-quality Internet for higher education and research

Outline

- 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

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"

NREN: Know your users

# of users

A> Lightweight users, browsing, mailing, home use

B> Business applications, multicast, streaming, VPN's, mostly LAN

C> Special scientific applications, computing, data grids, virtual-presence

A

B

C

ADSL

GigE LAN

BW requirements

This slide courtesy of Cees de Laat, University of Amsterdam
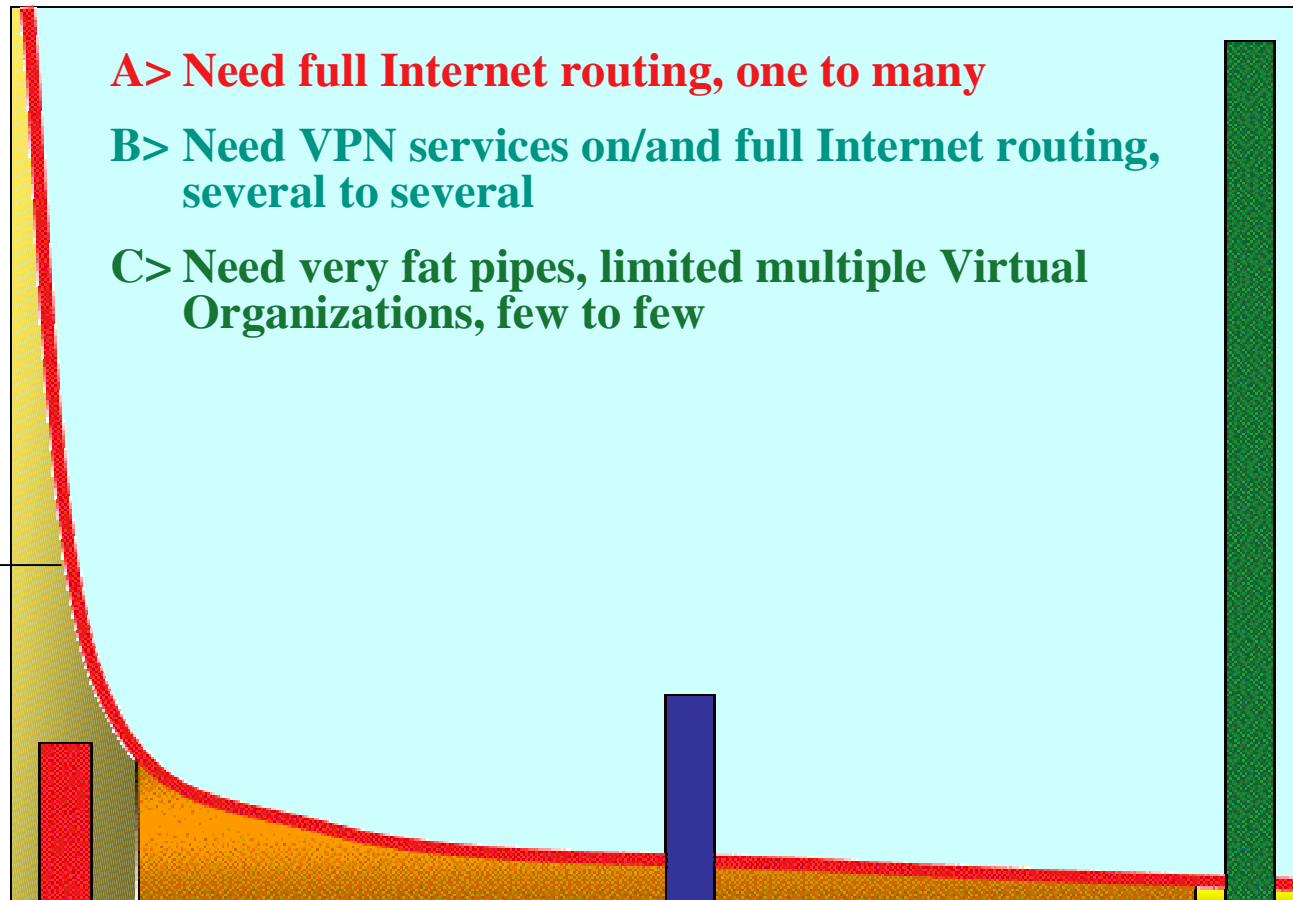
NREN: Know your users' req's

# of users

A> Need full Internet routing, one to many

B> Need VPN services on/and full Internet routing, several to several

C> Need very fat pipes, limited multiple Virtual Organizations, few to few

Total BW

ADSL

GigE LAN

BW requirements

This slide courtesy of Cees de Laat, University of Amsterdam 5

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   GbE

                          2.5G lambda

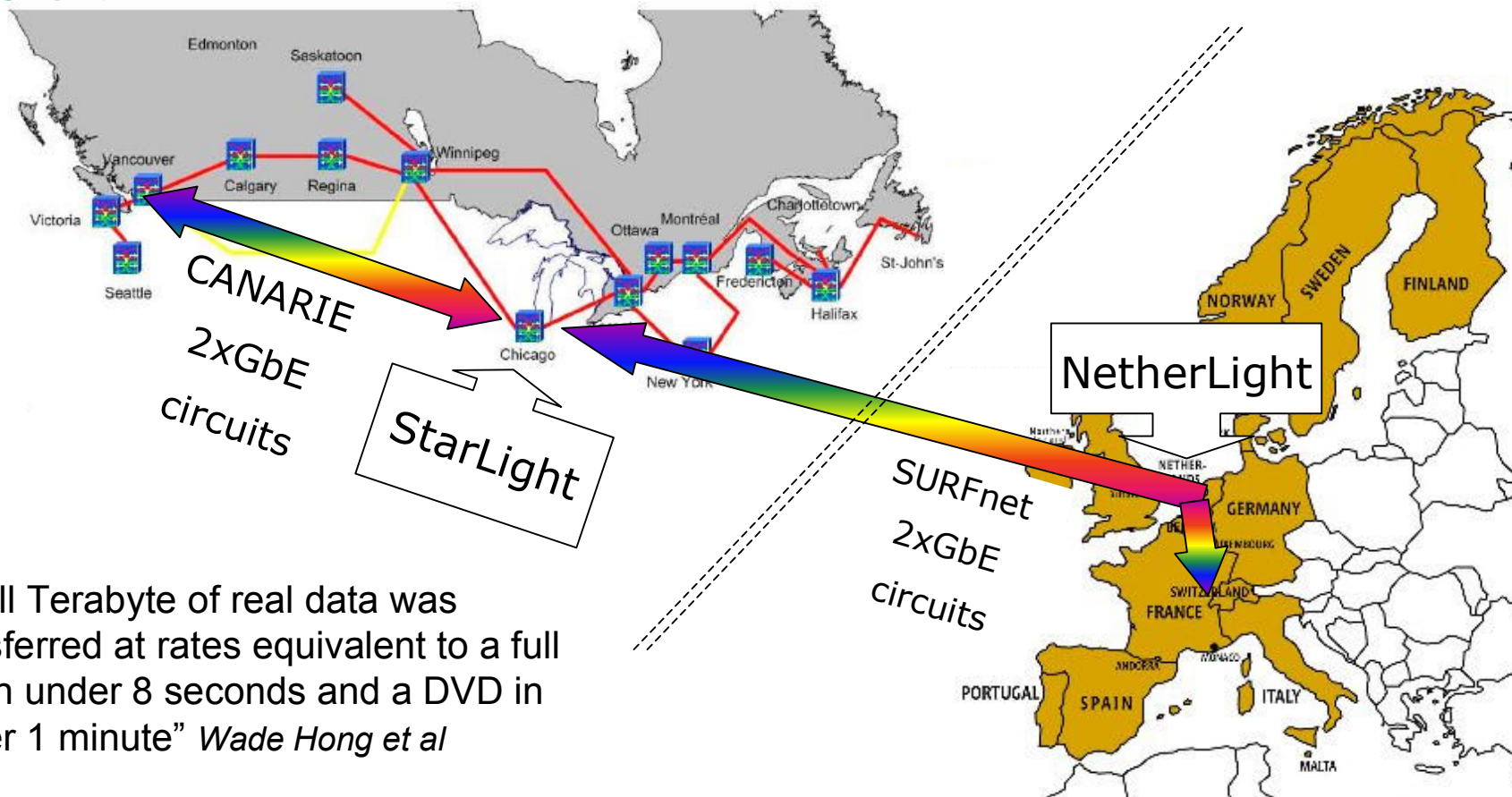GbE   GbE
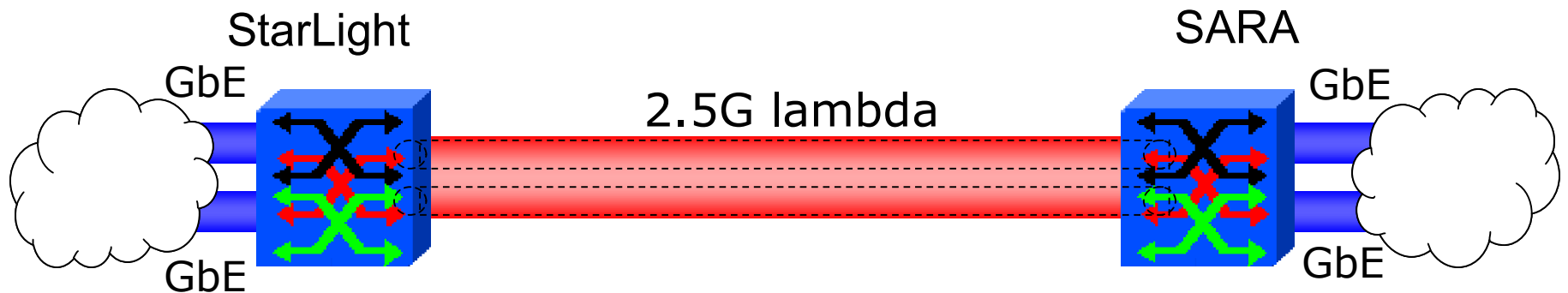
NetherLight Network: 2002

- The iGrid2002 event brought many lambdas to Amsterdam
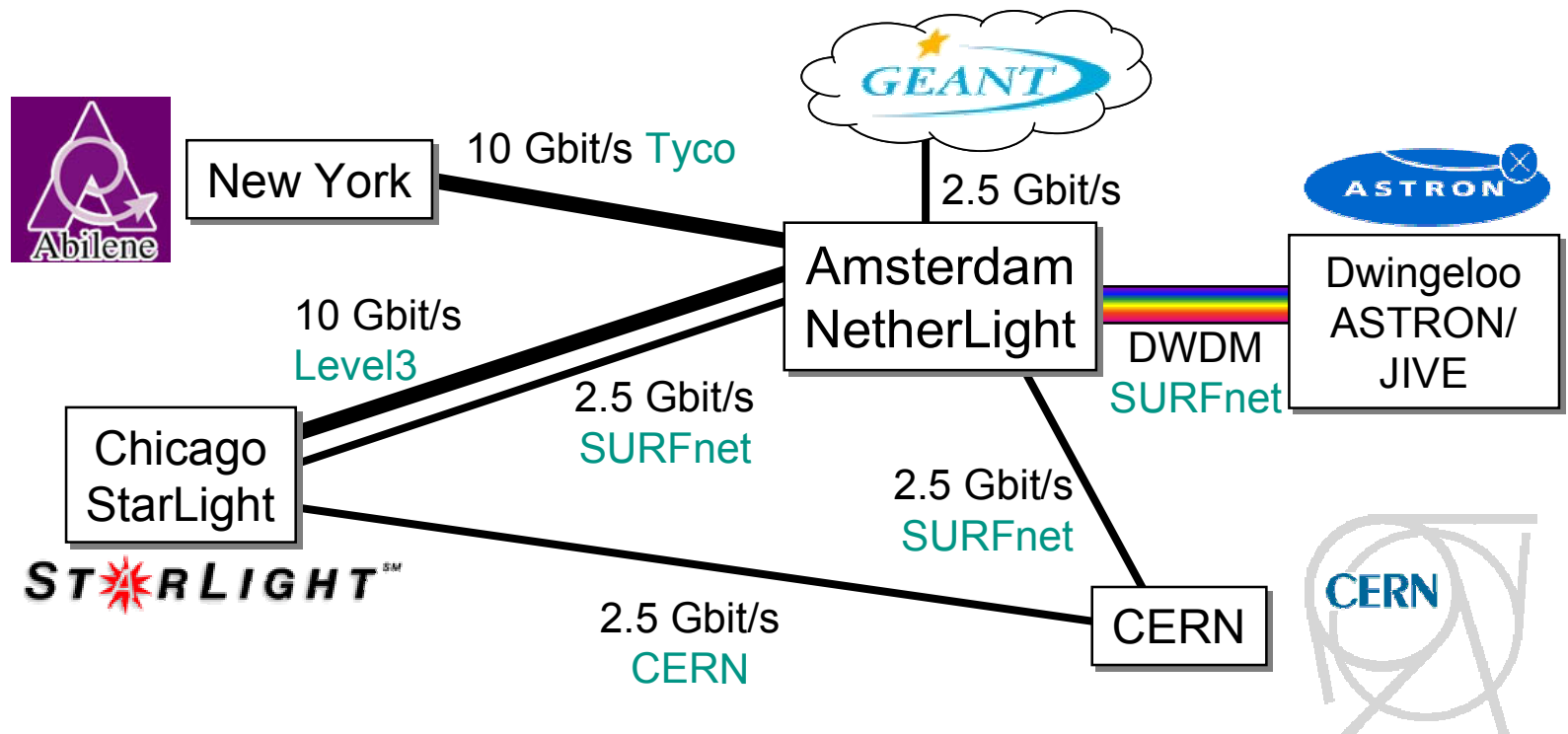
ATLAS Canada Lightpath trial
TRIUMF Vancouver ⟺ CERN Geneva
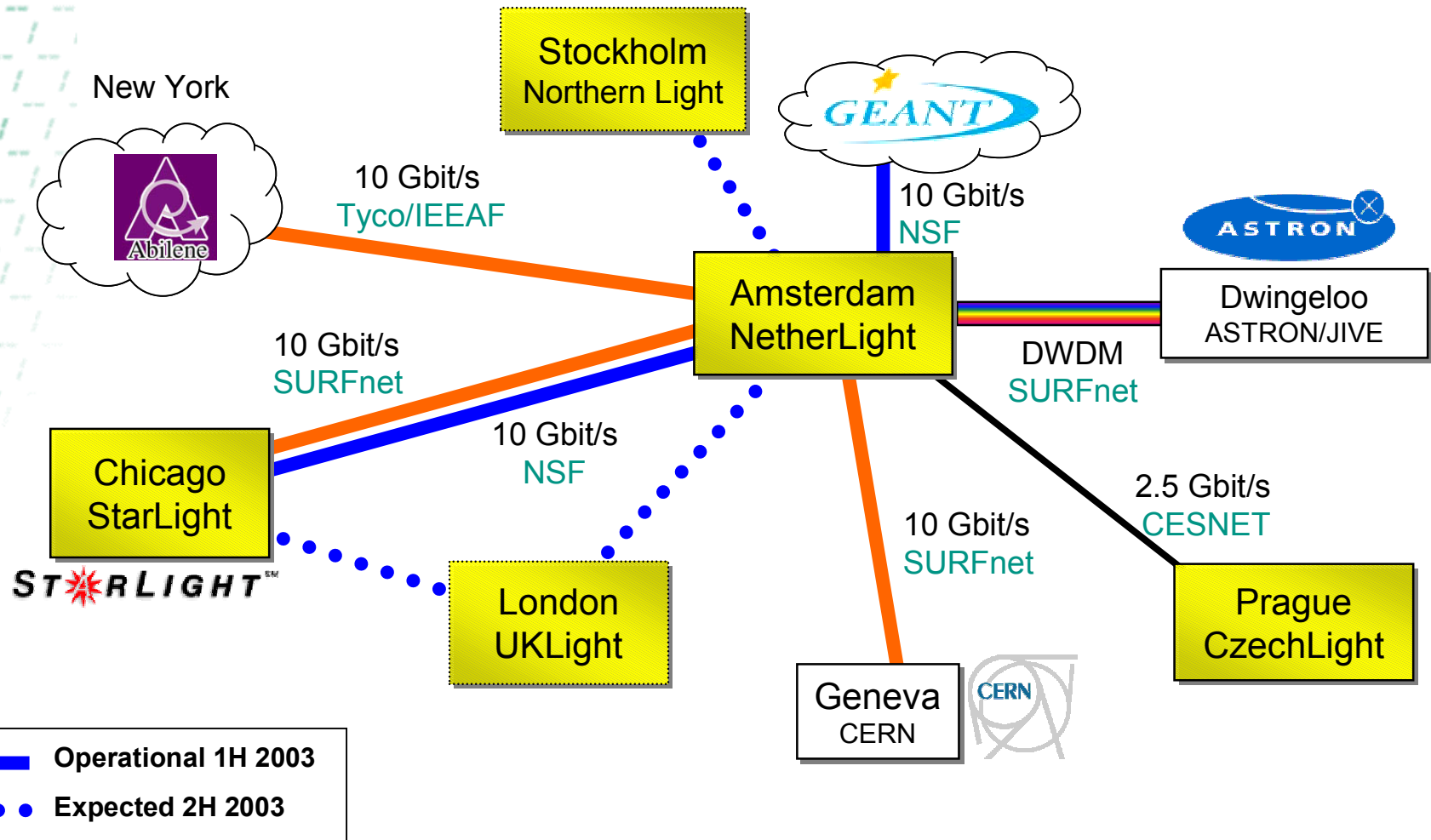
CANARIE
2xGbE
circuits

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 Network: 2003
Emerging international lambda grid

Stockholm Northern Light

GEANT

New York

10 Gbit/s
Tyco/IEEAF

10 Gbit/s
NSF

ASTRON

Amsterdam NetherLight

Dwingeloo ASTRON/JIVE

10 Gbit/s
SURFnet

DWDM
SURFnet

10 Gbit/s
NSF

Chicago StarLight

STARLIGHT

10 Gbit/s
SURFnet

2.5 Gbit/s
CESNET

London UKLight

Prague CzechLight

Geneva CERN

CERN

▬▬▬	**Operational 1H 2003**
● ● ● ●	**Expected 2H 2003**

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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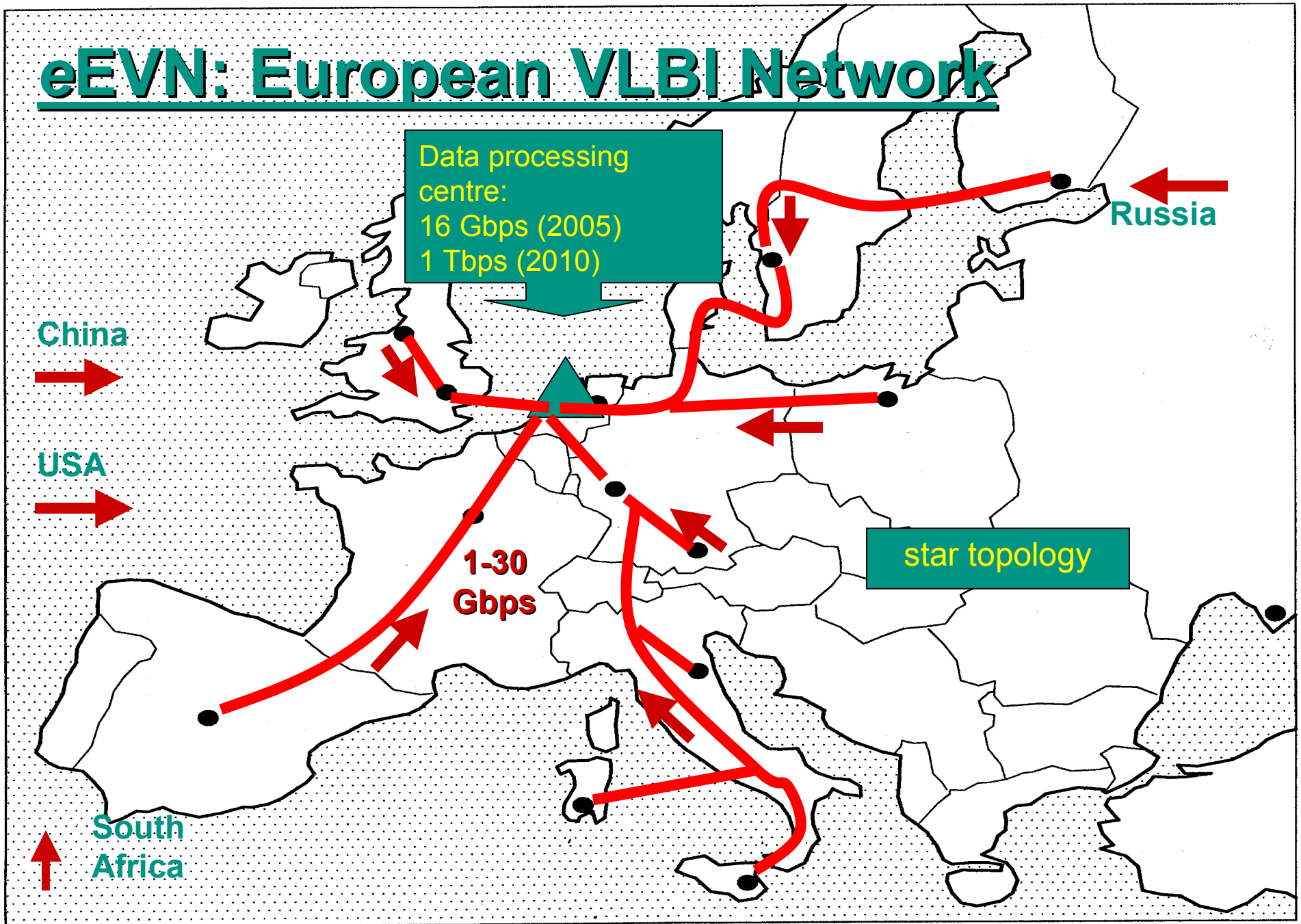www.netherlight.net

Extra slides

eEVN: European VLBI Network

Data processing centre:
16 Gbps (2005)
1 Tbps (2010)

China

USA

Russia

1-30 Gbps

star topology

South Africa

This slide courtesy of Richard Schilizzi, [schilizzi@jive.nl] 17

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)

NetherLight setup at SARA

Ethernet switch
(Cisco 6509)

Lambdas to Chicago,
Geneva, Prague etc

DWDM to ASTRON

L1 multiplexer
(Cisco ONS15454)

DWDM line terminal
(Cisco ONS15252)

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)