The Lambda Grid

www.science.uva.nl/~delaat

Cees de Laat

SURFnet

EU

University of Amsterdam

SARA

NIKHEF

NCF

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Contents of this talk

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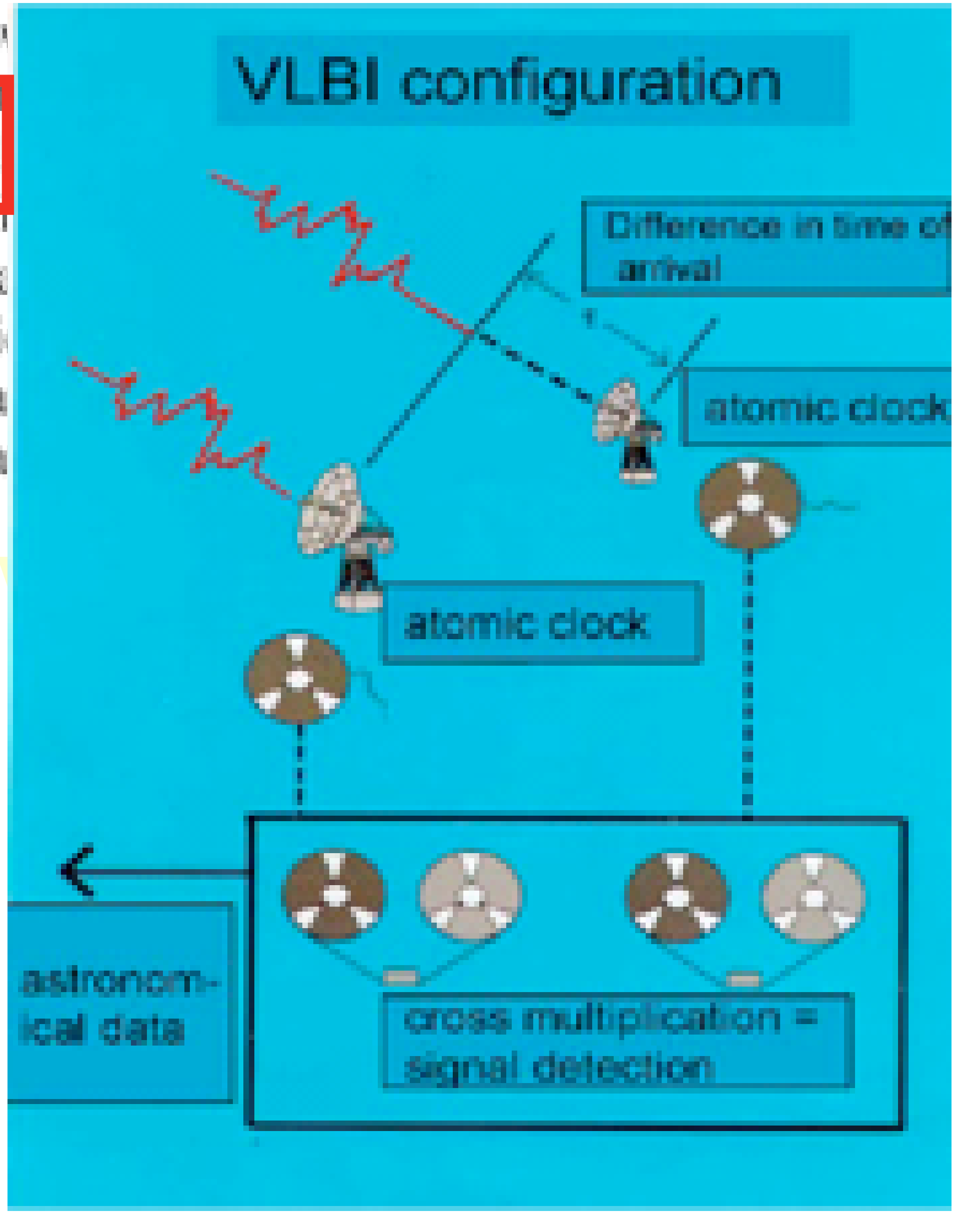
eVLBI

VLBI

ger term VLBI is easily capable of generating many Gb of data per
The sensitivity of the VLBI array scales w
(√data-rate) and there is a strong push to i
. Rates of 8Gb/s or more are entirely feasibl
ıder development. It is expected that parall
orrelator will remain the most efficient approa
s distributed processing may have an applic
lti-gigabit data streams will aggregate into la
or and the capacity of the final link to the da
tor.

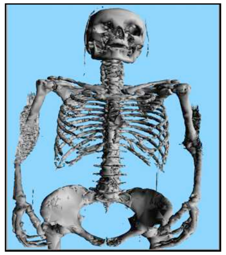
Westerbork Synthesis Radio Telescope - Netherlands

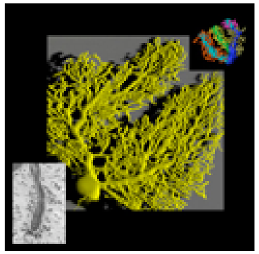
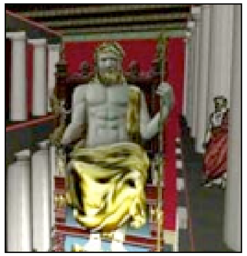
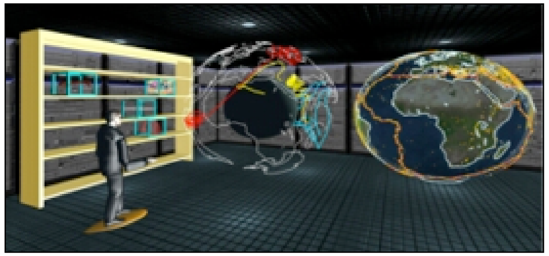
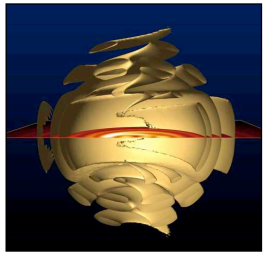


iGrid 2002

September 24-26, 2002, Amsterdam, The Netherlands

- 28 demonstrations from 16 countries: Australia, Canada, CERN, France, Finland, Germany, Greece, Italy, Japan, The Netherlands, Singapore, Spain, Sweden, Taiwan, United Kingdom, United States
- Applications demonstrated: art, bioinformatics, chemistry, cosmology, cultural heritage, education, high-definition media streaming, manufacturing, medicine, neuroscience, physics, tele-science



- Grid technologies demonstrated: Major emphasis on grid middleware, data management grids, data replication grids, visualization grids, data/visualization grids, computational grids, access grids, grid portals
- 25Gb transatlantic bandwidth (100Mb/attendee, 250x iGrid2000!)

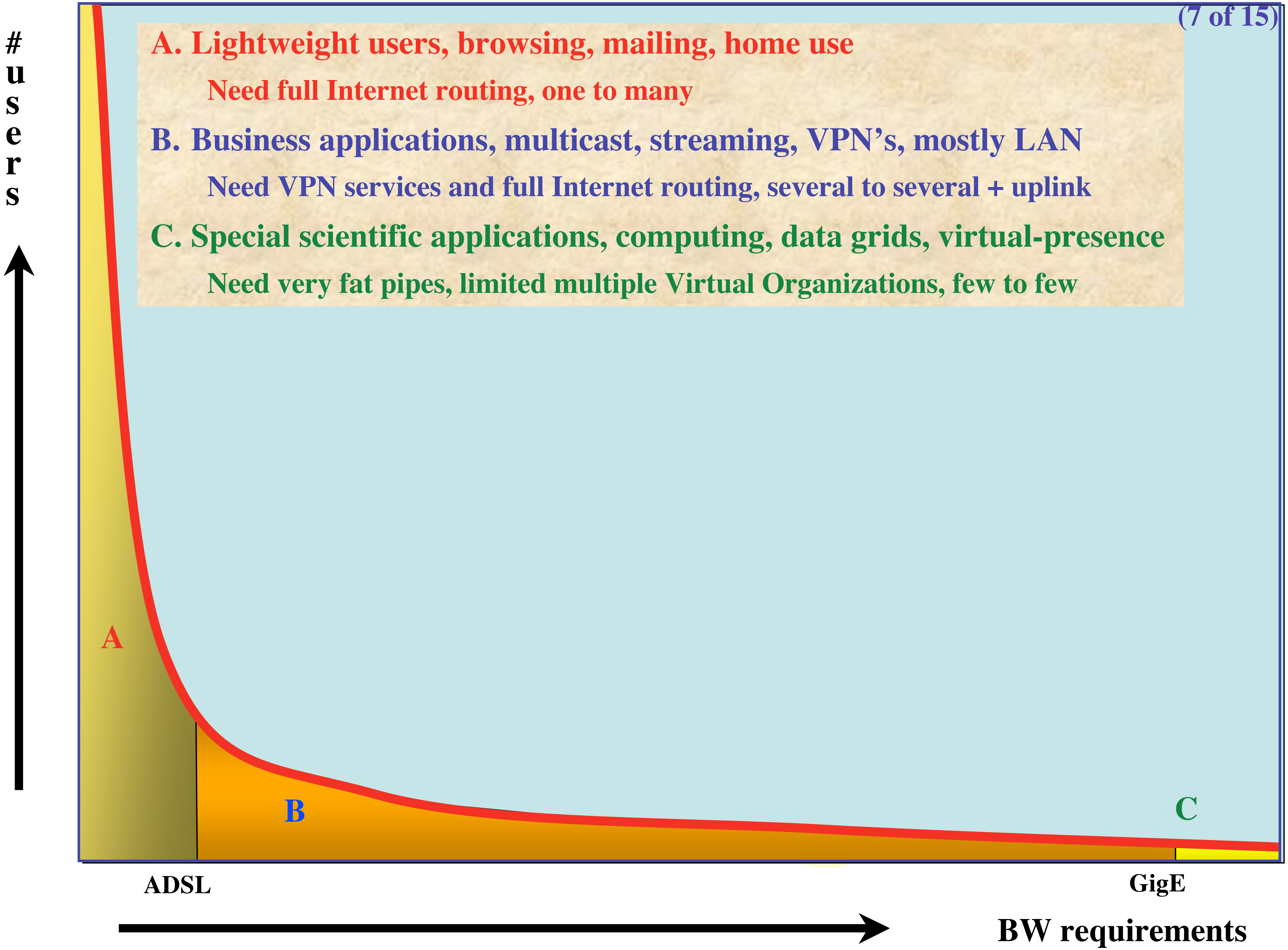
www.igrid2002.org

iGrid 2002

Sept 24-26, 2002, Amsterdam, The Netherlands

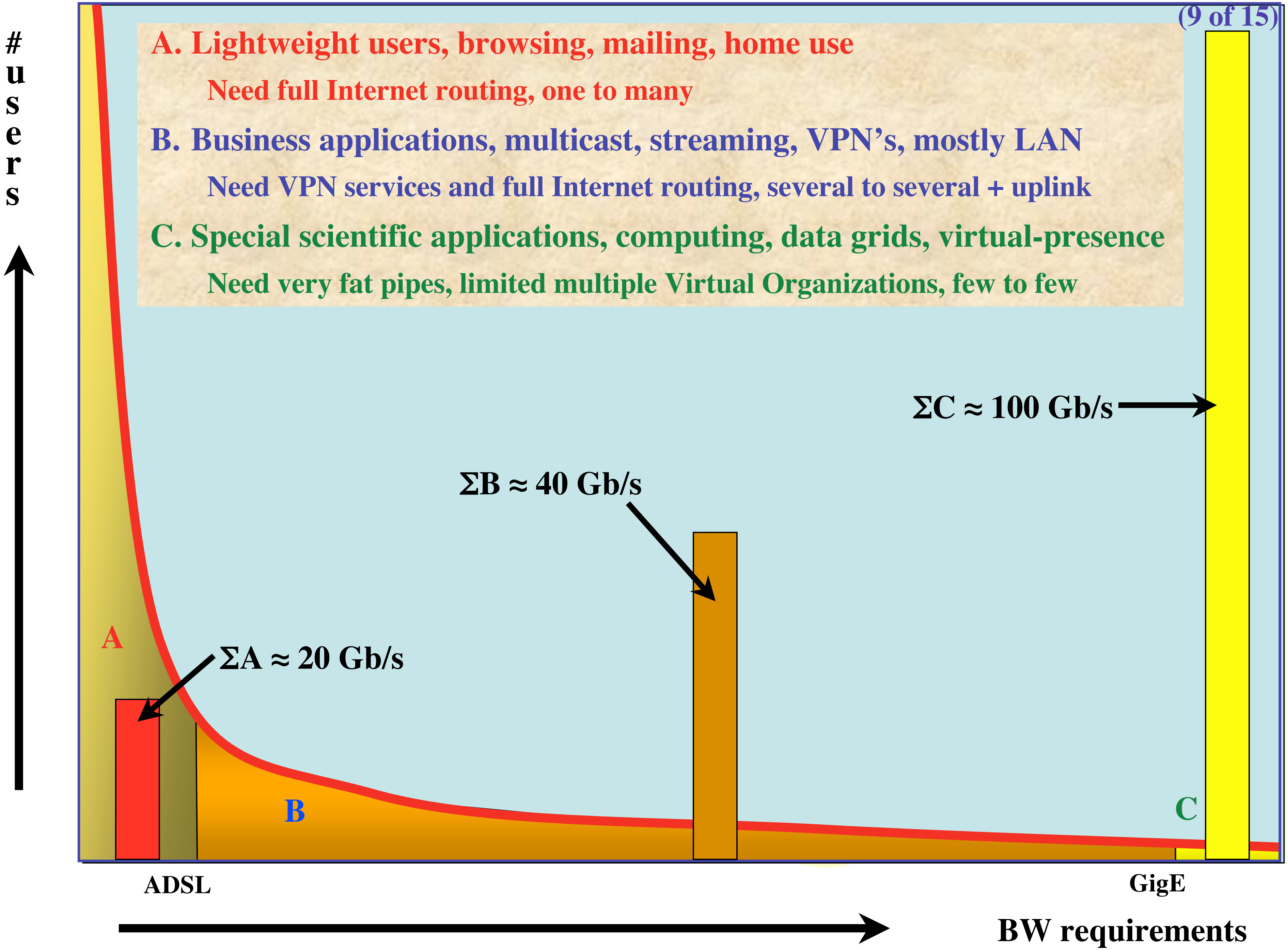
Conference issue
FGCS
Volume 19 (2003)
Number 6 august
22 refereed papers!

THESE ARE THE APPLICATIONS!


A. Lightweight users, browsing, mailing, home use
Need full Internet routing, one to many
B. Business applications, multicast, streaming, VPN's, mostly LAN
Need VPN services and full Internet routing, several to several + uplink
C. Special scientific applications, computing, data grids, virtual-presence
Need very fat pipes, limited multiple Virtual Organizations, few to few
users
A
B
C
ADSL
GigE
BW requirements

The Dutch Situation

- **Estimate A**
  - **17 M people, 6.4 M households, 25 % penetration of 0.5 Mb/s ADSL, 40 times under-provisioning ==> 20 Gb/s**
- **Estimate B**
  - **SURFnet has 10 Gb/s to about 12 institutes and 0.1 to 1 Gb/s to 180 customers, estimate same for industry (overestimation) ==> 20-40 Gb/s**
- **Estimate C**
  - **Leading HEF and ASTRO + rest ==> 80-120 Gb/s**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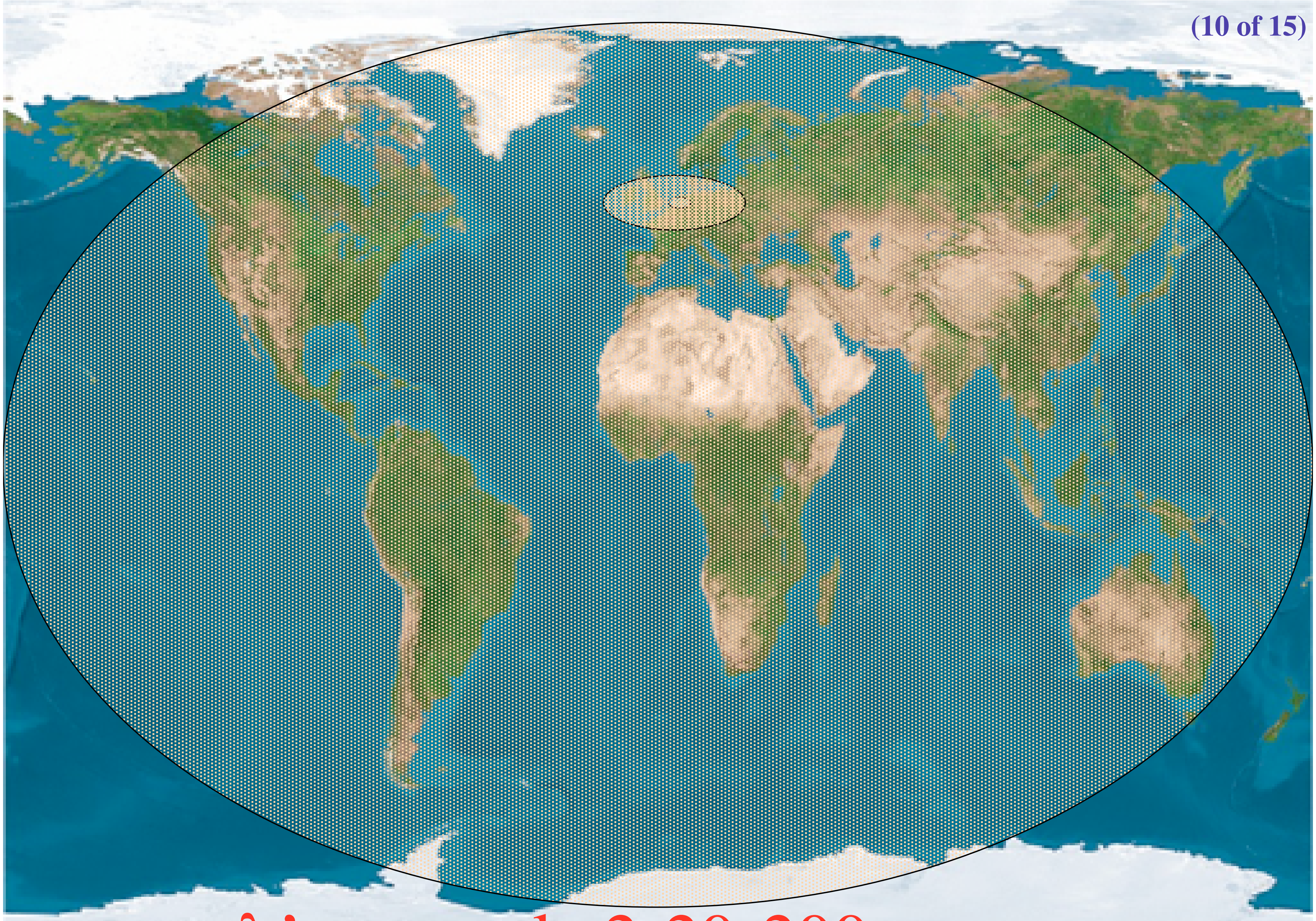
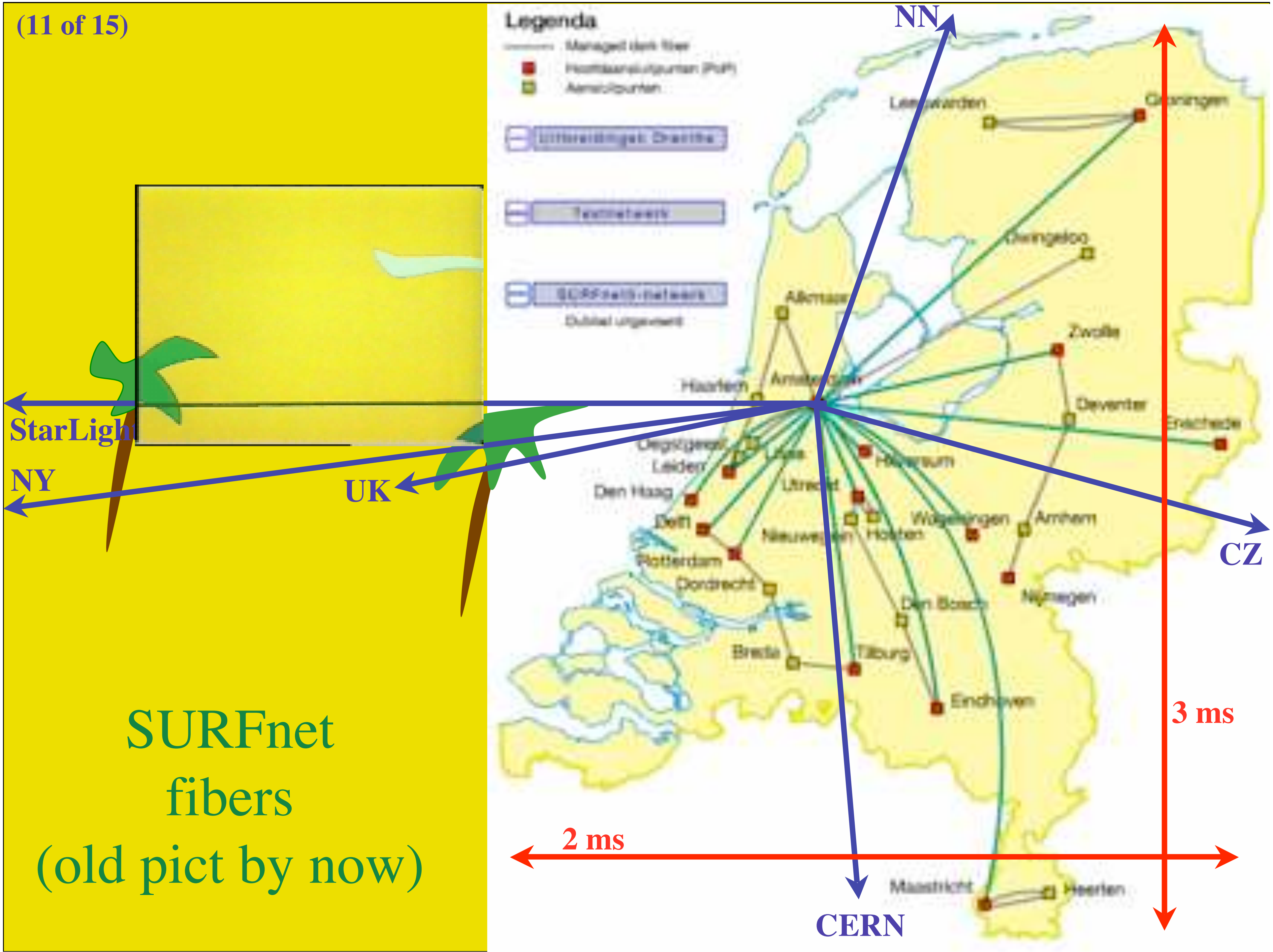
C. Special scientific applications, computing, data grids, virtual-presence
Need very fat pipes, limited multiple Virtual Organizations, few to few
users
ΣC ≈ 100 Gb/s
ΣB ≈ 40 Gb/s
ΣA ≈ 20 Gb/s
A
B
C
ADSL
GigE
BW requirements



λ’s on scale 2-20-200 ms rtt



SURFnet
fibers
(old pict by now)

The only formula's

$$\#\,\lambda(rtt,t) \approx \frac{200 * e^{(t-2002)}}{rtt}$$

Now, having been a High Energy Physicist we set

c = 1

e = 1

$\bar{h}$ = 1

and the formula reduces to: $\#\,\lambda(rtt,t) \approx \frac{200 * e^{(t-2002)}}{rtt}$

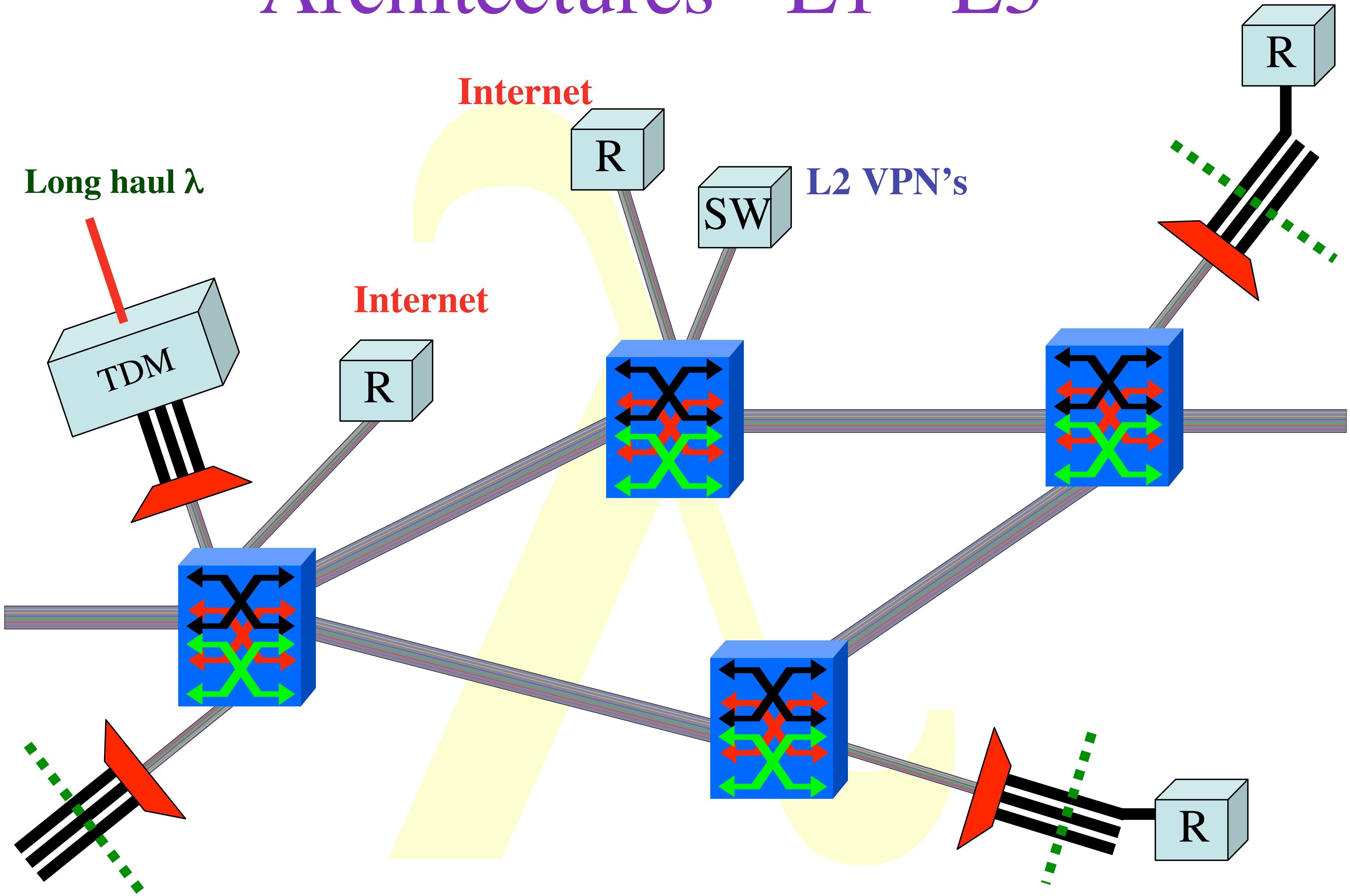
So what are the facts

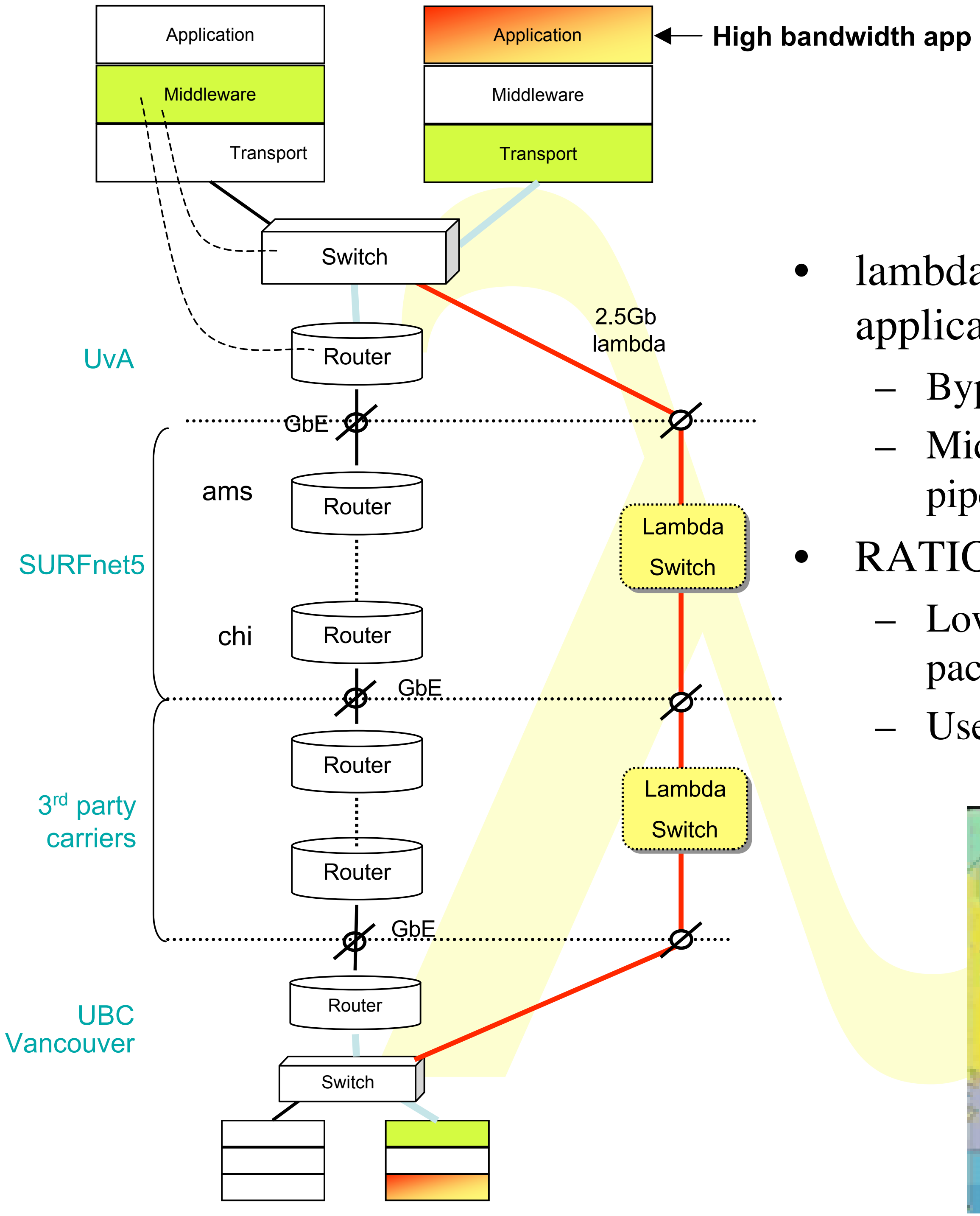
- Costs of fat pipes (fibers) are one/third of cost of equipment to light them up
  - Is what Lambda salesmen tell me
- Costs of optical equipment 10% of switching 10 % of full routing equipment for same throughput
  - 100 Byte packet @ 40 Gb/s -> 20 ns to look up in 140 kEntries routing table (light speed from me to you!)
- Big sciences need fat pipes
- Bottom line: look for a hybrid architecture which serves all classes in a cost effective way (A -> L3 , B -> L2 , C -> L1)
- Tested 10 gbps Ethernet WANPHY Amsterdam-CERN
  - http://www.surfnet.nl/en/publications/pressreleases/021003.html

Services

SCALE / CLASS	2 Metro	20 National/ regional	200 World
A	Switching/ routing	Routing	ROUTER$
B	Switches + E-WANPHY VPN's,	Switches + E-WANPHY (G)MPLS	ROUTER$
C	dark fiber Optical switching	Lambda switching	Sub-lambdas, ethernet-sdh

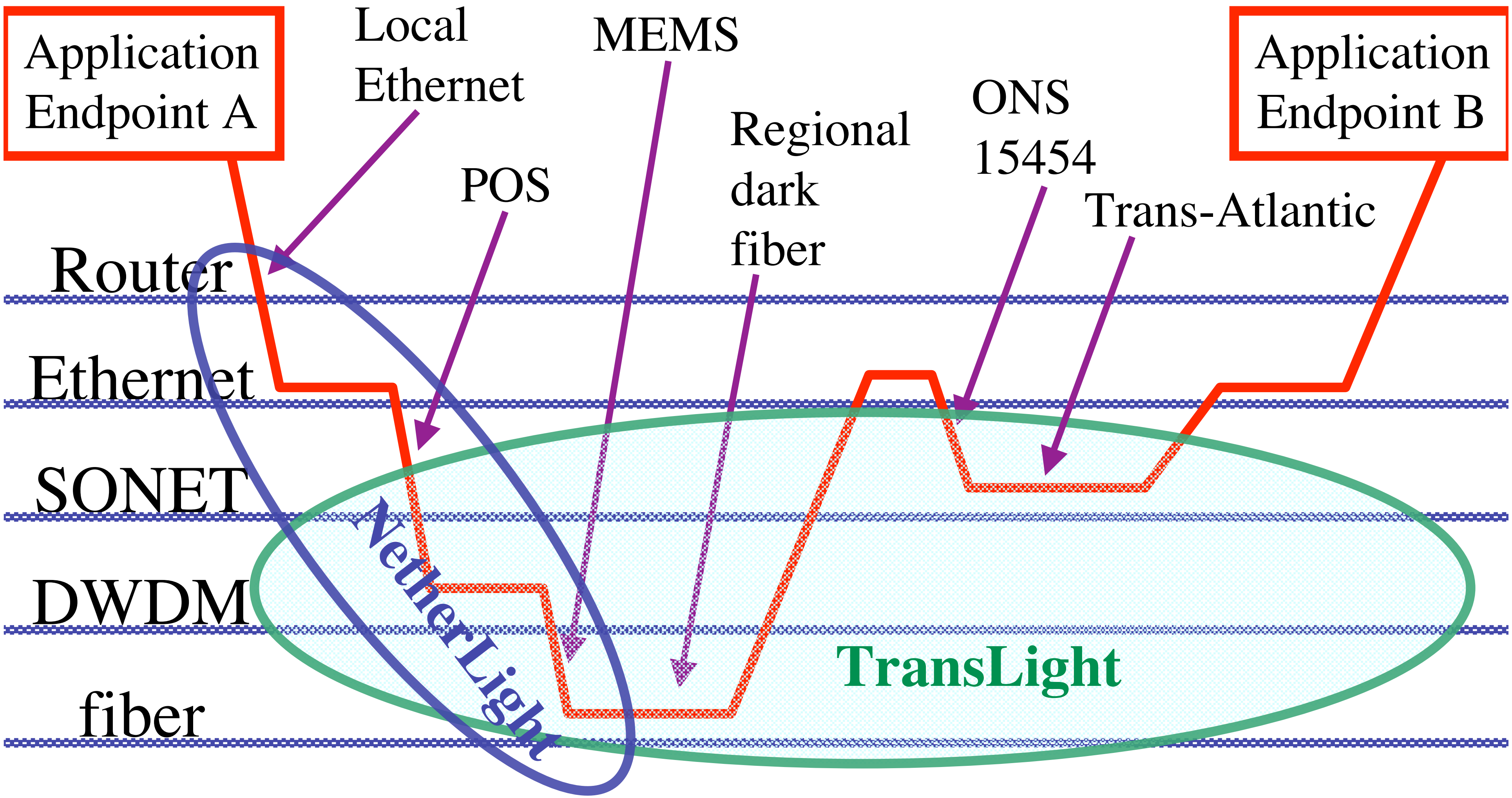
Architectures - L1 - L3



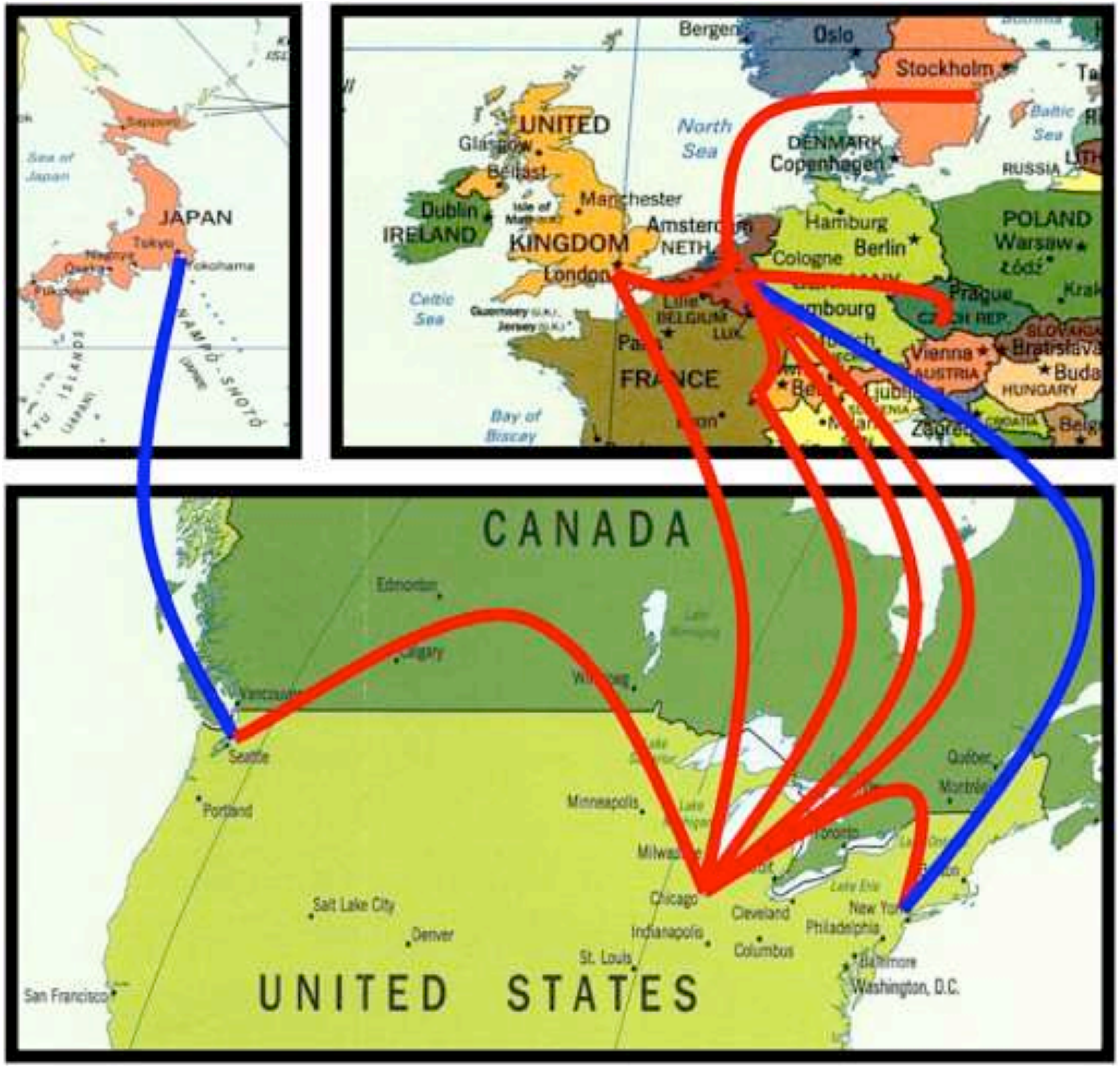


- lambda for high bandwidth applications
  - Bypass of production network
  - Middleware may request (optical) pipe
- RATIONALE:
  - Lower the cost of transport per packet
  - Use Internet as controlplane!

How low can you go?



TransLight Lambdas



European lambdas to US
–6 GigEs Amsterdam—Chicago
–2 GigEs CERN—Chicago
–8 GigEs London—Chicago

Canadian lambdas to US
–8 GigEs Chicago—Canada—NYC
–8 GigEs Chicago—Canada—Seattle

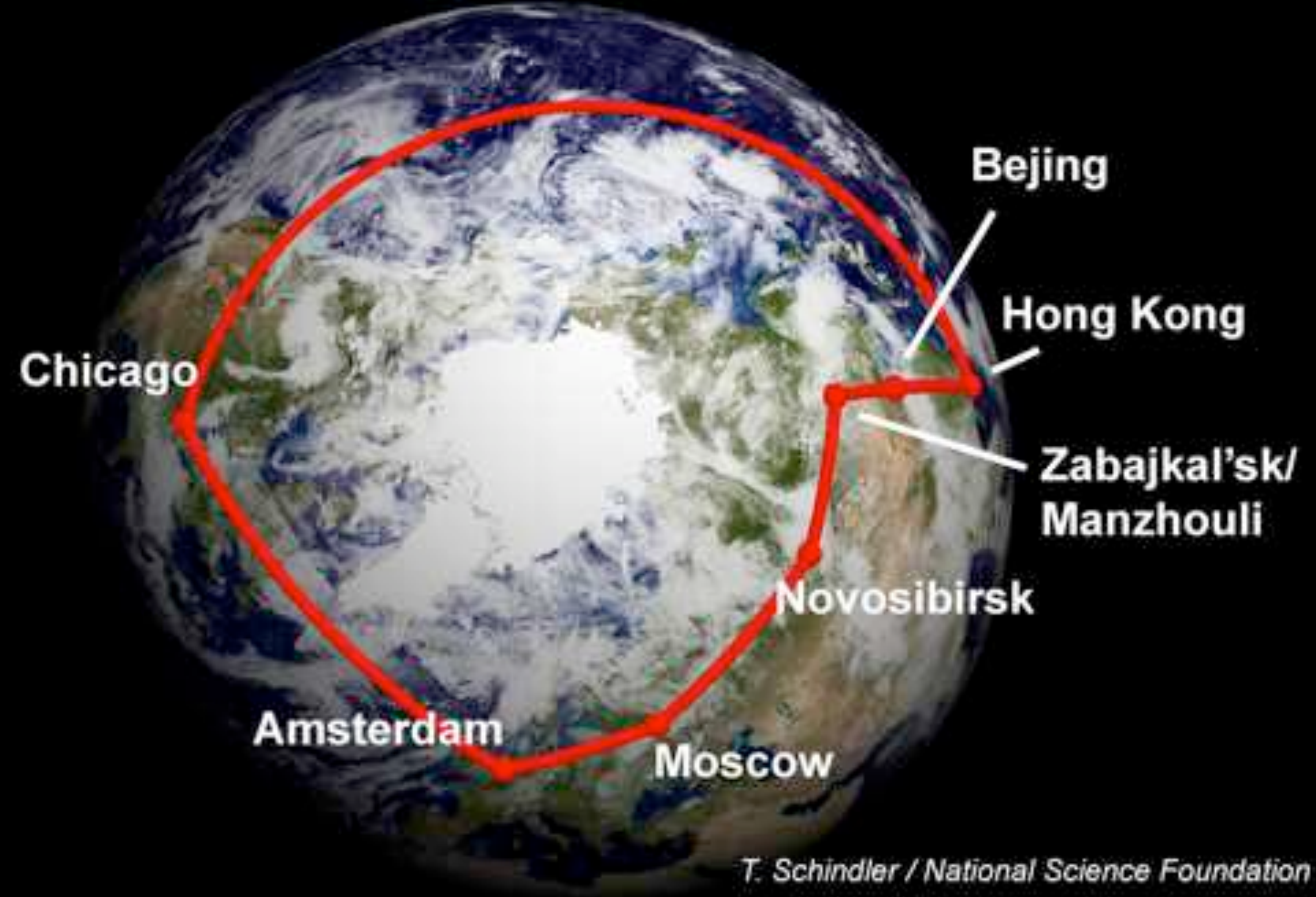
US lambdas to Europe
–4 GigEs Chicago—Amsterdam
–2 GigEs Chicago—CERN

European lambdas
–8 GigEs Amsterdam—CERN
–2 GigEs Prague—Amsterdam
–2 GigEs Stockholm—Amsterdam
–8 GigEs London—Amsterdam

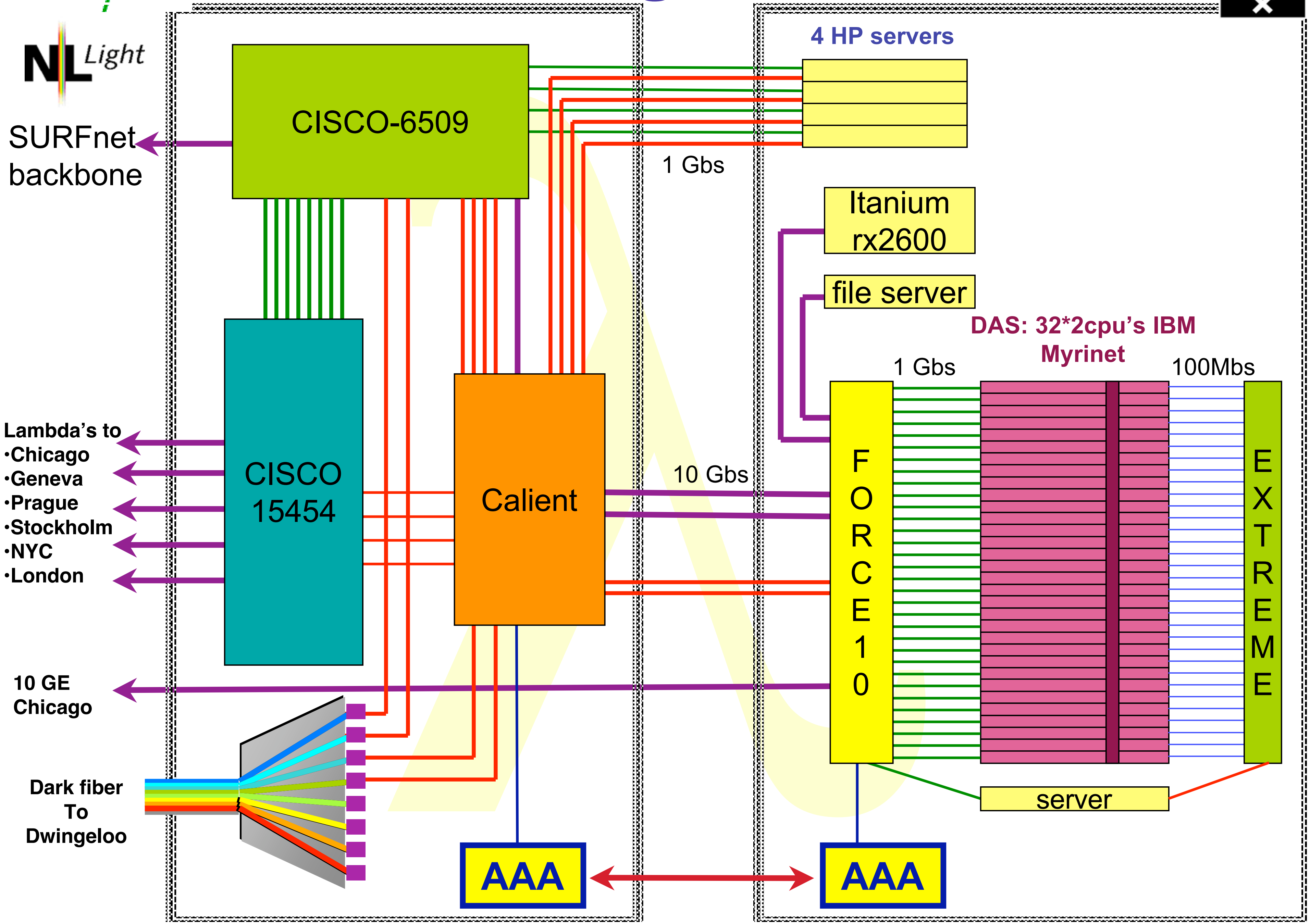
IEEAF lambdas (blue)
–8 GigEs Seattle—Tokyo
–8 GigEs NYC—Amsterdam

Little GLORIAD

http://www.nsf.gov/od/lpa/news/03/pr03151.htm



NetherLight - UvA



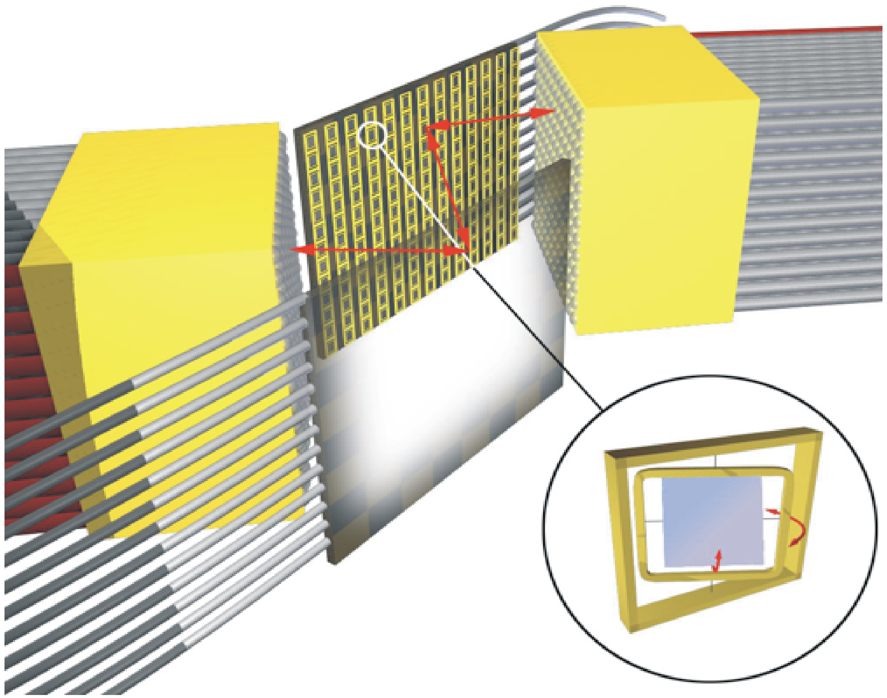
UVA/EVL's
64*64
Optical Switch
@ NetherLight
in SURFnet POP
@ SARA

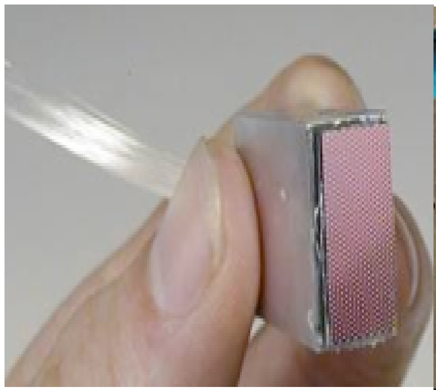
Costs 1/100th of
a similar
throughput router
but with specific
services!

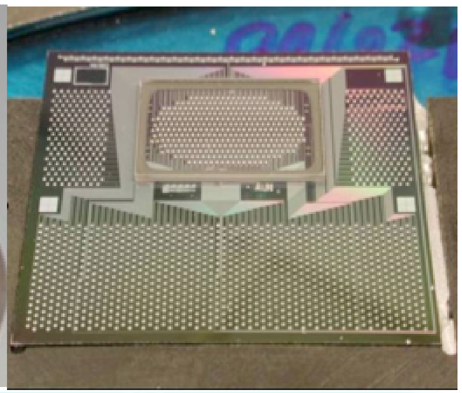
Core Switch Technology

(Intermezzo-2)

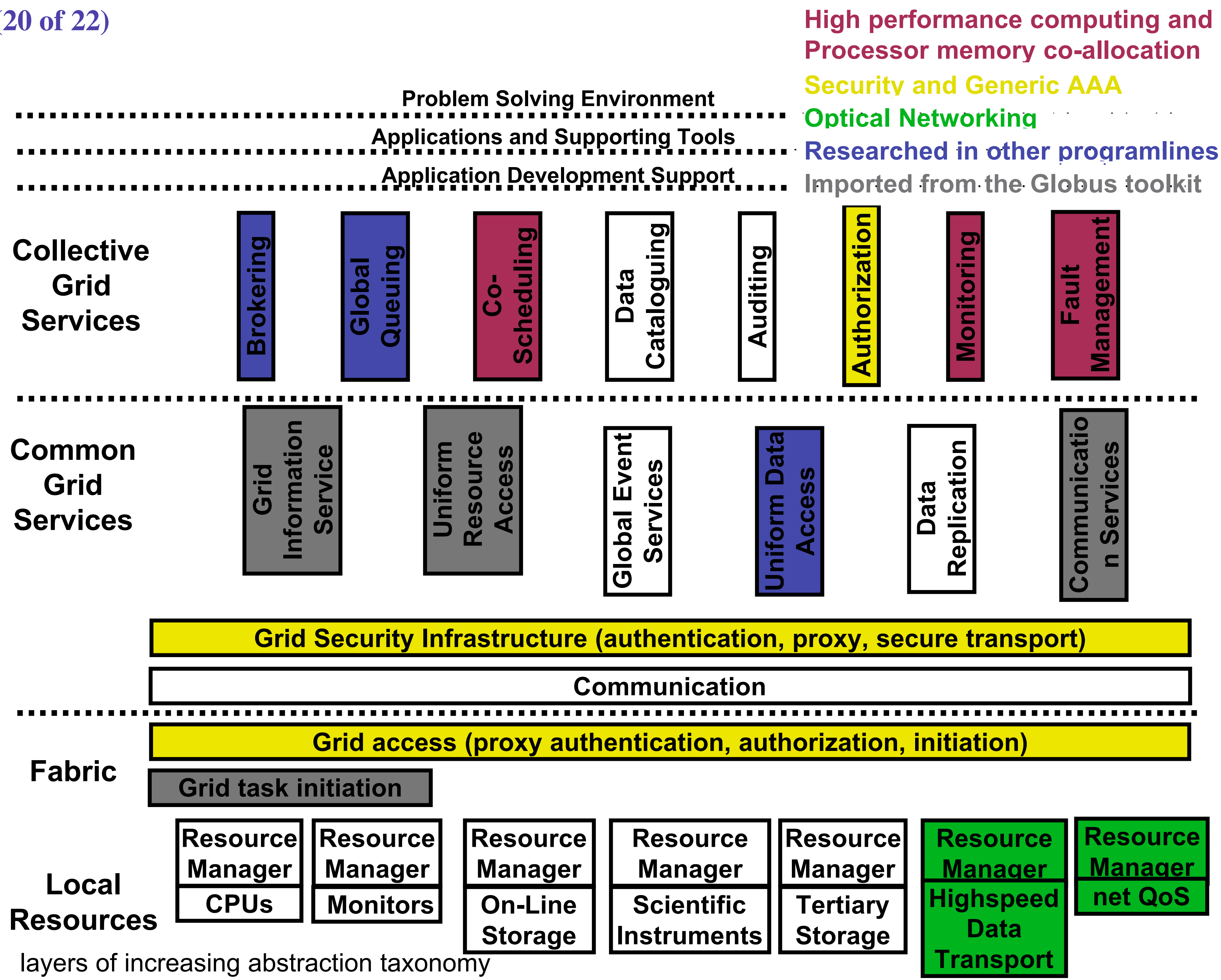
Calient NETWORKS





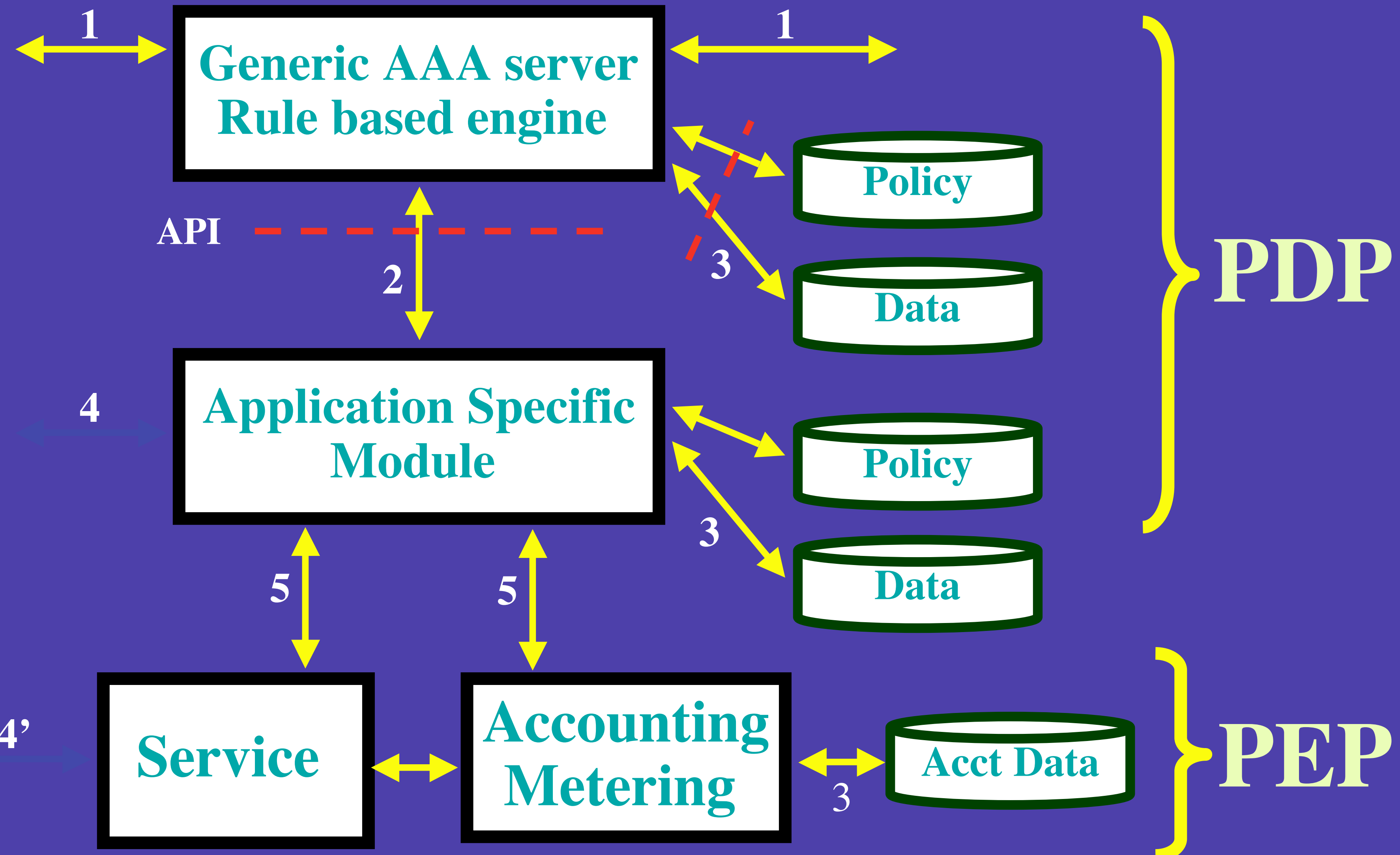


- **3D MEMS structure**
  - Bulk MEMS – High Density Chips
  - Electrostatic actuation
  - Short path length (~4cm)
  - <1.5 dB median loss
- **Completely Non-blocking**
  - Single-stage up to 1Kx1K
  - 10 ms switching time
- **Excellent Transparency**
  - Polarization
  - Bit rate
  - Wavelength



layers of increasing abstraction taxonomy

Starting point

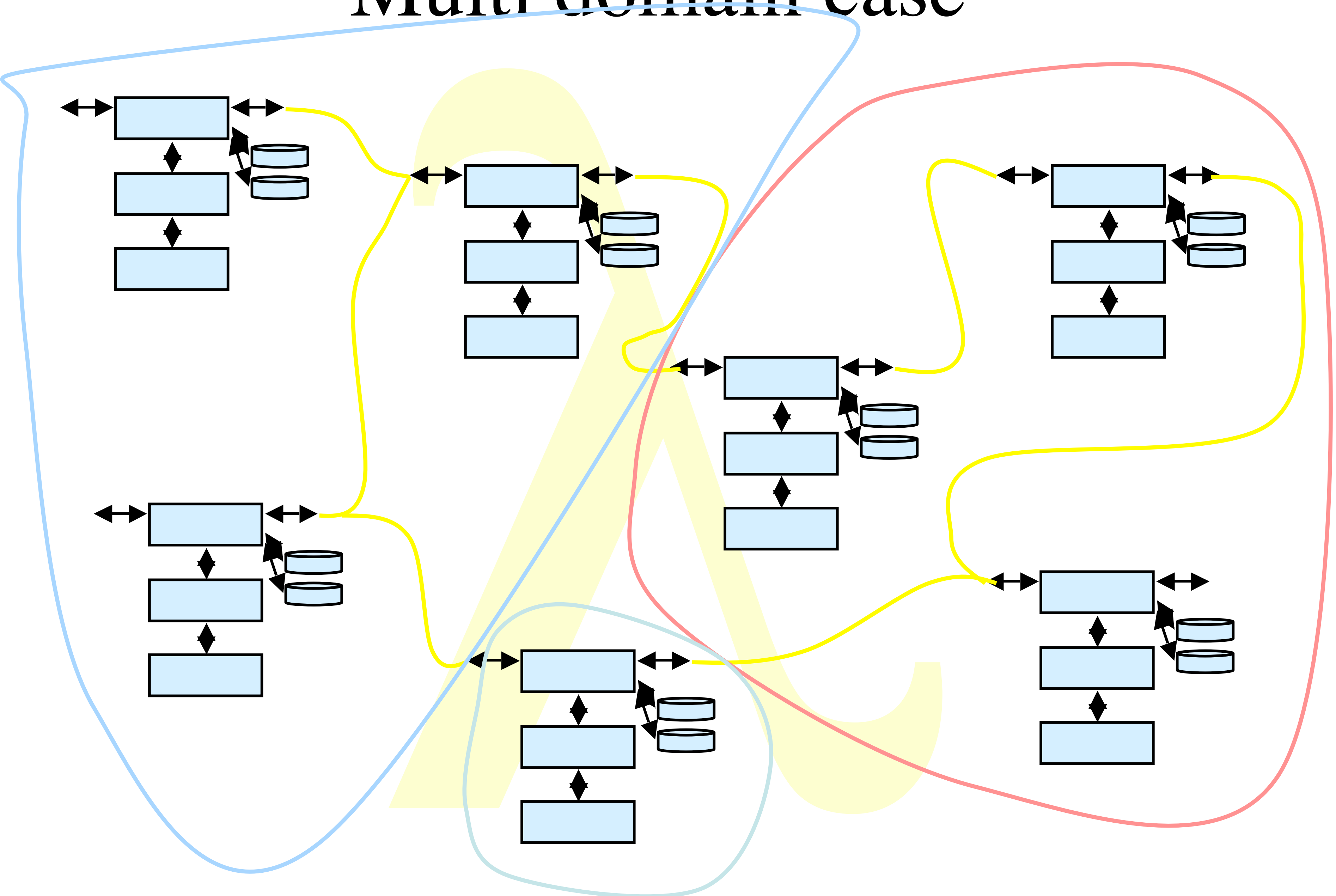


RFC 2903 - 2906 , 3334 , policy draft

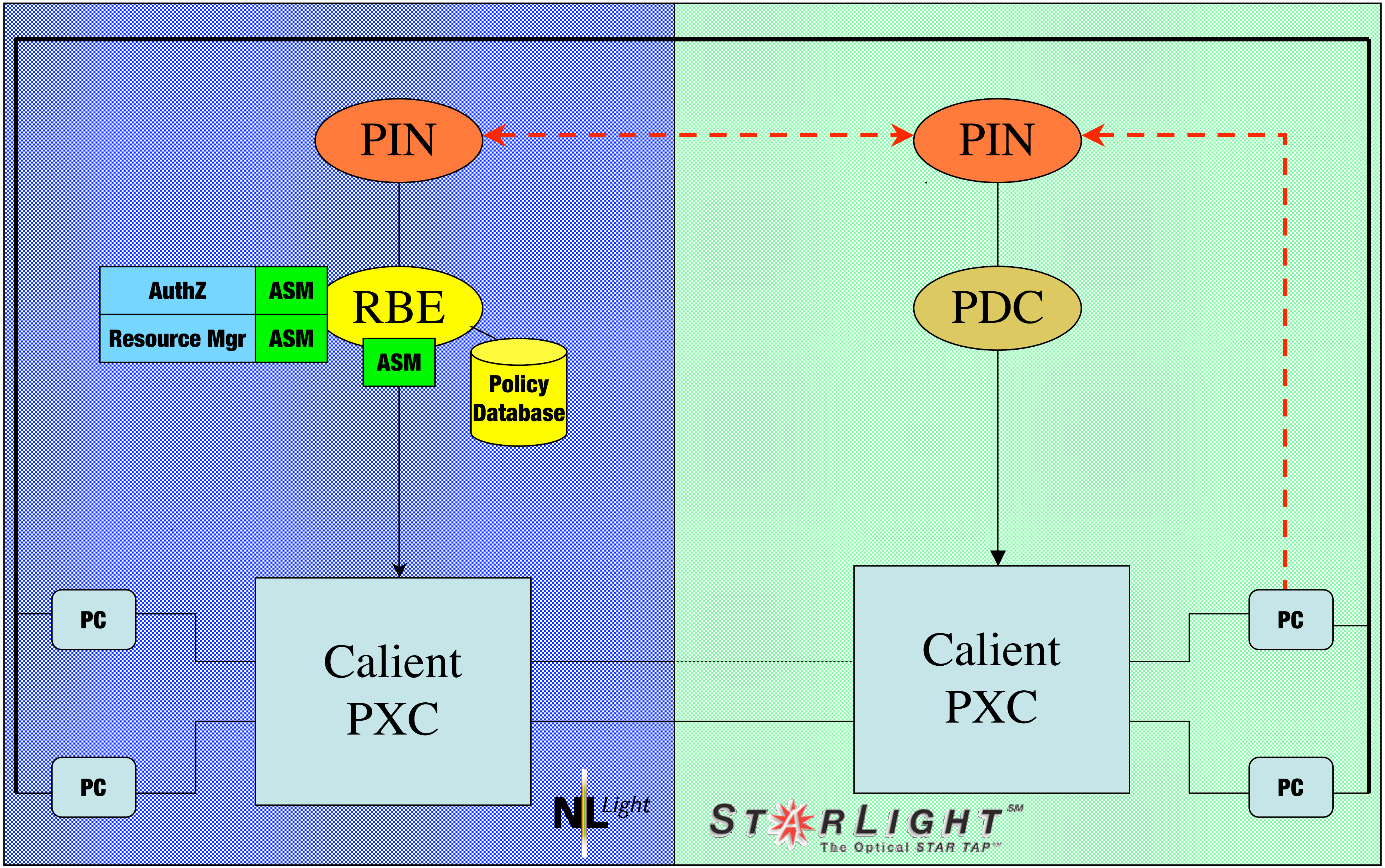
Multi Domain Lambda setup

- AAA based on RFC 2903-2906
- OGSI wrapper
- Interface to CALIENT optical switch, layer 2 switches
- Interface to PDC
- Broker for path searching, selection
- Web and application interface
- Demonstration on SC2003

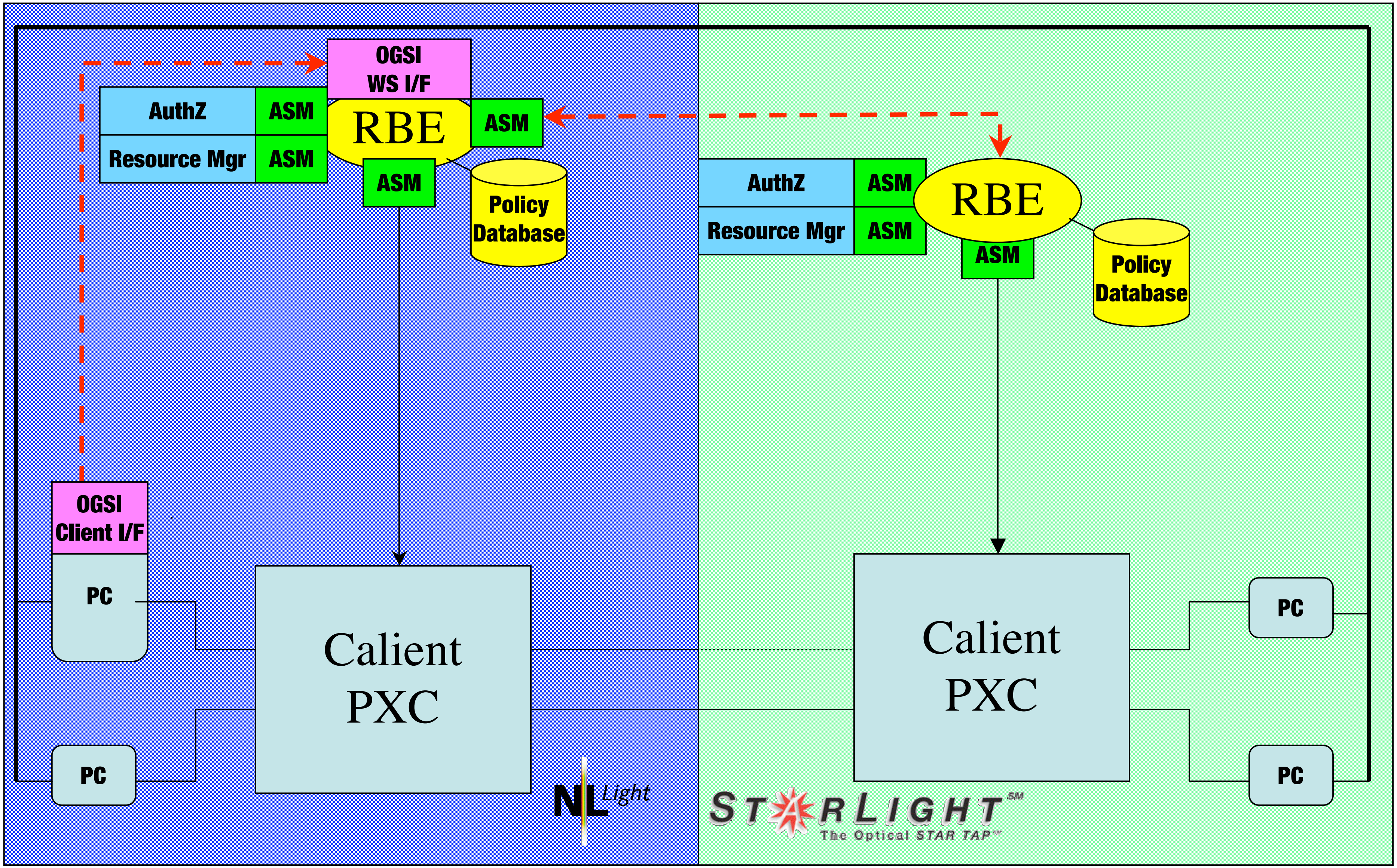
Multi domain case



Multi-domain experiment 1 at SC2003



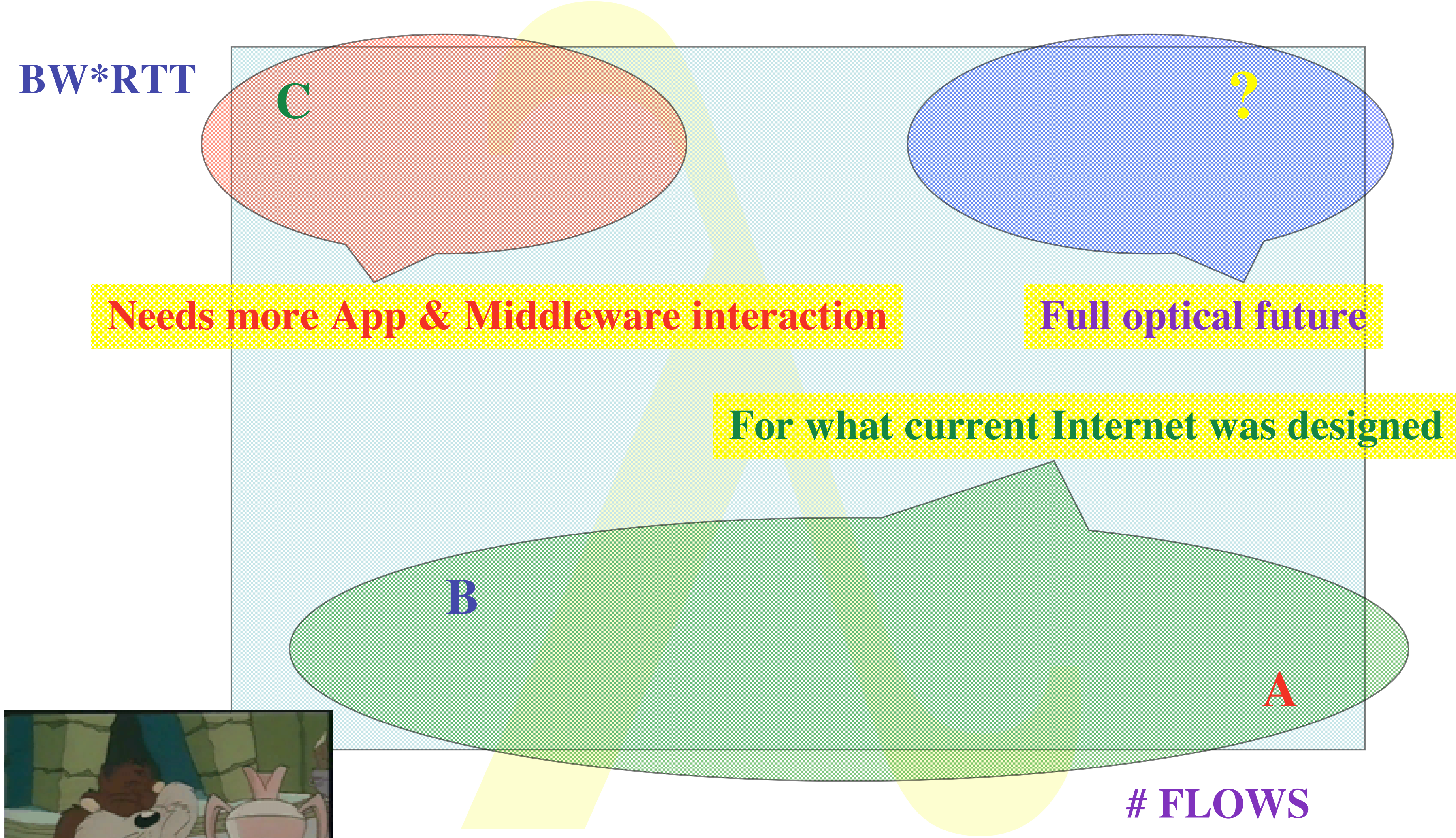
Multi-domain experiment 2 at SC2003



Research topics

- Optical networking architectures and models for usage
- Transport protocols for massive amounts of data
- Authorization of complex resources in multiple domains
- Embedding in Grid environments

Transport in the corners



The END

Thanks to

SURFnet: Kees Neggers,UIC&iCAIR: Tom DeFanti, Joel Mambretti, CANARIE: Bill St. Arnaud

Freek Dijkstra, Hans Blom, Leon Gommans, Bas van oudenaarde, Arie Taal, Pieter de Boer, Bert Andree, Martijn de Munnik, Antony Antony, Rob Meijer, VL-team.

Lambda workshop

- **Amsterdam - Terena**
  - **Concepts**
  - **Initial testbed (SURFnet Lambda to StarLight)**
- **Amsterdam - iGrid2002**
  - **Rechecking concepts models**
  - **Initial experiences and measurements**
  - **Expansion of Lambda testbed**
- **Reykjavik - NORDUnet**
  - **Towards persistent demonstrations and applications**

3th Lambda workshop @ NORDUnet 2003