Lambda Networking for Grid Applications

www.science.uva.nl/~delaat

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EU

SURFnet

University of Amsterdam

SARA

NIKHEF

NCF

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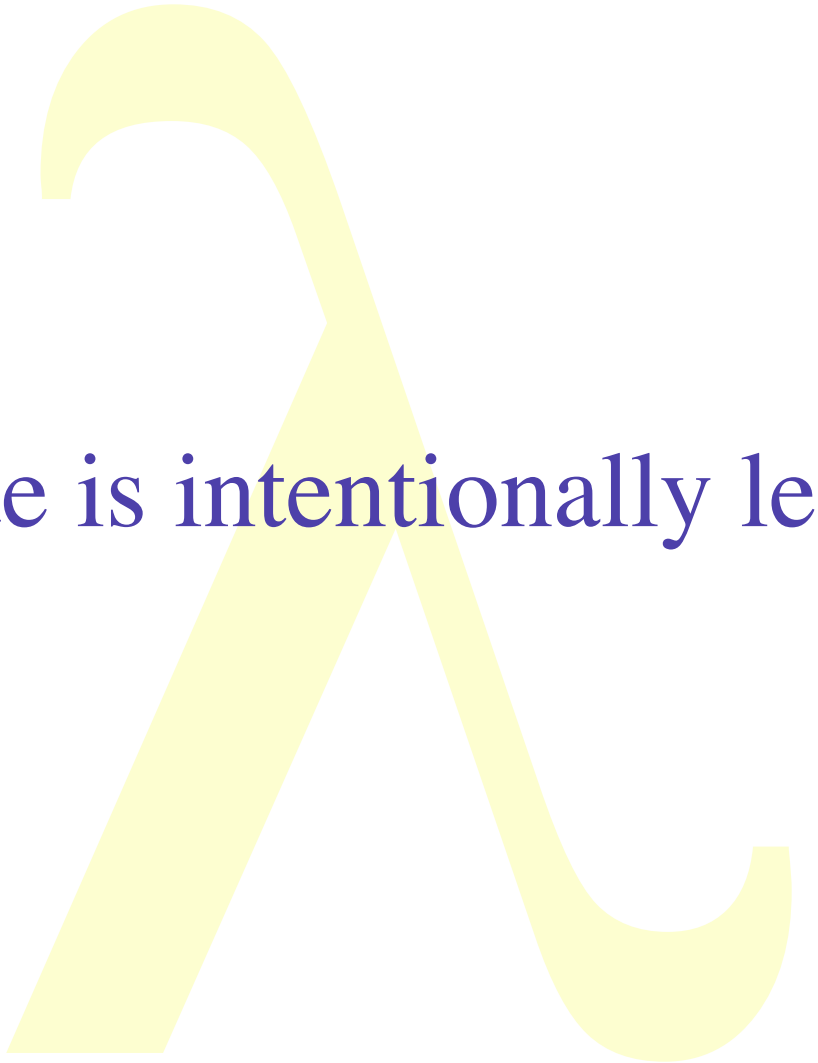
Contents of this talk



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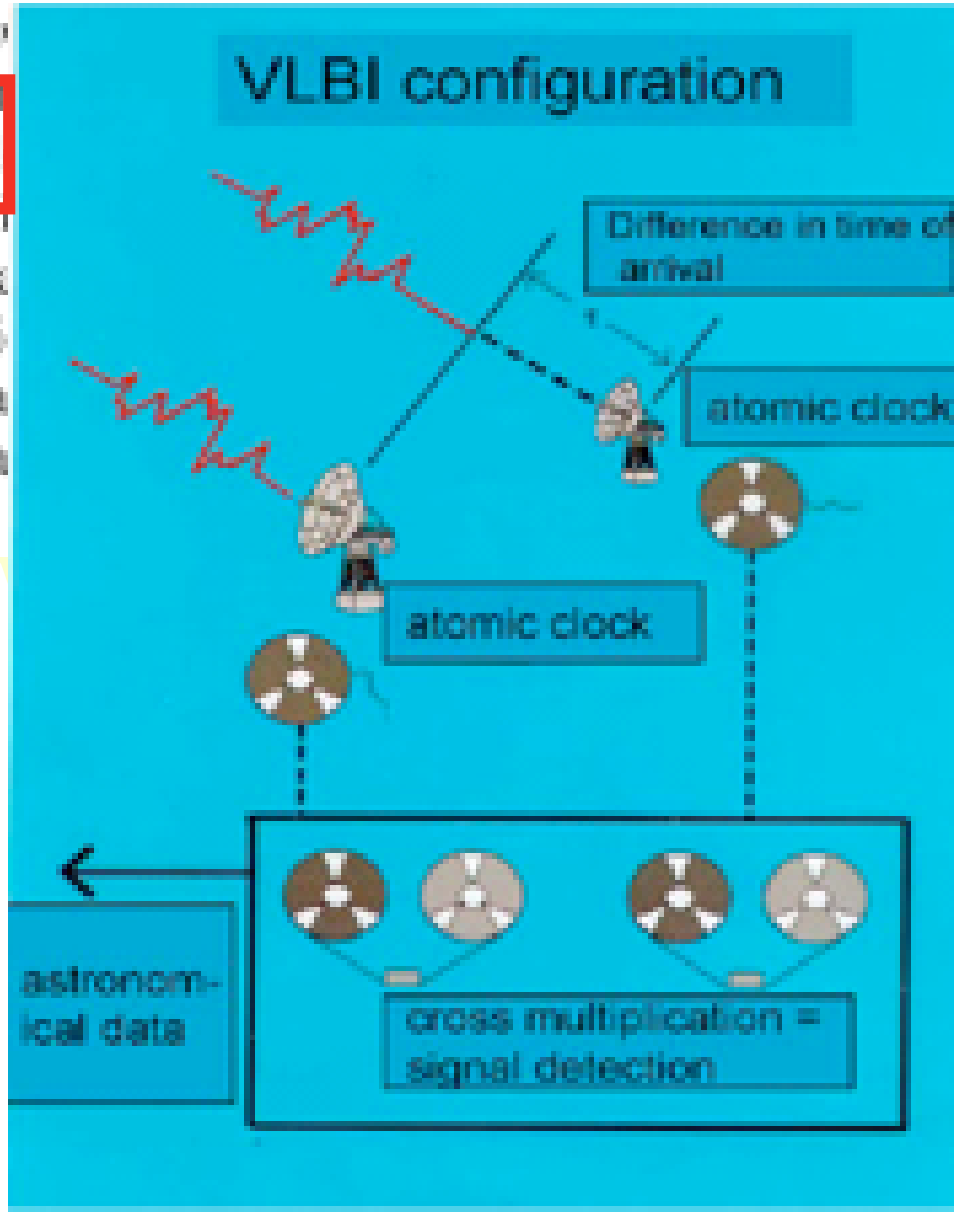
eVLBI

VLBI

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

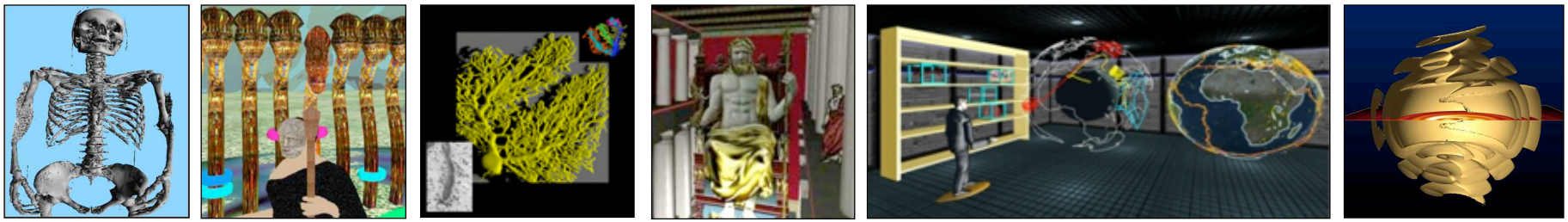
Westerbork Synthesis Radio Telescope - Netherlands



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!)

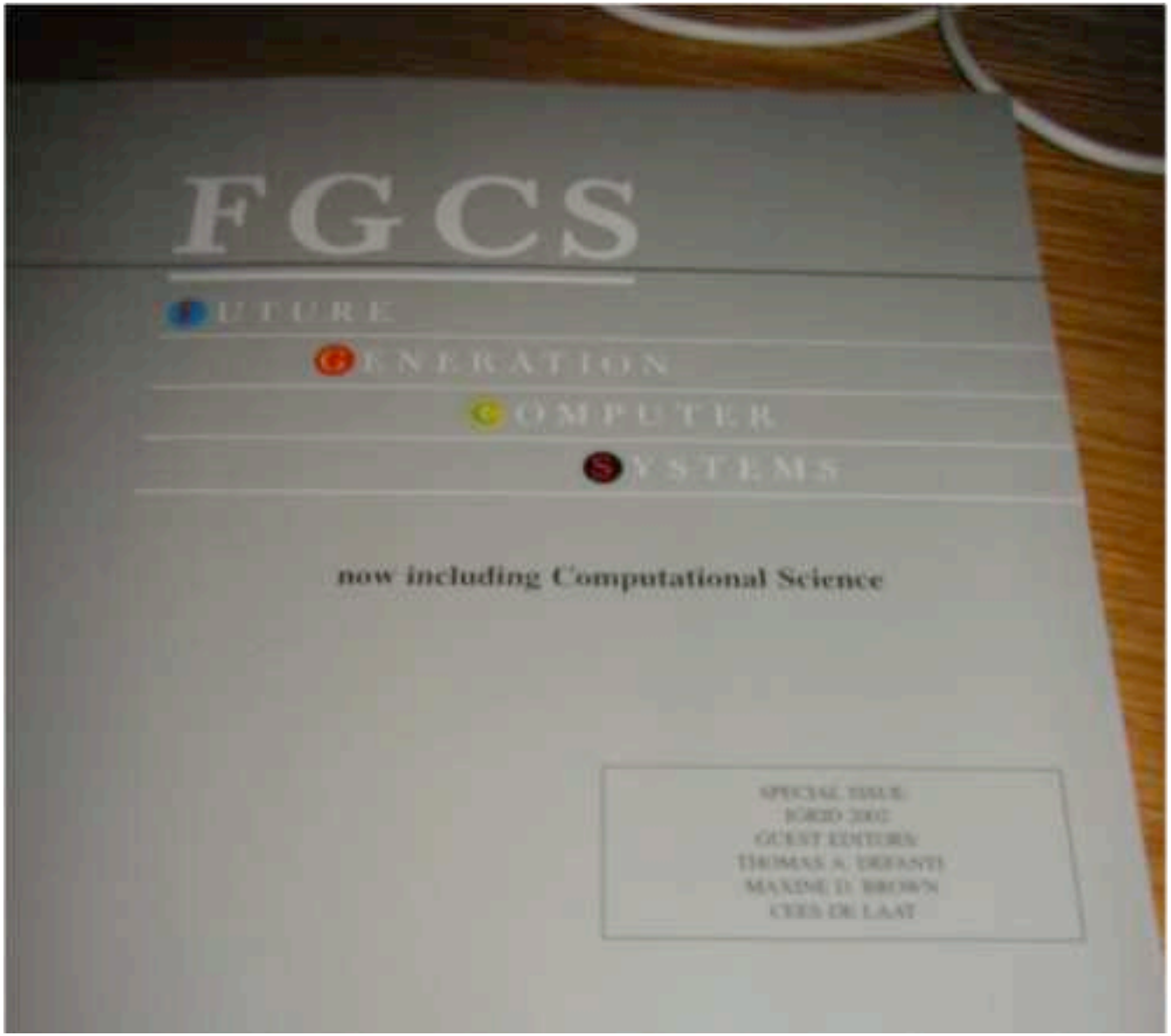
www.igrid2002.org

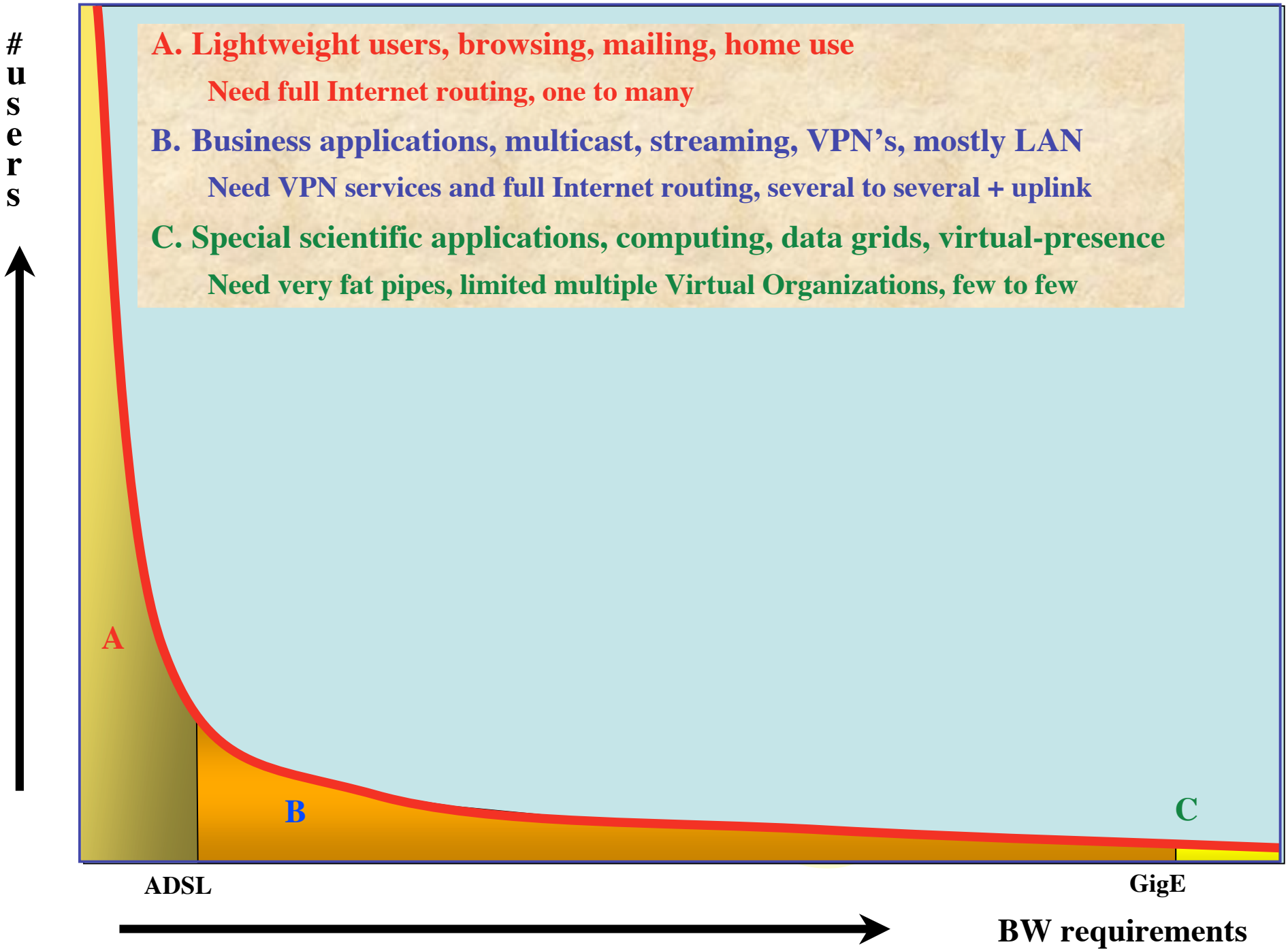
iGrid 2002

September 24-26, 2002, Amsterdam, The Netherlands

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

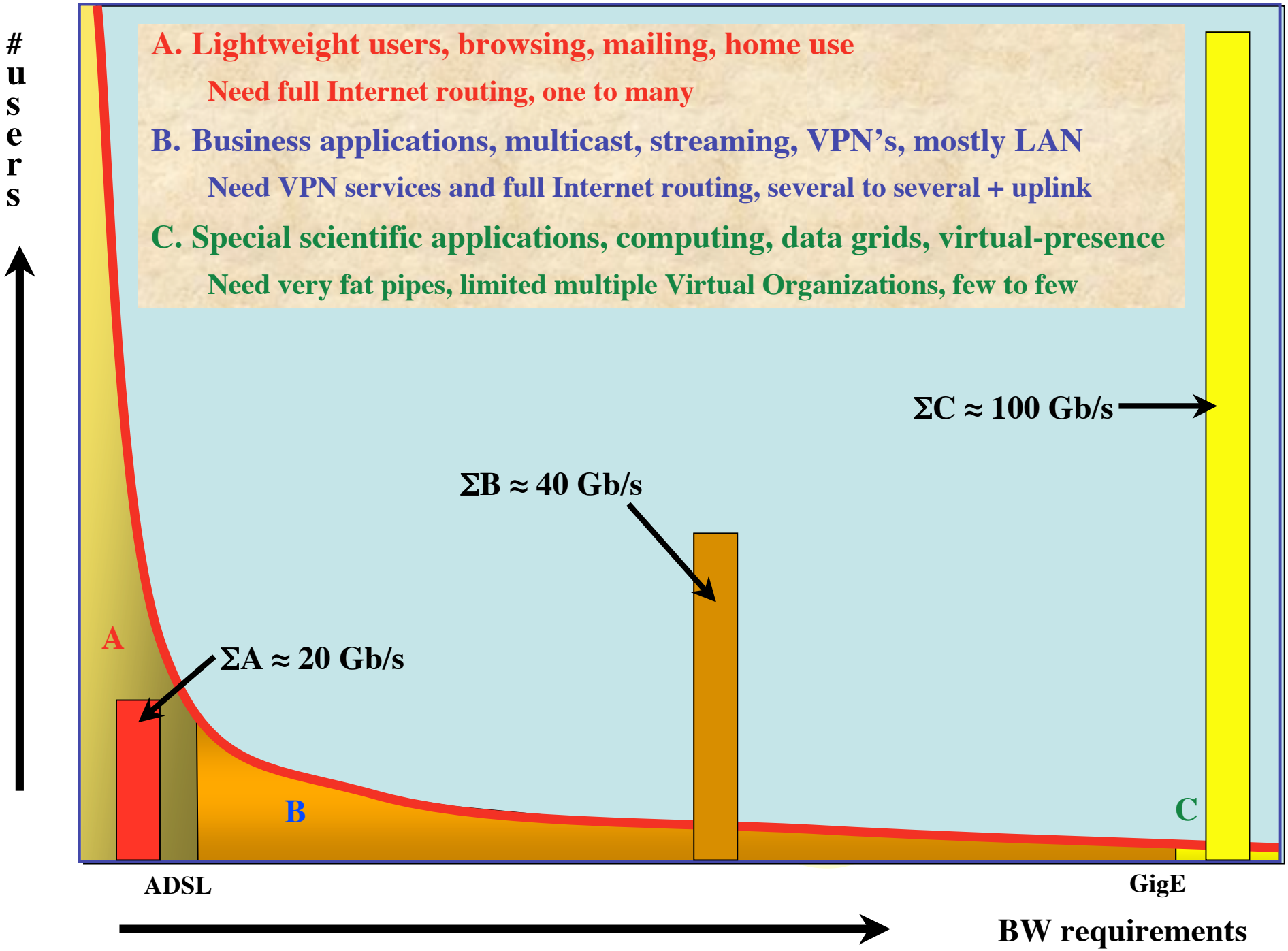
THESE
ARE
THE
APPLICATIONS!




#users
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
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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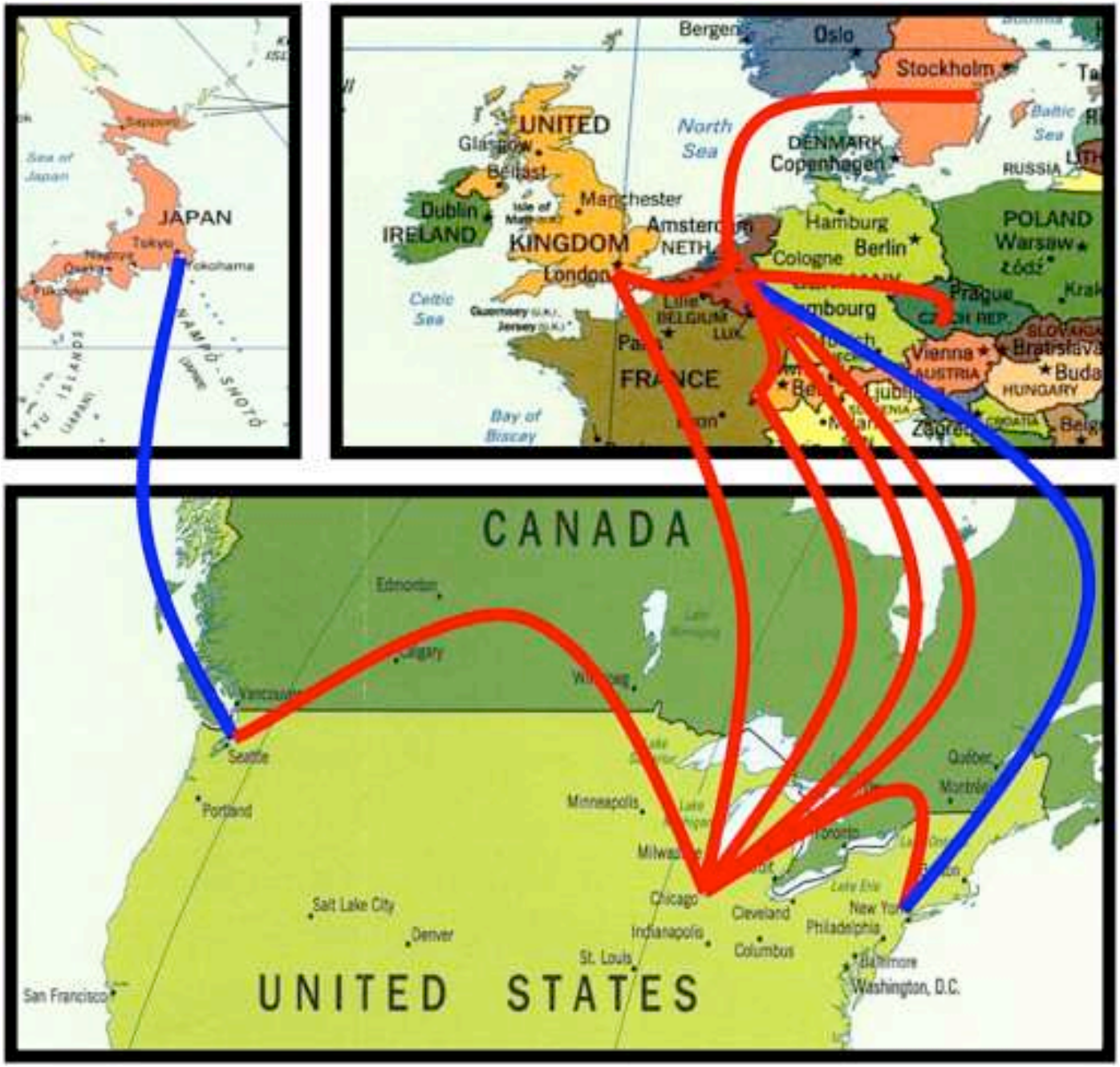
Need very fat pipes, limited multiple Virtual Organizations, few to few
users
ΣC ≈ 100 Gb/s
ΣB ≈ 40 Gb/s
ΣA ≈ 20 Gb/s
A
B
C
ADSL
GigE
BW requirements

TransLight Lambdas



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

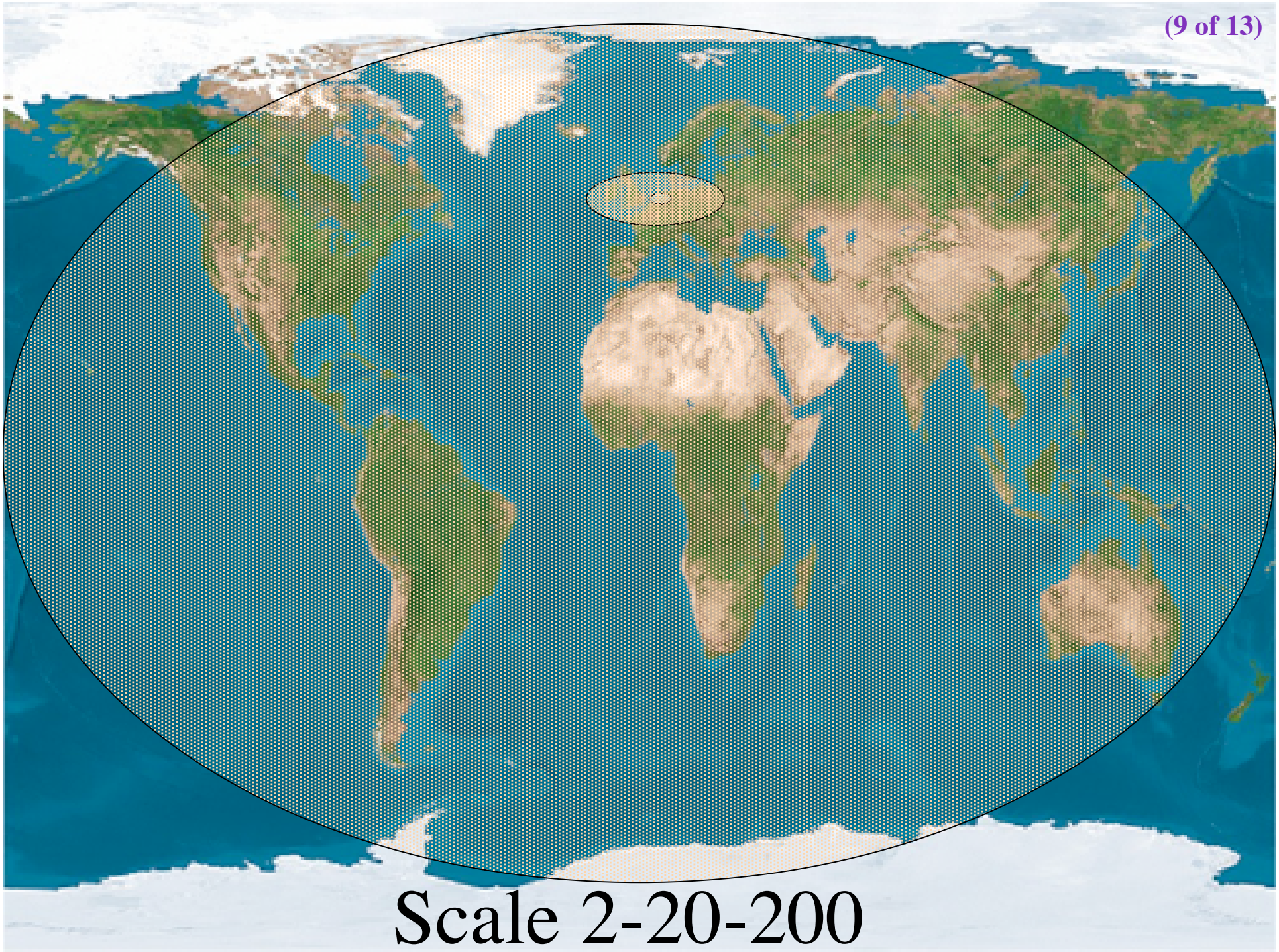
Canadian lambdas to US
–8 GigEs Chicago—Canada—NYC

–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



Scale 2-20-200

Services

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

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 users in a cost effective way

Lambda users

- **National Research Network's**
- **Virtual/Real Organization's**
- **Institutions**
- **Extreme applications**
- **Internet**

Lambda workshop

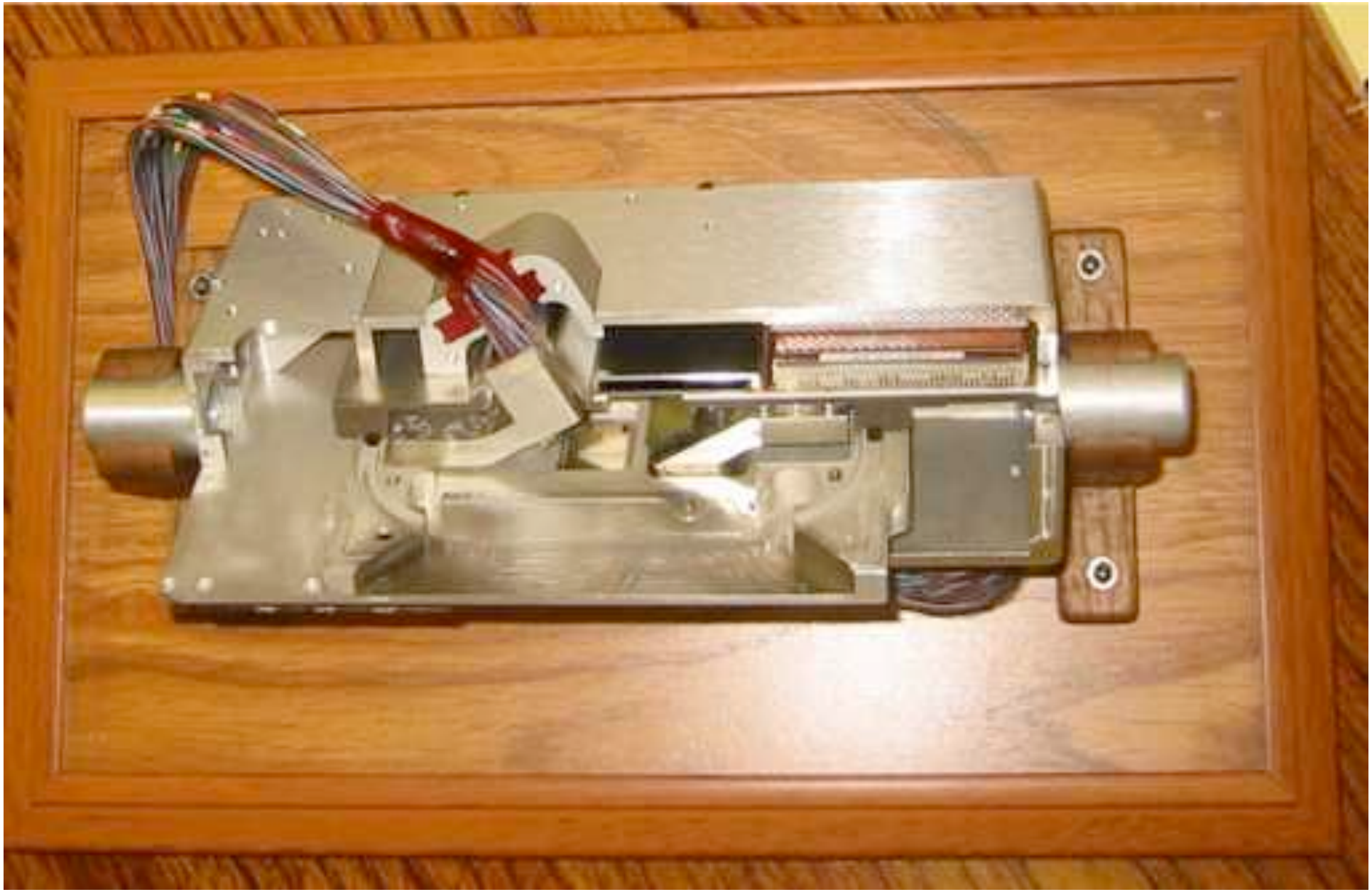
- **Amsterdam - Terena**
  - **Concepts**
  - **Initial testbed (SURFnet Lambda to StarLight)**
- **Amsterdam - iGrid2002**
  - **Rechecking concepts models**
  - **Initial experiences and measurements**
  - **Expansion of Lambda testbed**
- **Reykjavik - NORDUnet**
  - **Towards persistent demonstrations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

(Intermezzo)

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

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

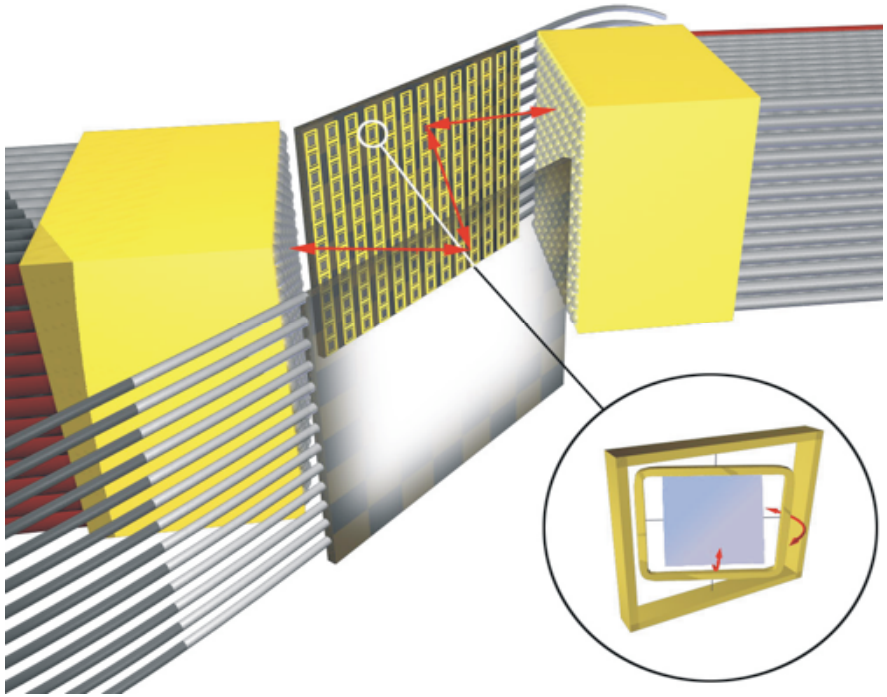
MEMS optical switch (CALIENT)

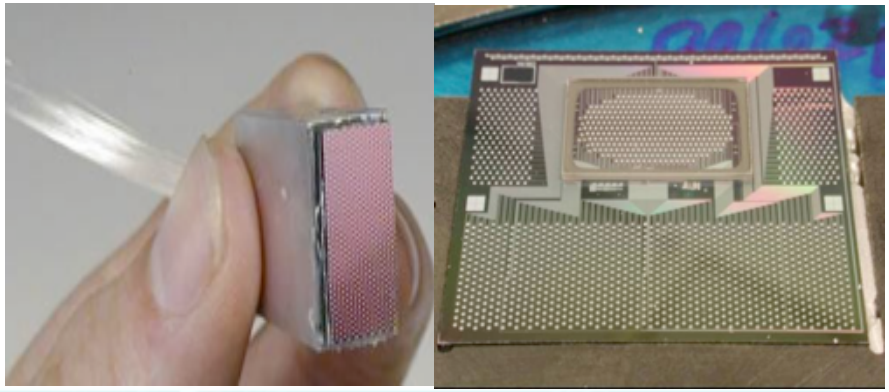


Core Switch Technology

(Intermezzo-3)

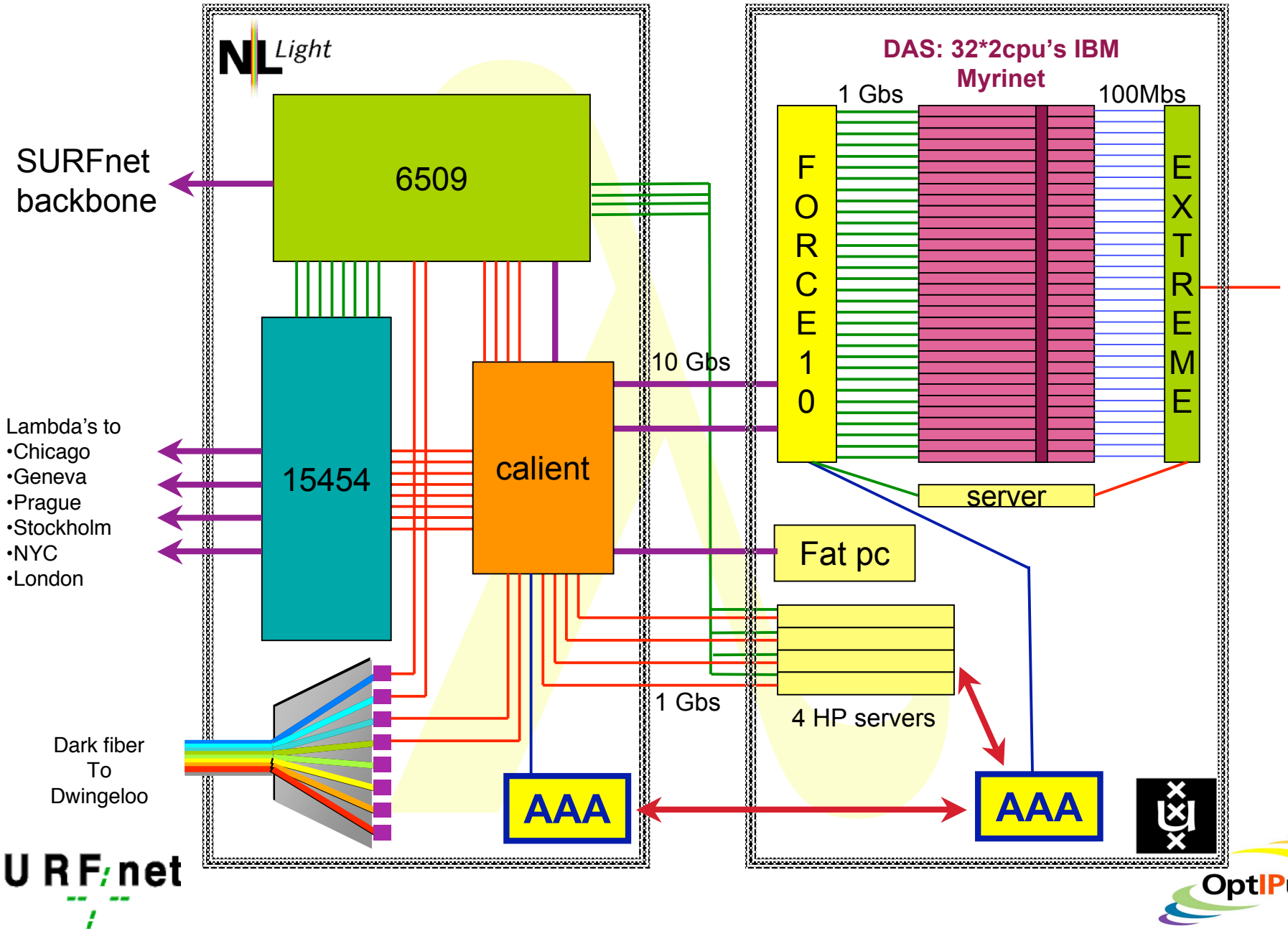
Calient NETWORKS





- **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

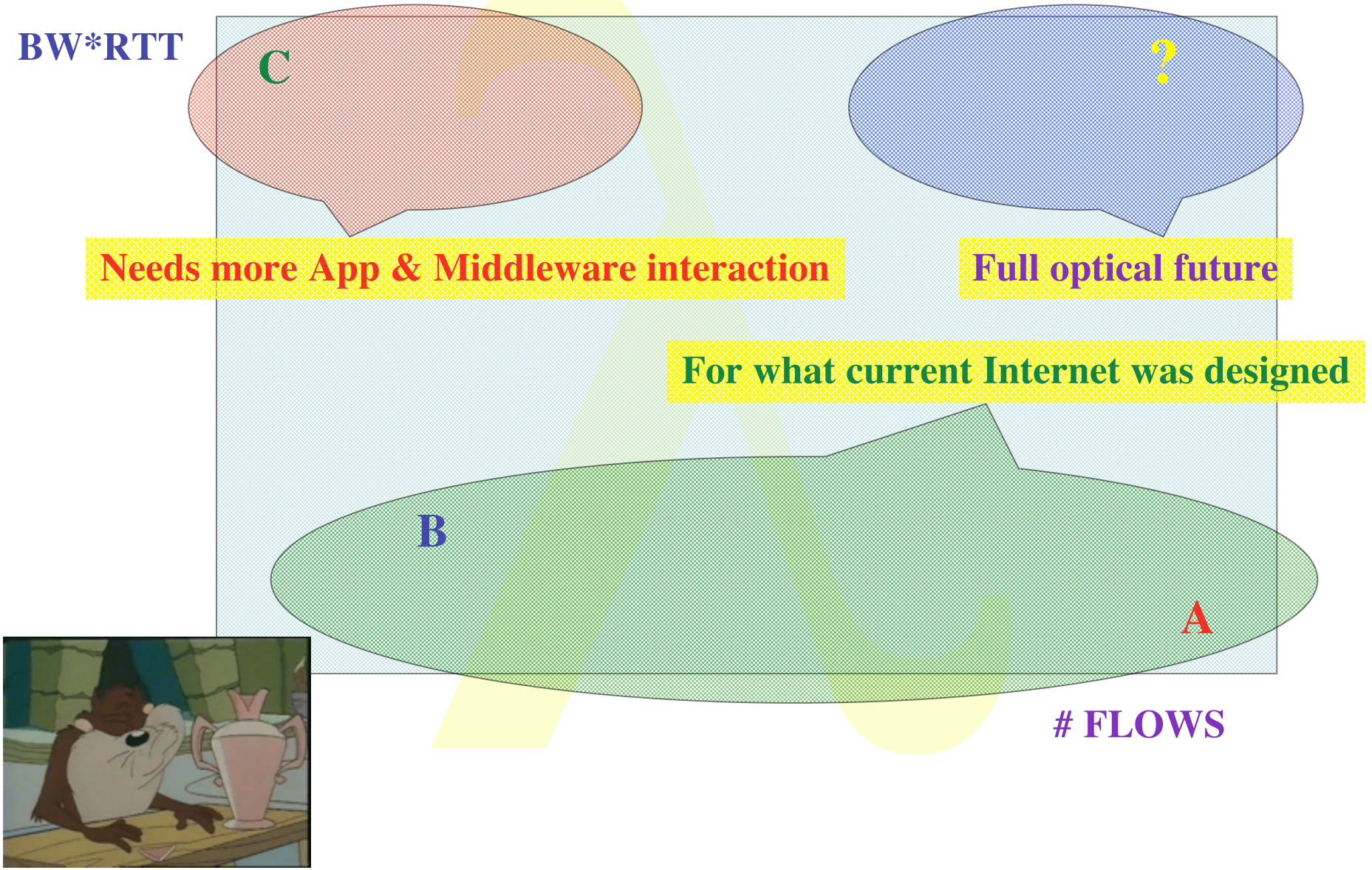
NetherLight UvA Setup



SURFnet

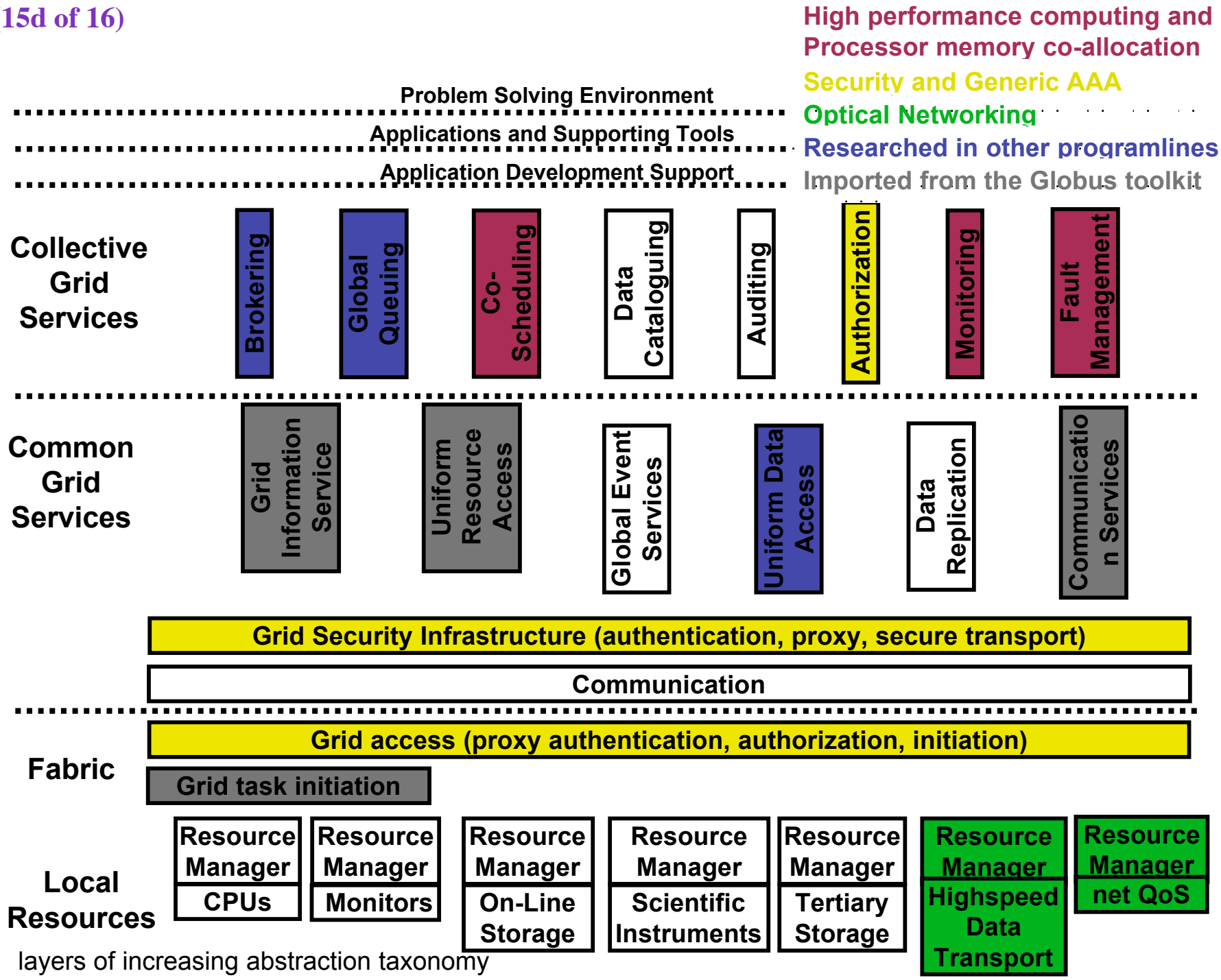
OptIPuter

Transport in the corners



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



layers of increasing abstraction taxonomy

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.