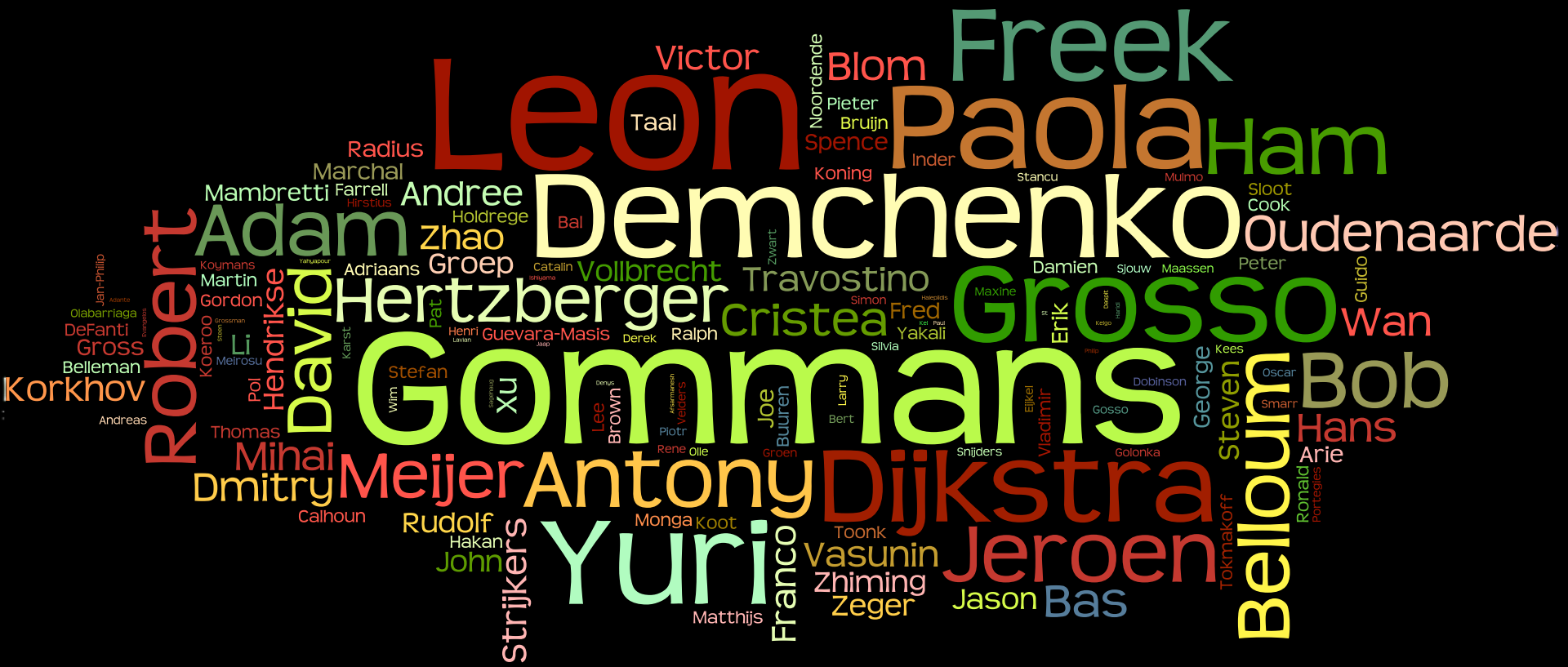
System and Network Engineering Research for Big Data Sciences

Cees de Laat



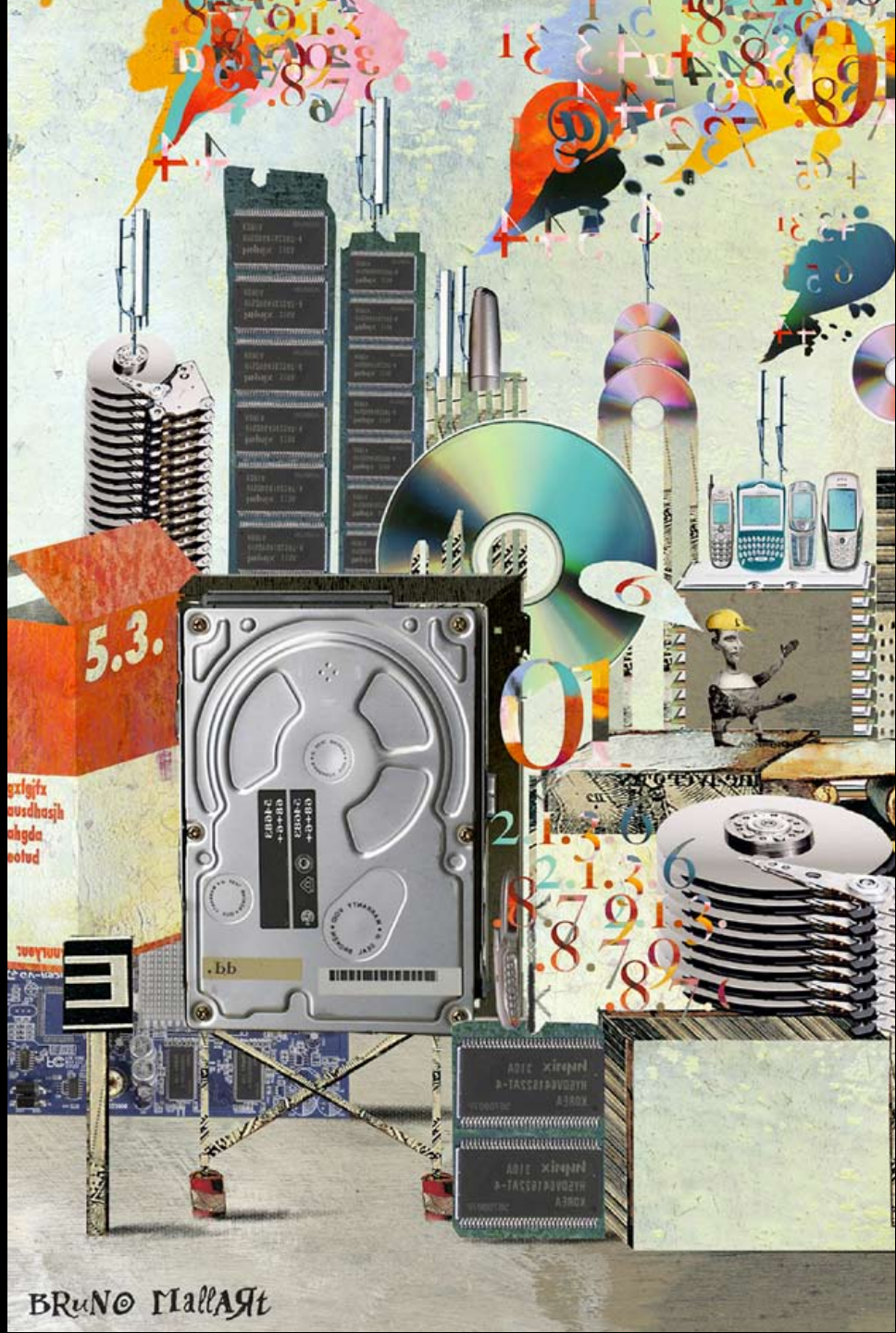
From King's Dutch Academy of Sciences

The Dutch Research Agenda

"Information technology (IT) now permeates all aspects of public, commercial, social, and personal life. bank cards, satnav, and weather radar... IT has become completely indispensable."

"But to guarantee the reliability and quality of constantly bigger and more complicated IT, we will need to find answers to some fundamental questions!"

https://www.knaw.nl/nl/actueel/publicaties/the-dutch-research-agenda/@@download/pdf_file/20111029.pdf



Reduction of Complexity by Integration

By combining services such as telephony, television, data, and computing capacity within a single network, we can cut down on complexity, energy consumption and maintenance.

- How can we describe and analyze complex information systems effectively?
- How can we specify and measure the quality and reliability of a system?
- How can we combine various different systems?
- How can we design systems in which separate processors can co-operate efficiently via mutual network connections within a much larger whole?
- Can we design information systems that can diagnose their own malfunctions and perhaps even repair them?
- How can we specify, predict, and measure system performance as effectively as possible?

SNE addresses a.o. the **highlighted** questions!

http://www.knaw.nl/Content/Internet_KNAW/publicaties/pdf/20111029.pdf


TEMP
GIMBAL LOCK
PROG
RESTART
TRACKER
VERB
NOUN
+ 7 8 9
− 4 5 6
0 1 2


UPLINK ACTY
TEMP
AUTO
GIMBAL LOCK
PROG
RESTART
NO ATT
TRACKER
STBY
KEY REL
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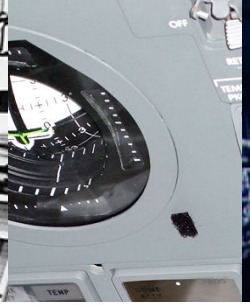


AT&T 3G
9:42 AM
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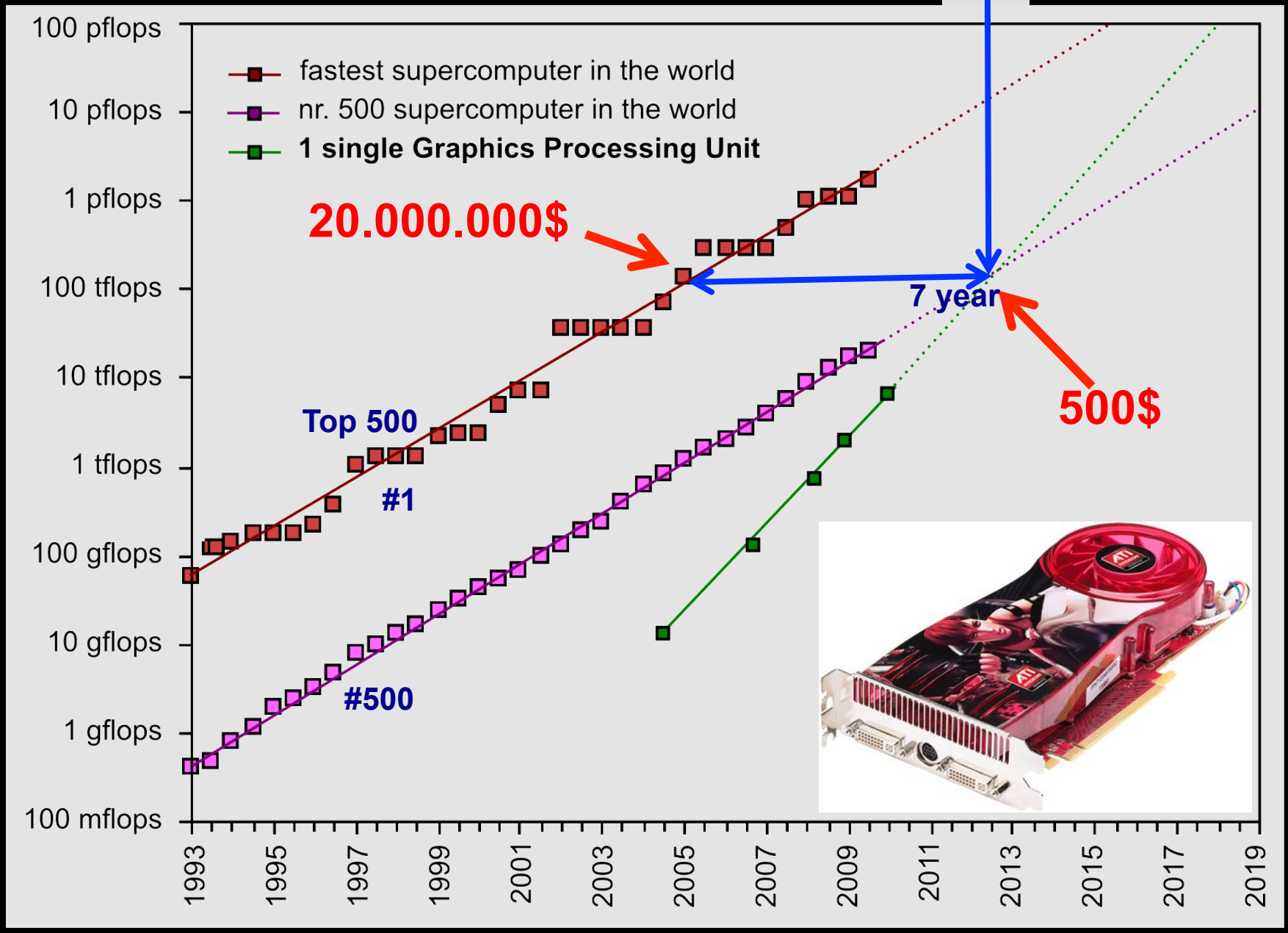
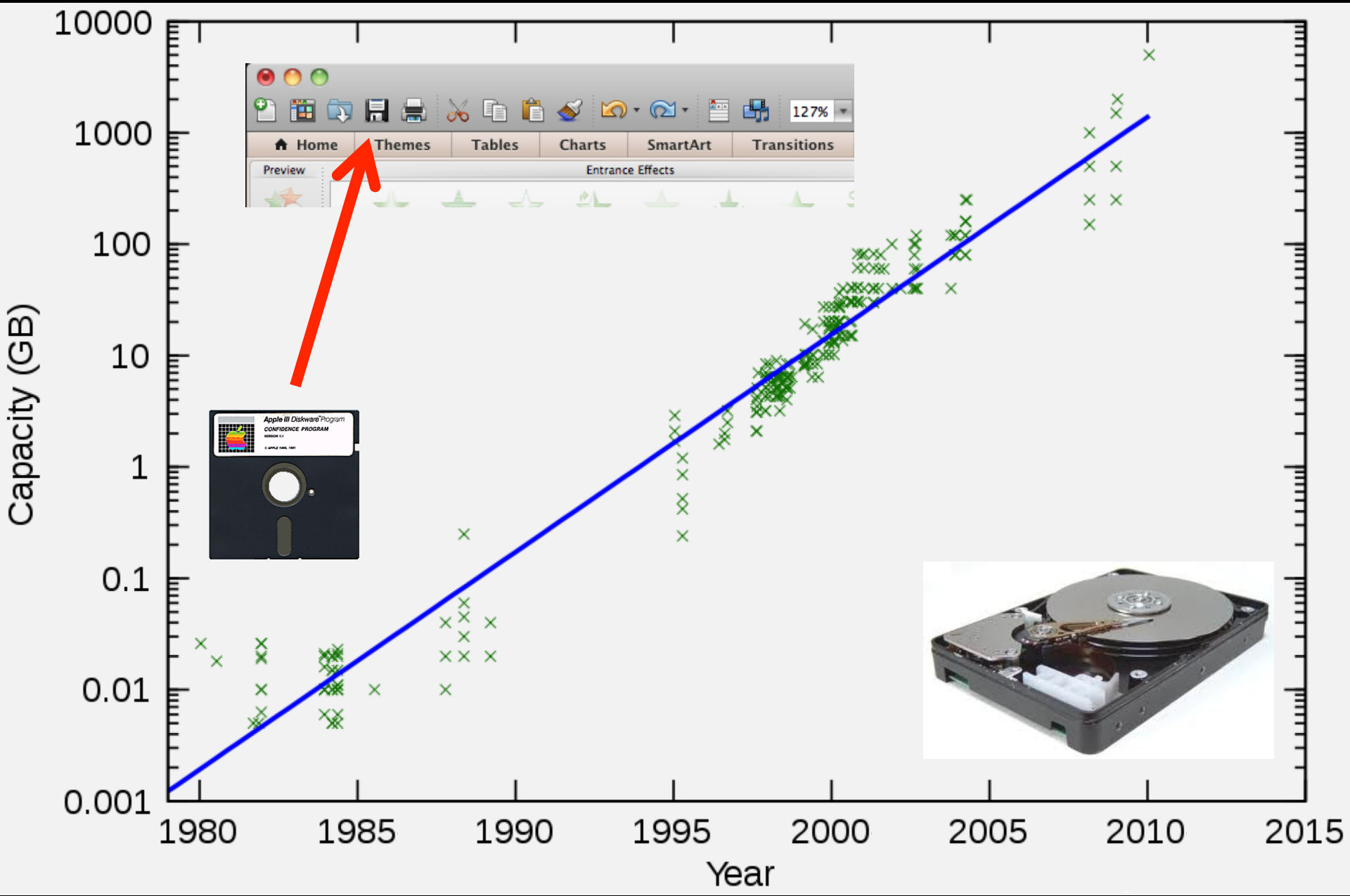
Text
Tuesday
9
Calendar
Photos
Camera
YouTube
Stocks
280
Maps
73°
Weather
Clock
Calculator
Notes
Settings
iTunes
App Store
Phone
Mail
Safari
iPod

GPU cards are distruptive!



Data storage: doubling every 1.5 year!

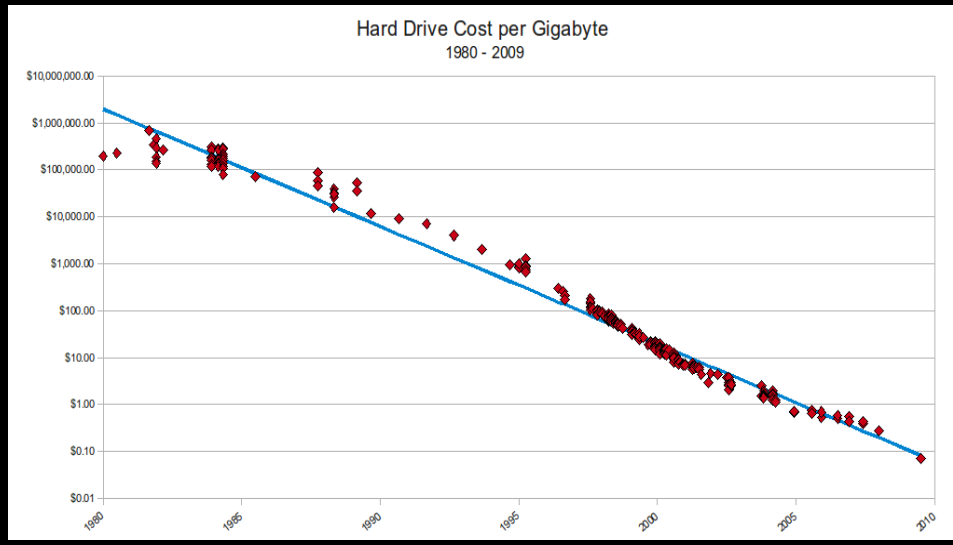


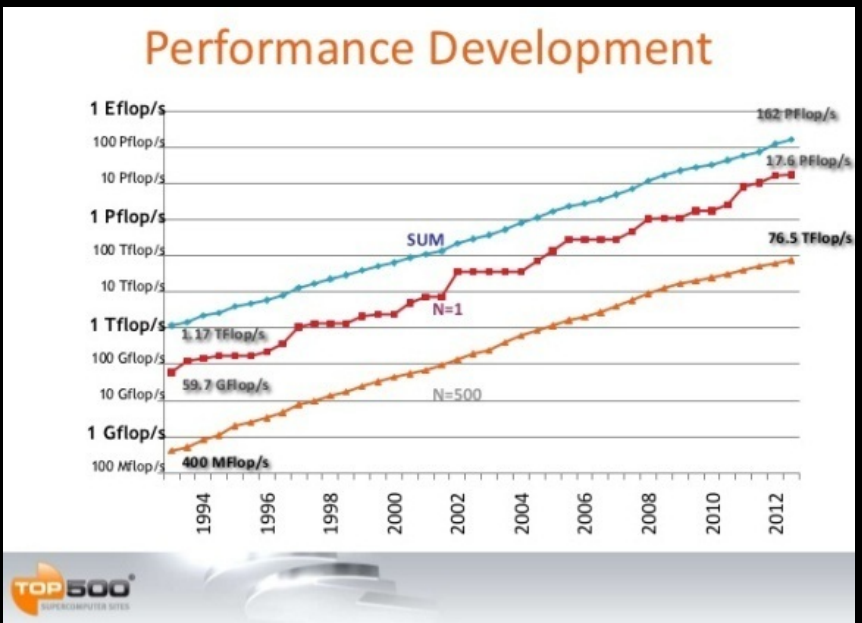
Reliable and Safe!

This omnipresence of IT makes us not only strong but also vulnerable.

- A virus, a hacker, or a system failure can instantly send digital shockwaves around the world.

The hardware and software that allow all our systems to operate is becoming bigger and more complex all the time, and the capacity of networks and data storage is increasing by leaps and bounds.

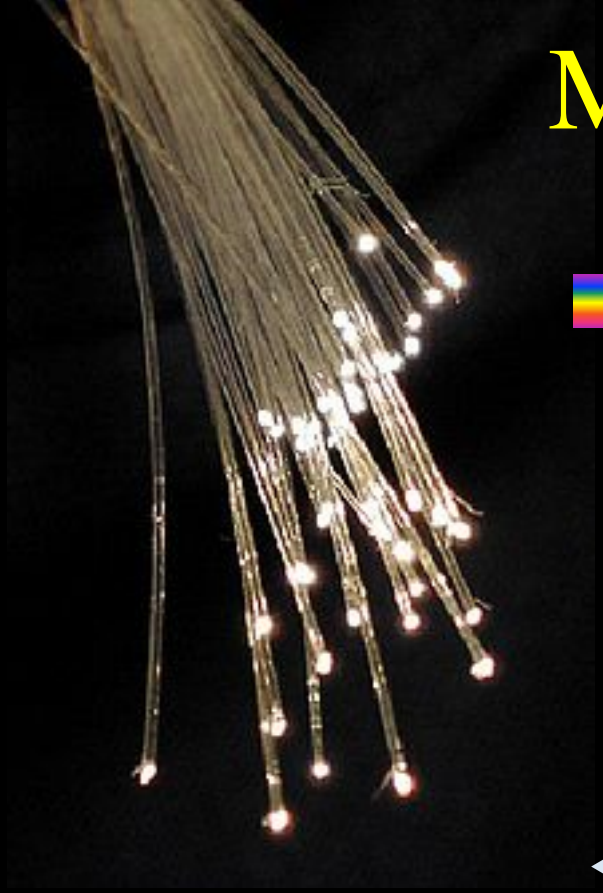


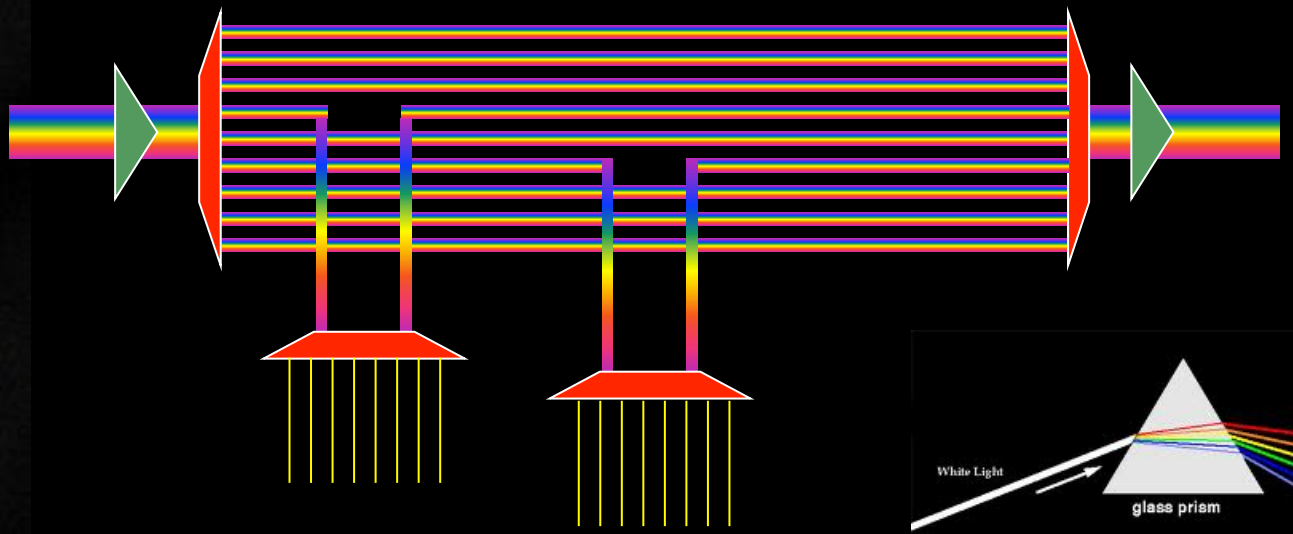


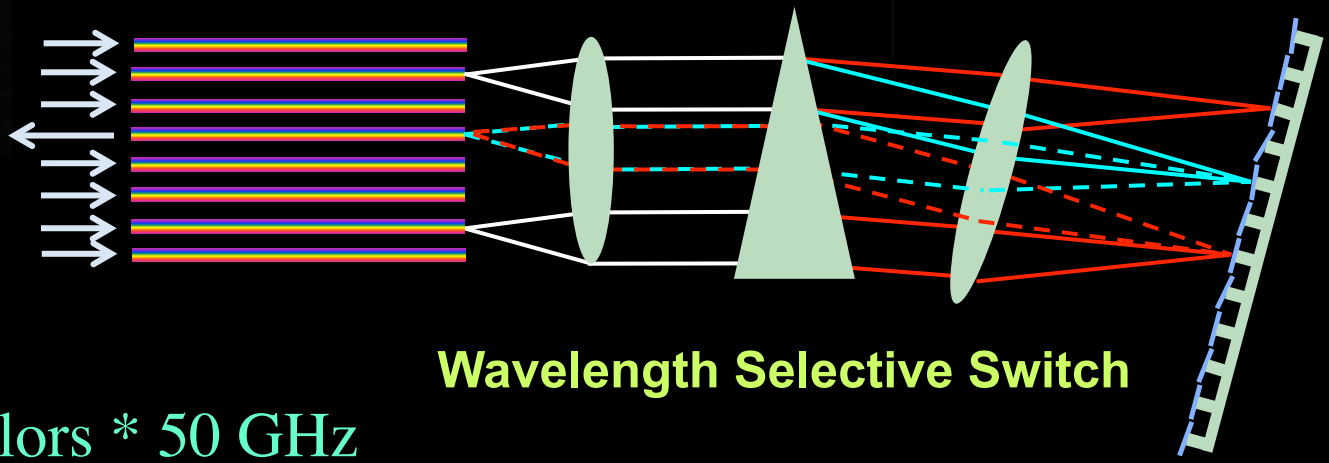
We will soon reach the limits of what is currently feasible and controllable.

http://www.knaw.nl/Content/Internet_KNAW/publicaties/pdf/20111029.pdf

Multiple colors / Fiber







Wavelength Selective Switch

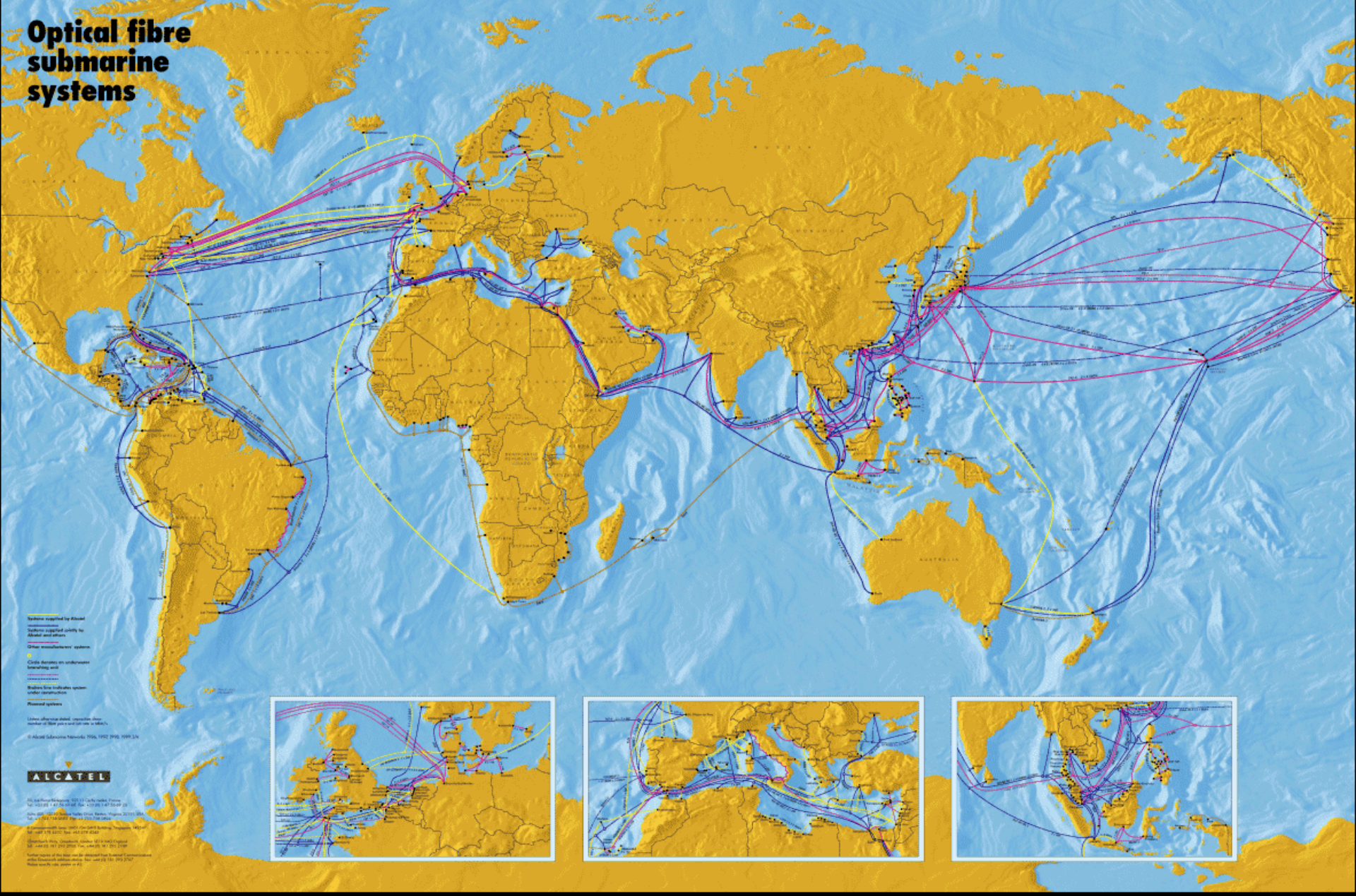
Per fiber: ~ 80-100 colors * 50 GHz

Per color: 10 – 40 – 100 – 200 ... Gbit/s

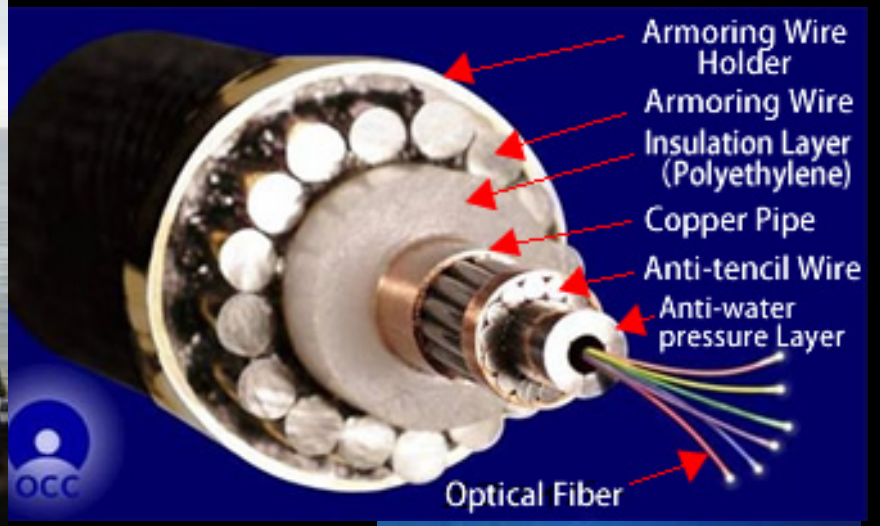
BW * Distance ~ $2*10^{17}$ bm/s

New: Hollow Fiber!

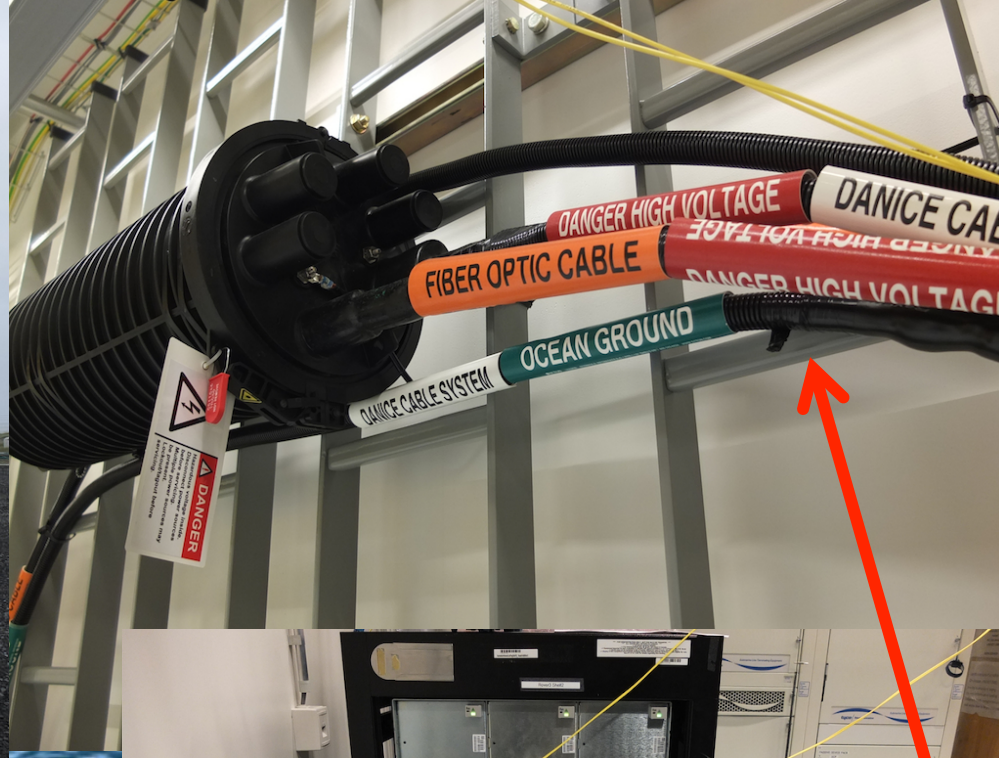
➔ less RTT!



Undersea Cable System



A **cable landing station** may or may not be required, depending on whether, for example, the submarine cable requires power to power submarine repeaters or amplifiers. The voltages applied to the cables can be high **3,000 to 4,000 volts** for a typical trans-Atlantic telecommunications cable system, and 1,000 volts for a cross-channel telecommunications cable system. Submarine power cables can operate at many kilovolts: for example, the[Fenno-Skan power cable operates at 400 kV DC.]



Undersea Cable HV

Wireless Networks

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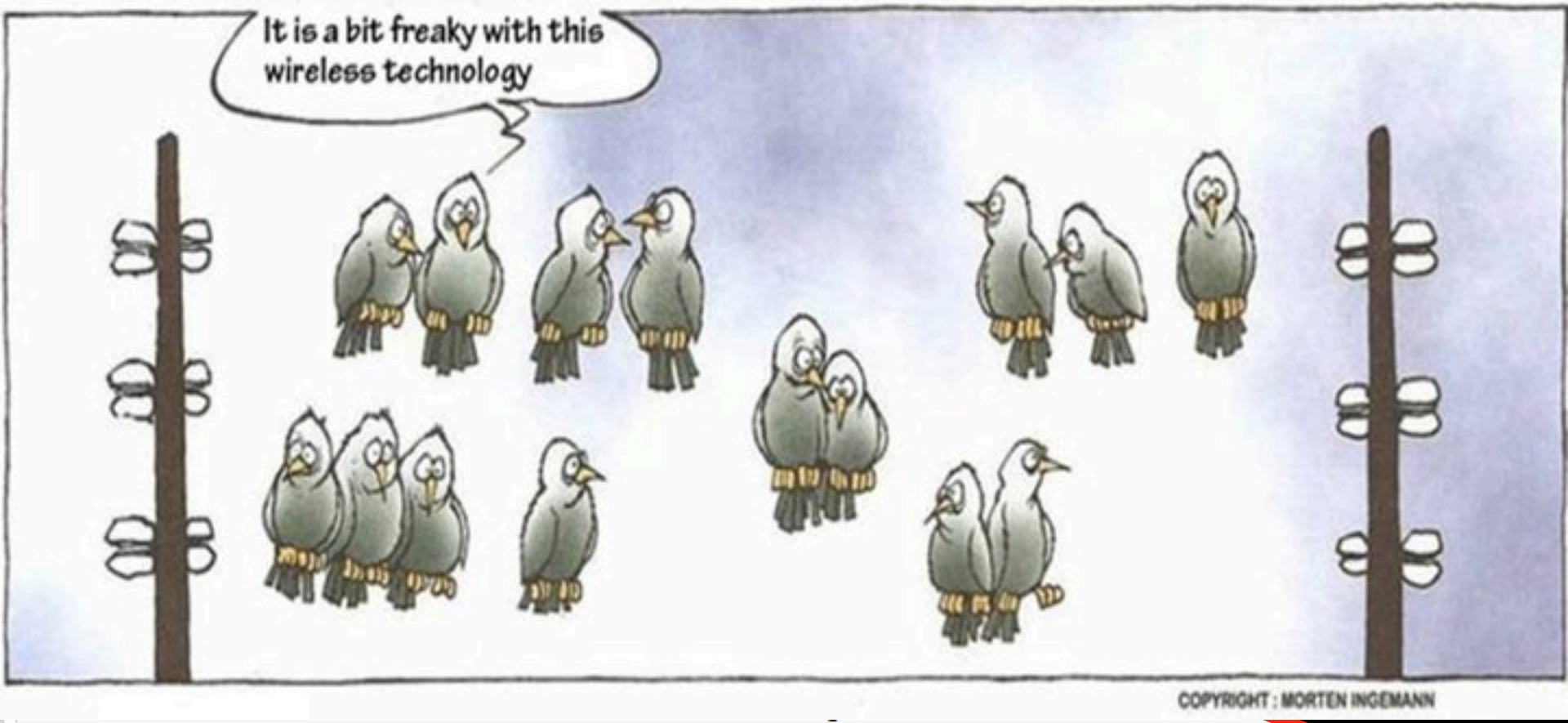
SEP 06

Next Generation Wireless LAN Technology 802.11ac 1 Gbps throughput with

Published By admin under Network Devices Tags: 1gbps throughput, 1gbps wireless, 1gbps wireless lans, generation, new generation, technologies, technology, throughput, wireless, wireless lan

WiFi is one of the most preferred communication protocol LAN due to the easy comparison and convenience in the digital home. While consumer PC products has just started to migrate to a much higher bandwidth of 802.11n wireless LAN now working on next-generation standard definition is already in progress.

Wireless Networks

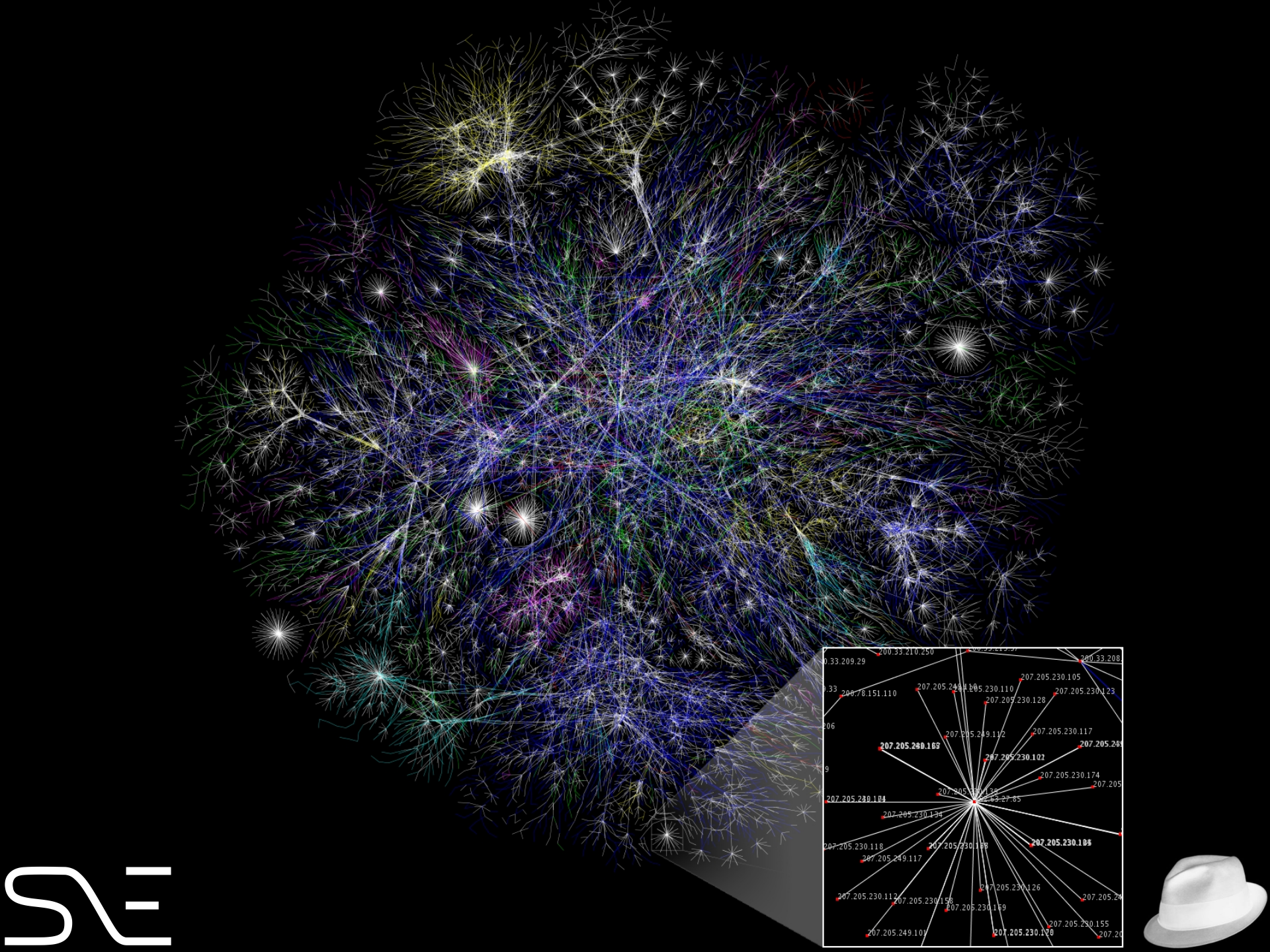


protocol LAN due to the easy comparison and convenience in the digital home. While consumer PC products has just started to migrate to a much higher bandwidth of 802.11n wireless LAN now working on next-generation standard definition is already in progress.

Mission SNE

Can we create smart and safe data processing infrastructures that can be tailored to diverse application needs?

- *Capacity*
  - *Bandwidth on demand, QoS, architectures, photonics, performance, GPU's*
- *Capability*
  - *Programmability, virtualization, complexity, semantics, workflows*
- *Security*
  - *Authorization, Anonymity, integrity of data in distributed data processing*
- *Sustainability*
  - *Greening infrastructure, awareness*
- *Resilience*
  - *Systems under attack, failures, disasters*


200.33.210.250
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200.78.151.110
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207.205.230.118
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207.205.230.126
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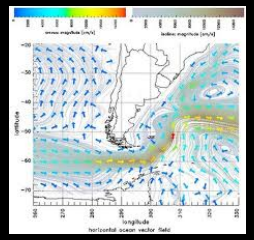
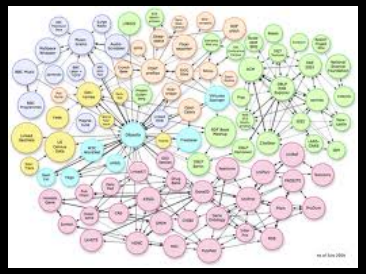
Internet developments

... more data!

... more realtime!

... more users!



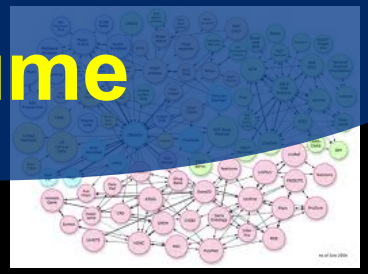


Internet developments

... more data!

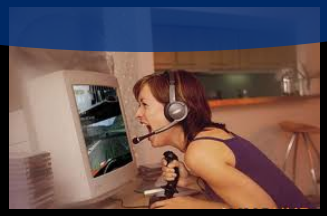
Speed

Volume



Deterministic

Real-time

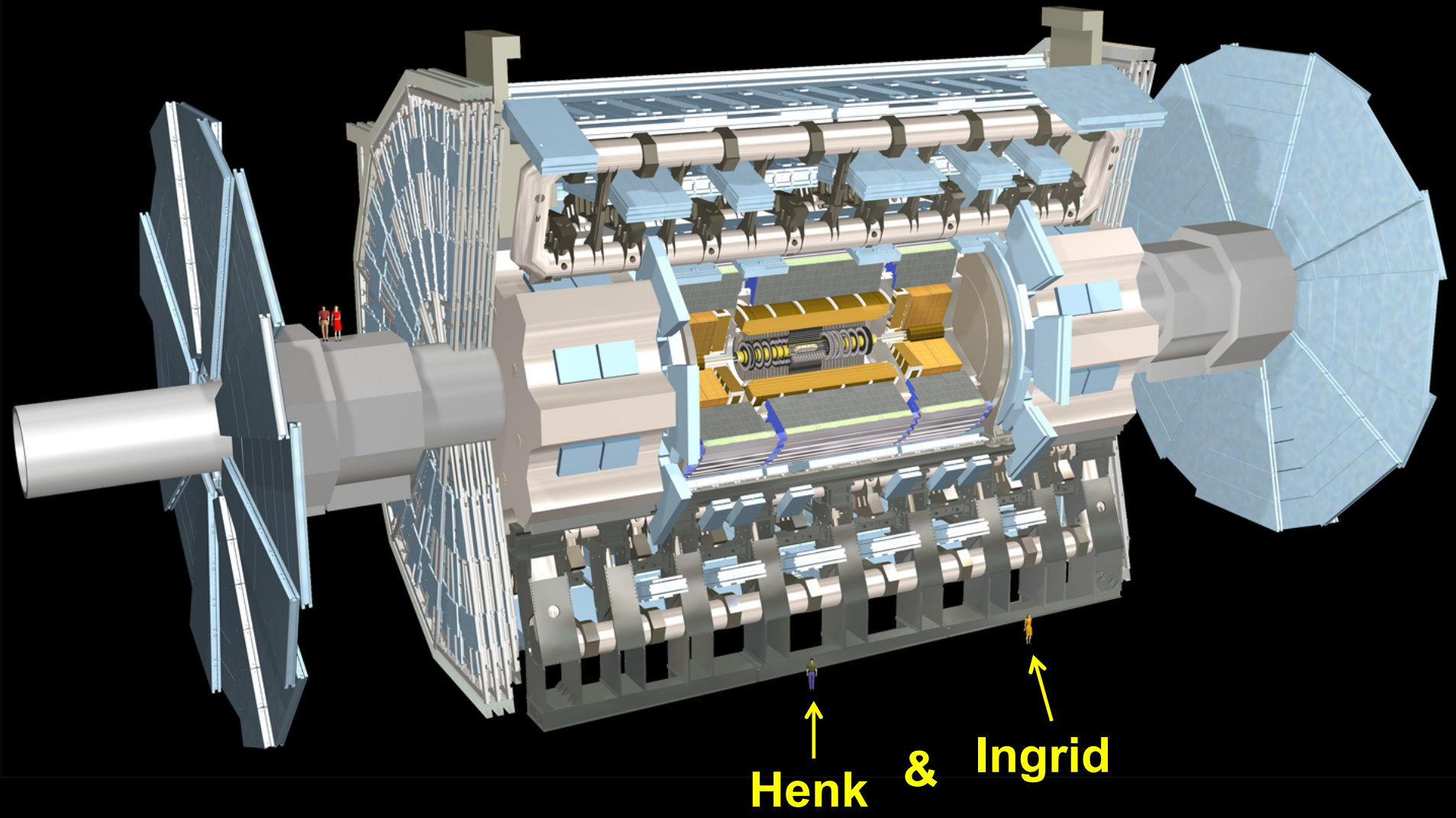


Scalable

Secure

... more users!

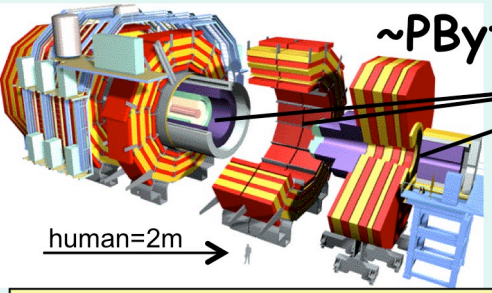
ATLAS detector @ CERN Geneve



ATLAS detector @ CERN Geneve

LHC Data Grid Hierarchy

CMS as example, Atlas is similar



~PByte/sec

Online System

~100 MBytes/sec

100000 flops/byte

10 Pflops/s

event simulation

Tier 0 +1

HPSS

event reconstruction

CMS detector: 15m X 15m X 22m

12,500 tons, $700M.

~2.5 Gbits/sec

Status 2002!

Tier 1

Italian Regional Center

German Regional Center

NIKHEF Dutch Regional Center

FermiLab, USA Regional Center

...

~0.6-2.5 Gbps

analysis

Tier2 Center

Tier 2

~0.6-2.5 Gbps

Tier 3

Institute ~0.25TIPS

Physics data cache

100 - 1000 Mbits/sec

Tier 4

Workstations

Courtesy Harvey Newman, CalTech and CERN

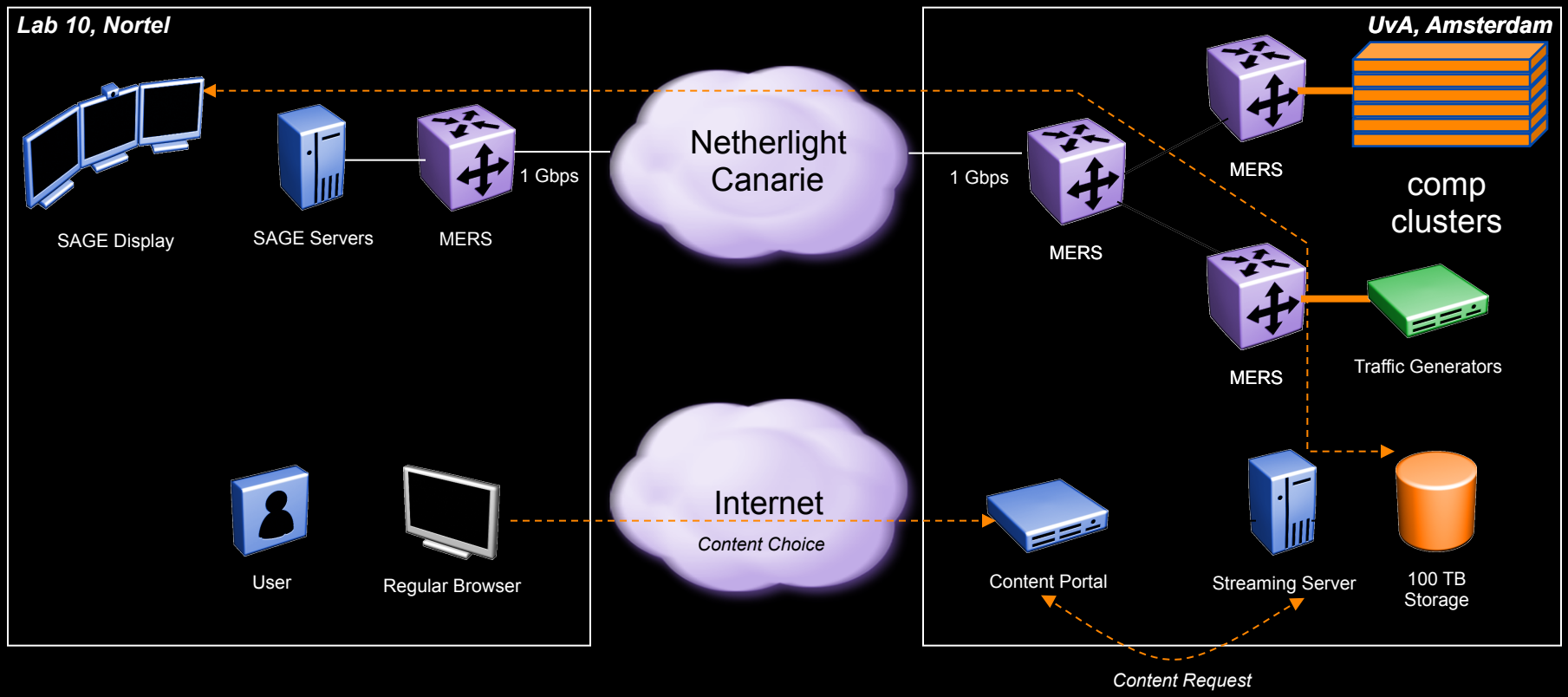
CERN/CMS data goes to 6-8 Tier 1 regional centers, and from each of these to 6-10 Tier 2 centers.

Physicists work on analysis "channels" at 135 institutes. Each institute has ~10 physicists working on one or more channels.

2000 physicists in 31 countries are involved in this 20-year experiment in which DOE is a major player.

Big and small flows don’t go well together on the same wire! ☹

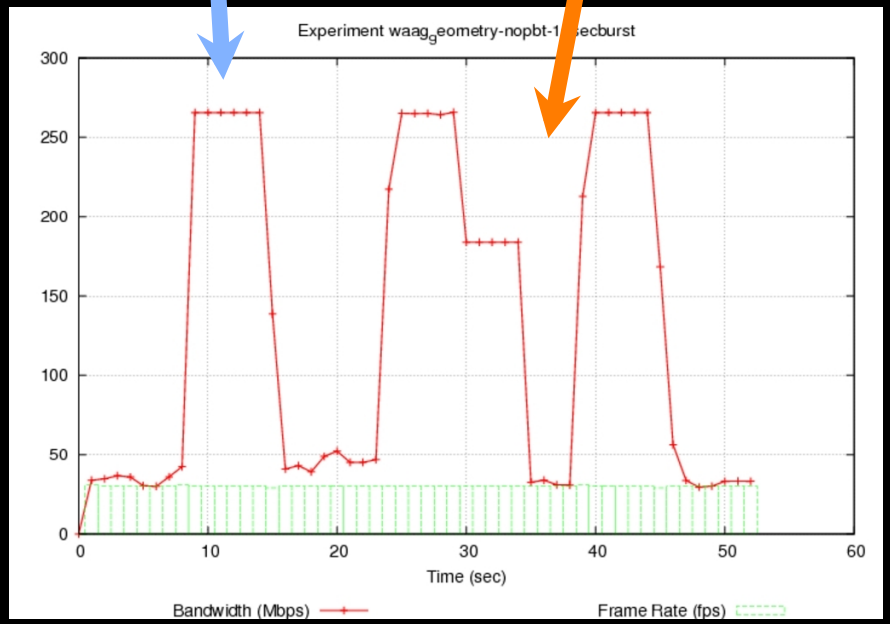
Diagram for SAGE video streaming to ATS



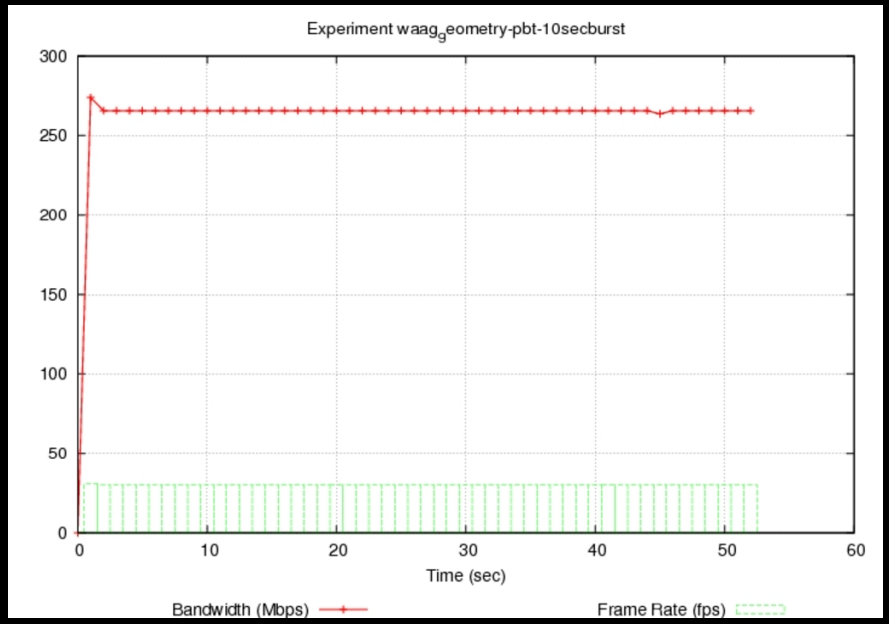
Experimental Data

Sage without background traffic

Sage with background traffic



10 Second Traffic bursts with No PBT



10 Second Traffic bursts with PBT

PBT is *SIMPLE* and *EFFECTIVE* technology to build a shared Media-Ready Network

Alien light From idea to realisation!

40Gb/s alien wavelength transmission via a multi-vendor 10Gb/s DWDM infrastructure

NCF

Alien wavelength advantages

- Direct connection of customer equipment[1] → cost savings
- Avoid OEO regeneration → power savings
- Faster time to service[2] → time savings
- Support of different modulation formats[3] → extend network lifetime

Alien wavelength challenges

- Complex end-to-end optical path engineering in terms of linear (i.e. OSNR, dispersion) and non-linear (FWM, SPM, XPM, Raman) transmission effects for different modulation formats.
- Complex interoperability testing.
- End-to-end monitoring, fault isolation and resolution.
- End-to-end service activation.

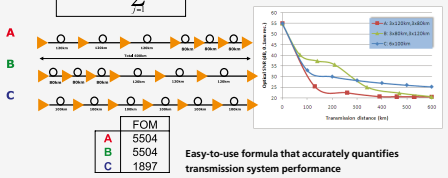
In this demonstration we will investigate the performance of a 40Gb/s PM-QPSK alien wavelength installed on a 10Gb/s DWDM infrastructure.

New method to present fiber link quality, FoM (Figure of Merit)

In order to quantify optical link grade, we propose a new method of representing system quality: the FOM (Figure of Merit) for concatenated fiber spans.

$$FOM = \sum_{j=1}^{N} 10^{\left(\frac{L_j}{10}\right)}$$

Lj, span losses in dB
N, number of spans

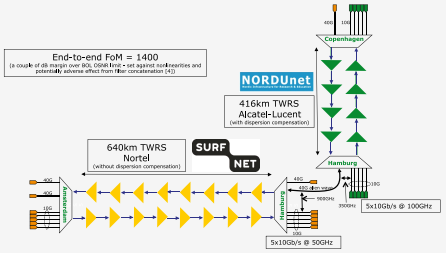


	FOM
A	5504
B	5504
C	1897

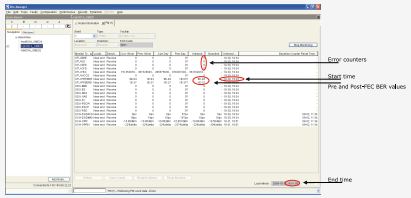
Easy-to-use formula that accurately quantifies transmission system performance

Transmission system setup

JOINT SURFnet/NORDUnet 40Gb/s PM-QPSK alien wavelength DEMONSTRATION.



Test results



Error-free transmission for 23 hours, 17 minutes → BER < 3.0 10^{-16}

Conclusions

- We have investigated experimentally the all-optical transmission of a 40Gb/s PM-QPSK alien wavelength via a concatenated native and third party DWDM system that both were carrying live 10Gb/s wavelengths.
- The end-to-end transmission system consisted of 1056 km of TWRS (TrueWave Reduced Slope) transmission fiber.
- We demonstrated error-free transmission (i.e. BER below 10-15) during a 23 hour period.
- More detailed system performance analysis will be presented in an upcoming paper.

NORTEL NORDUnet telindus together with ISTY SURF NET

REFERENCES [1] "OPERATIONAL SOLUTIONS FOR AN OPEN DWDM LAYER", O. GERSTEL ET AL, OFC'2009 | [2] "AT&T OPTICAL TRANSPORT SERVICES", BARBARA E. SMITH, OFC'09 [3] "OPEX SAVINGS OF ALL-OPTICAL CORE NETWORKS", ANDREW LORD AND CARL ENGINEER, ECOC2009 | [4] NORTEL/SURFNET INTERNAL COMMUNICATION

ACKNOWLEDGEMENTS WE ARE GRATEFUL TO NORDUNET FOR PROVIDING US WITH BANDWIDTH ON THEIR DWDM LINK FOR THIS EXPERIMENT AND ALSO FOR THEIR SUPPORT AND ASSISTANCE DURING THE EXPERIMENTS. WE ALSO ACKNOWLEDGE TELINDUS AND NORTEL FOR THEIR INTEGRATION WORK AND SIMULATION SUPPORT

ClearStream @ TNC2011

Setup codename: FlightCees

UvA

iPerf
I7 3.2 GHz Q-core

iPerf
Amd Ph II 3.6 GHz HexC

Mellanox

40G E

Copenhagen

iPerf
2* dual 2.8 GHz Q-core

iPerf

Mellanox

CIENA OME 6500

CERN

Hamburg

CIENA DWDM

Alcatel DWDM

CIENA OME 6500

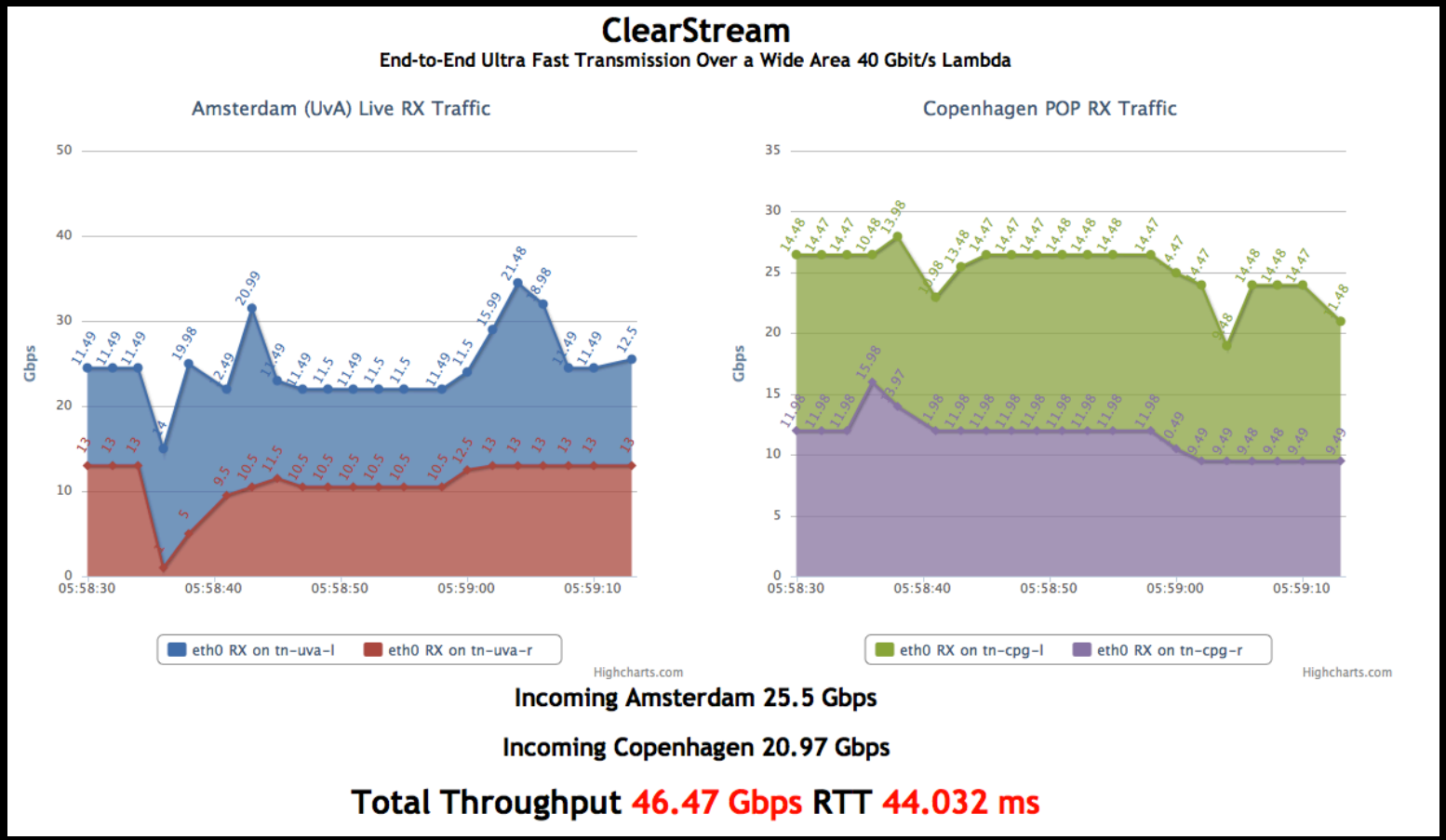
CIENA OME 6500

17 ms RTT

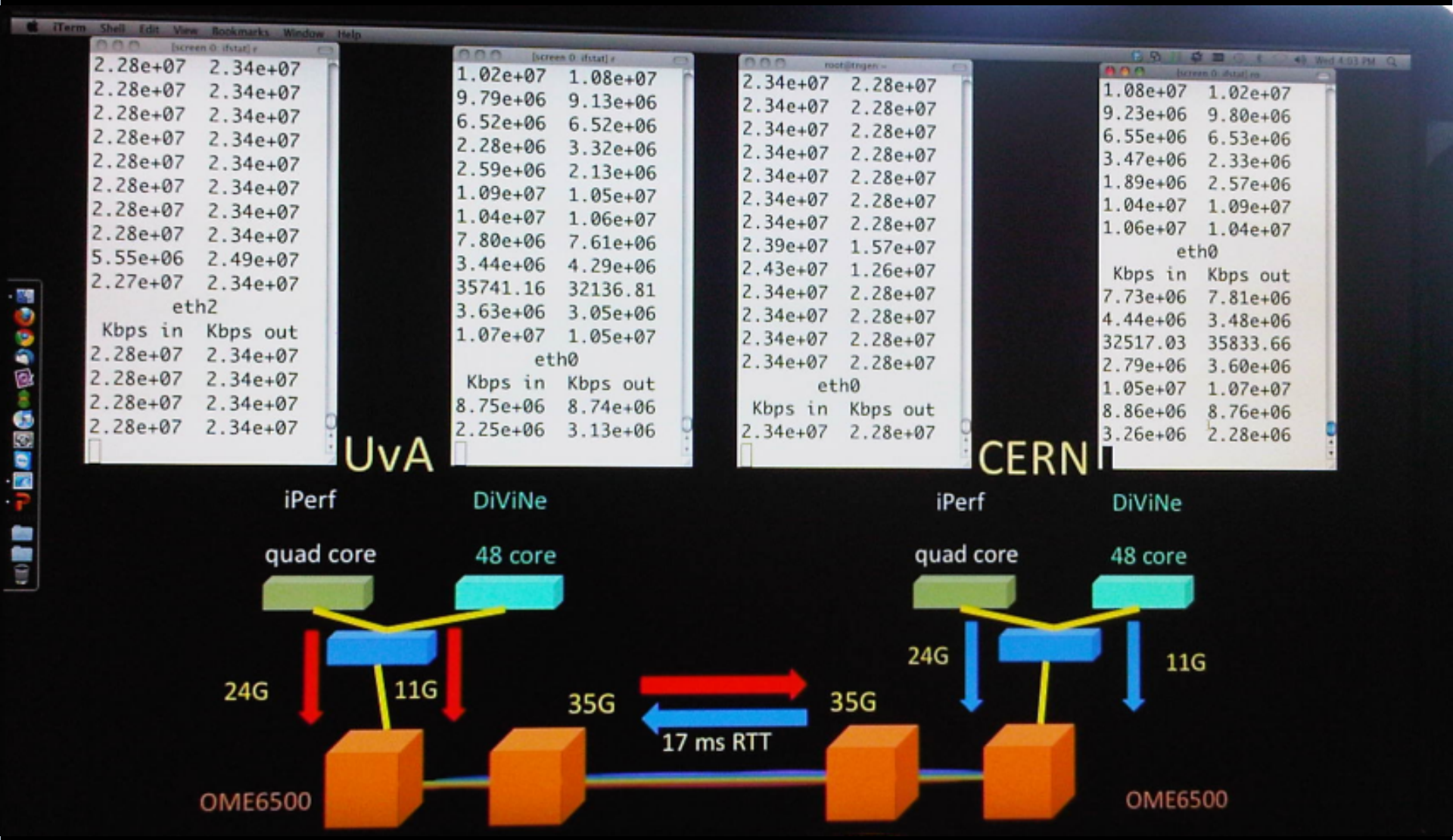
27 ms RTT

Amsterdam – Geneva (CERN) – Copenhagen – 4400 km (2700 km alien light)

Visit CIENA Booth
surf to http://tnc11.delaat.net



From GLIF October 2010 @ CERN



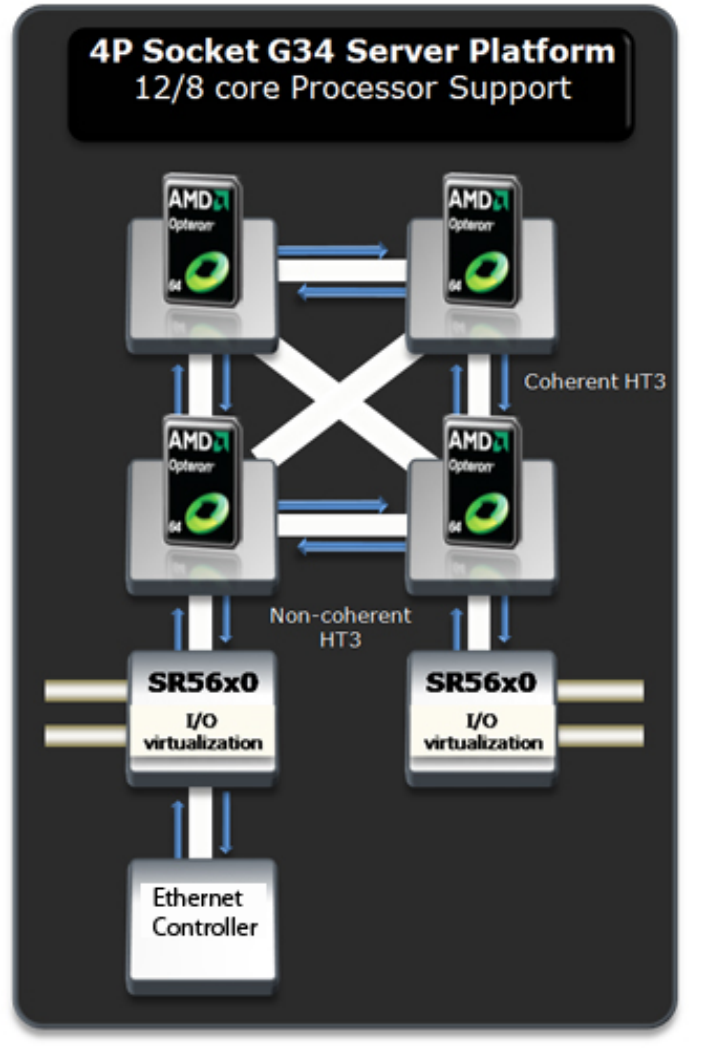
Results (rtt = 17 ms)

- Single flow iPerf 1 core -> 21 Gbps
- Single flow iPerf 1 core <> -> 15+15 Gbps
- Multi flow iPerf 2 cores -> 25 Gbps
- Multi flow iPerf 2 cores <> -> 23+23 Gbps
- DiViNe <> -> 11 Gbps
- Multi flow iPerf + DiVine -> 35 Gbps
- Multi flow iPerf + DiVine <> -> 35 + 35 Gbps

Performance Explained

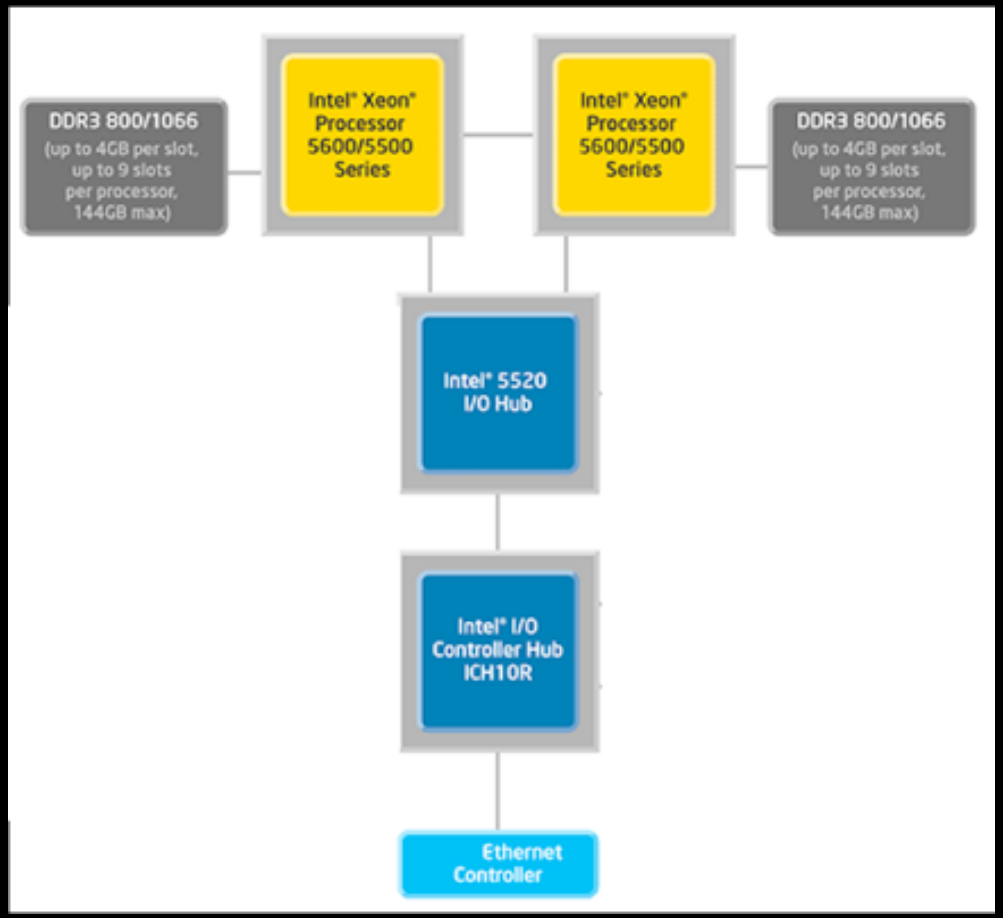
- Mellanox 40GE card is PCI-E 2.0 8x (5GT/s)
- 40Gbit/s raw throughput but ….
- PCI-E is a network-like protocol
  - 8/10 bit encoding -> 25% overhead -> 32Gbit/s maximum data throughput
  - Routing information
- Extra overhead from IP/Ethernet framing
- Server architecture matters!
  - 4P system performed worse in multithreaded iperf

Server Architecture



DELL R815

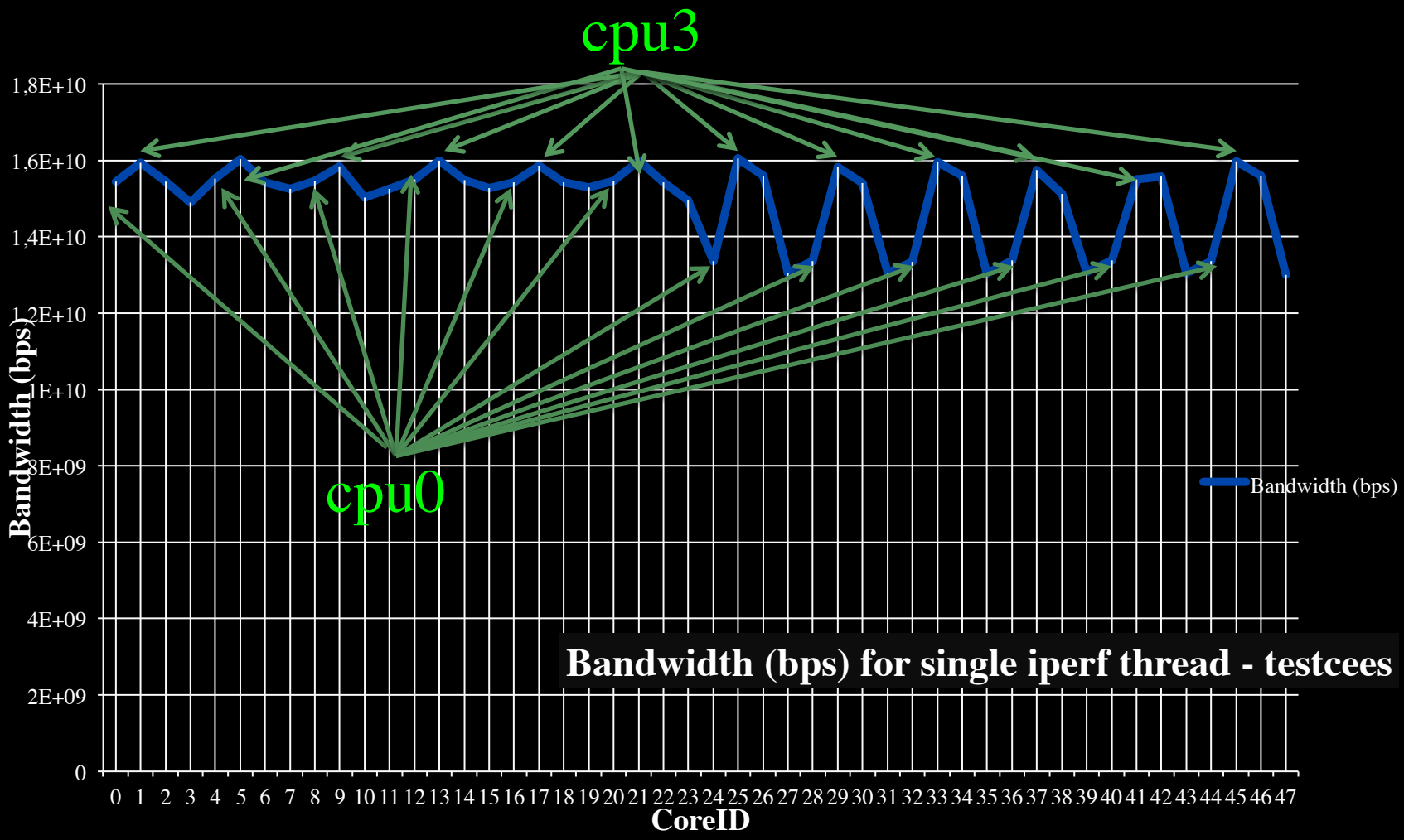
4 x AMD Opteron 6100



Supermicro X8DTT-HIBQF

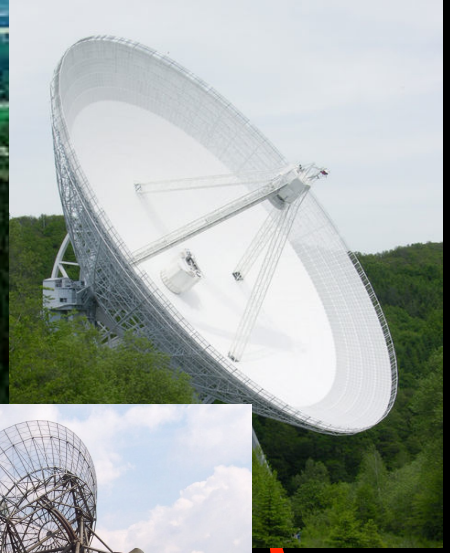
2 x Intel Xeon

CPU Topology benchmark



We used numactl to bind iperf to cores

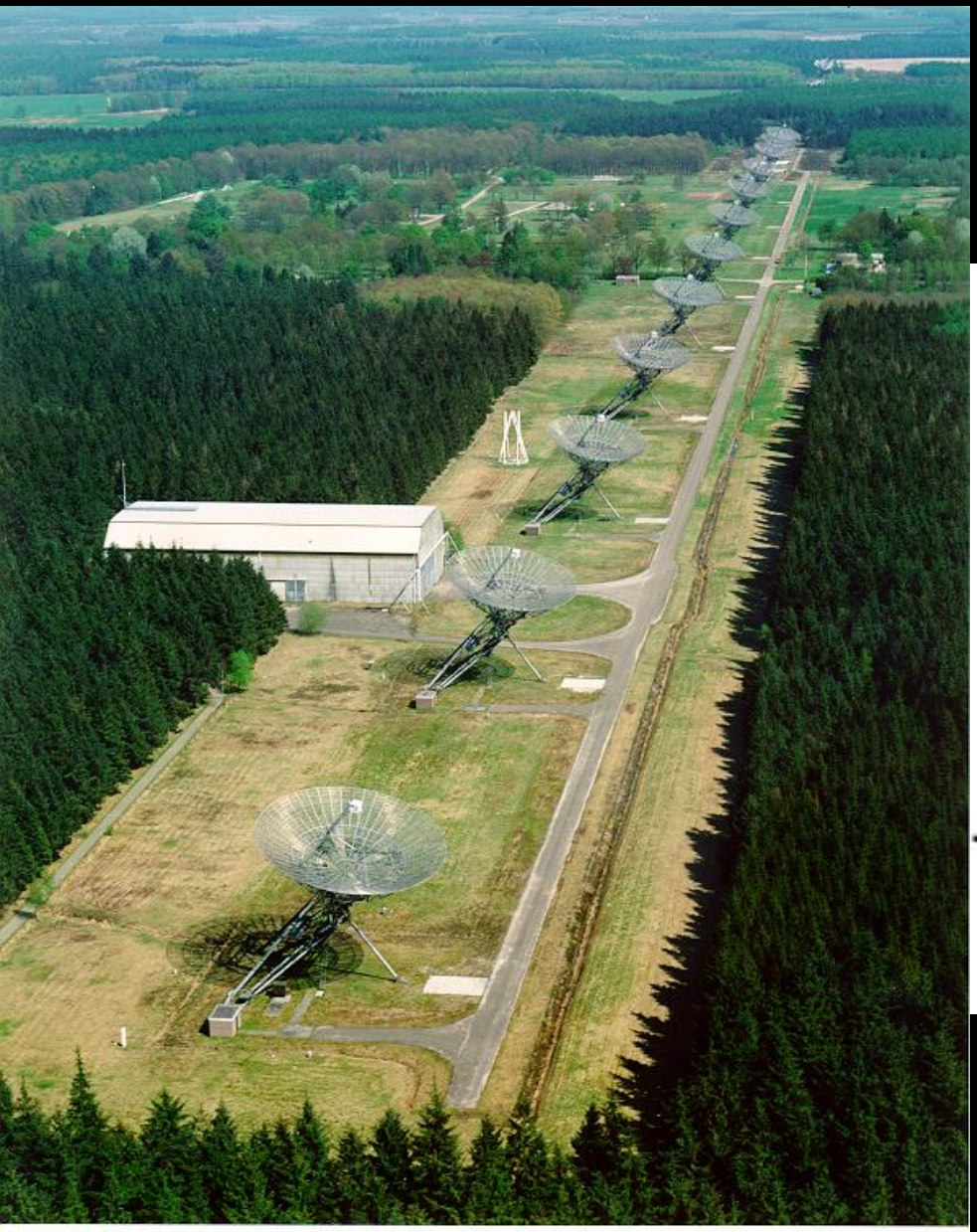
SNE @ UvA

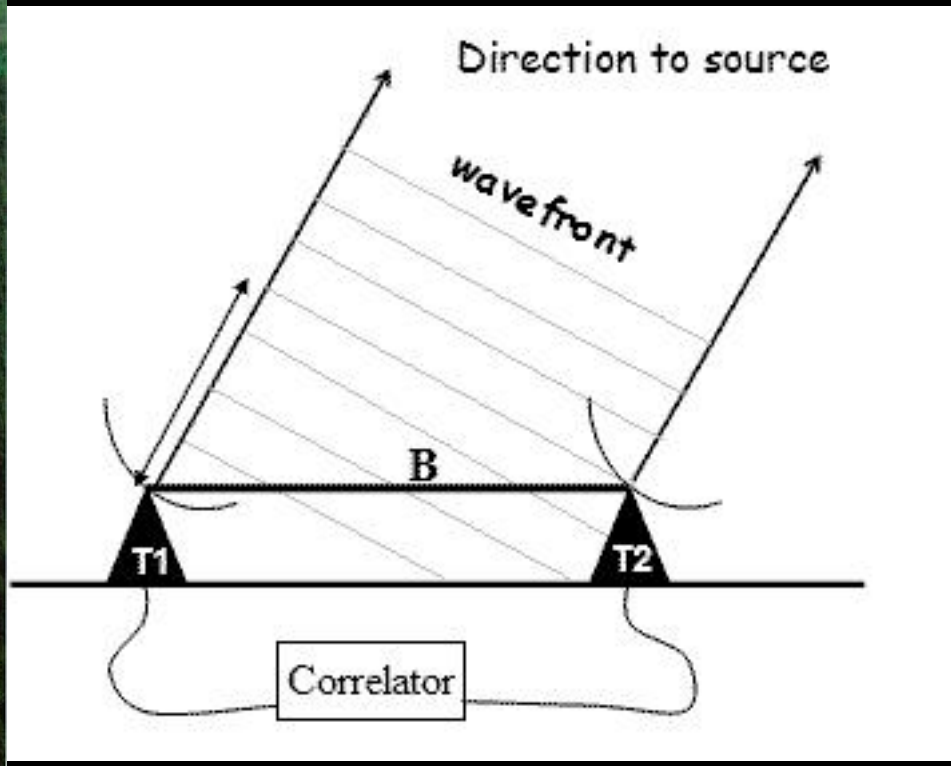


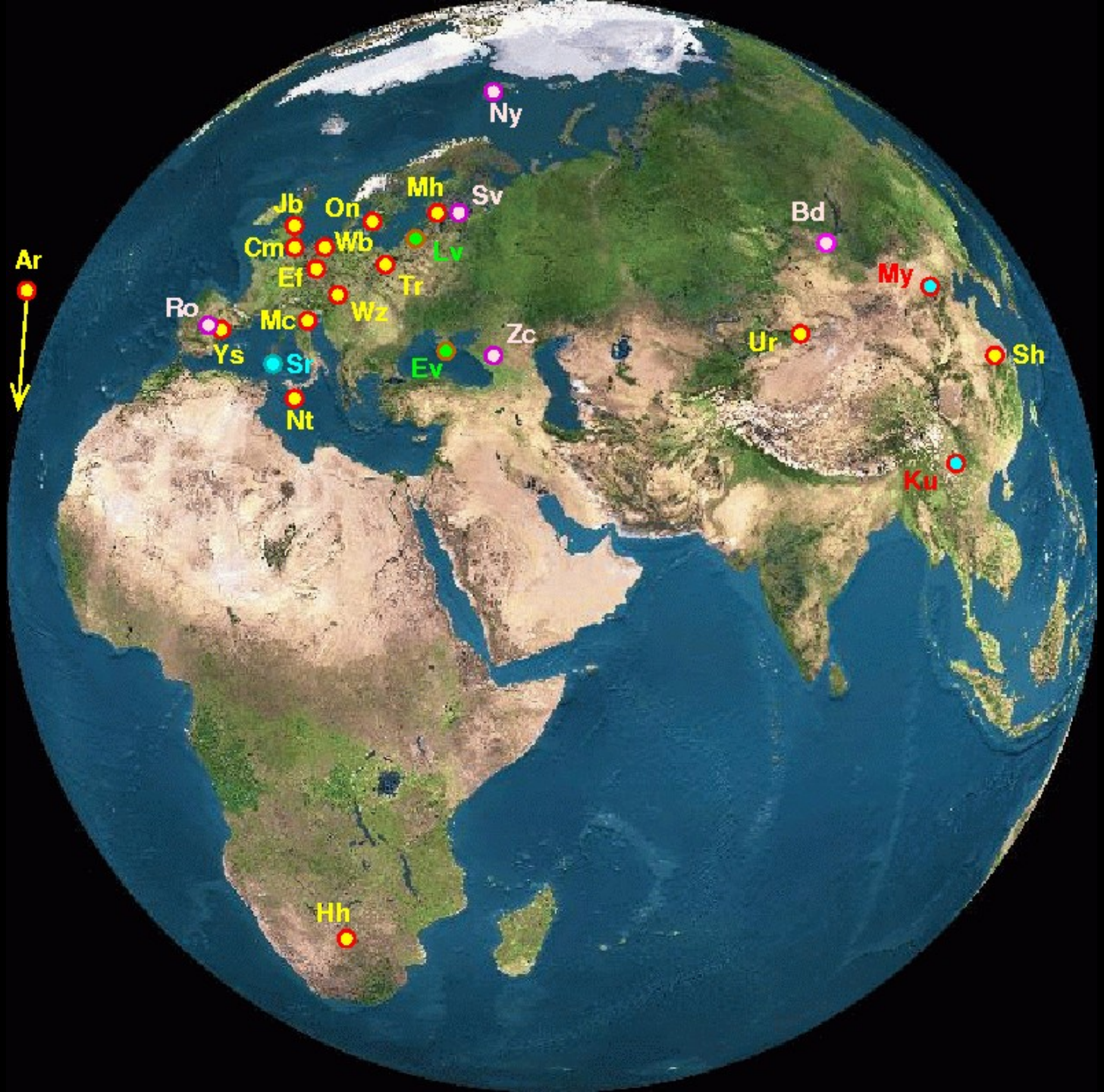
Ijkdijk/Urban Flood
Medical
LifeWatch
CosmoGrid/eVLBI
CineGrid
EU-GN3/NOVI/Geysers
SURFnet/GLIF/Cloud

	Ijkdijk/Urban Flood	Medical	LifeWatch	CosmoGrid/eVLBI	CineGrid	EU-GN3/NOVI/Geysers	SURFnet/GLIF/Cloud
Green-IT						X	X
Privacy/Trust		X		X			
Authorization/policy		X	X		X	X	
Programmable networks	X		X				
40-100Gig/TCP/WF/QoS	X		X	X		X	
Topology/Architecture		X		X	X	X	
Optical Photonic		X	X		X		

e -Very Large Base Interferometer






Ny
Mh
Sv
Jb
On
Cm
Wb
Lv
Ef
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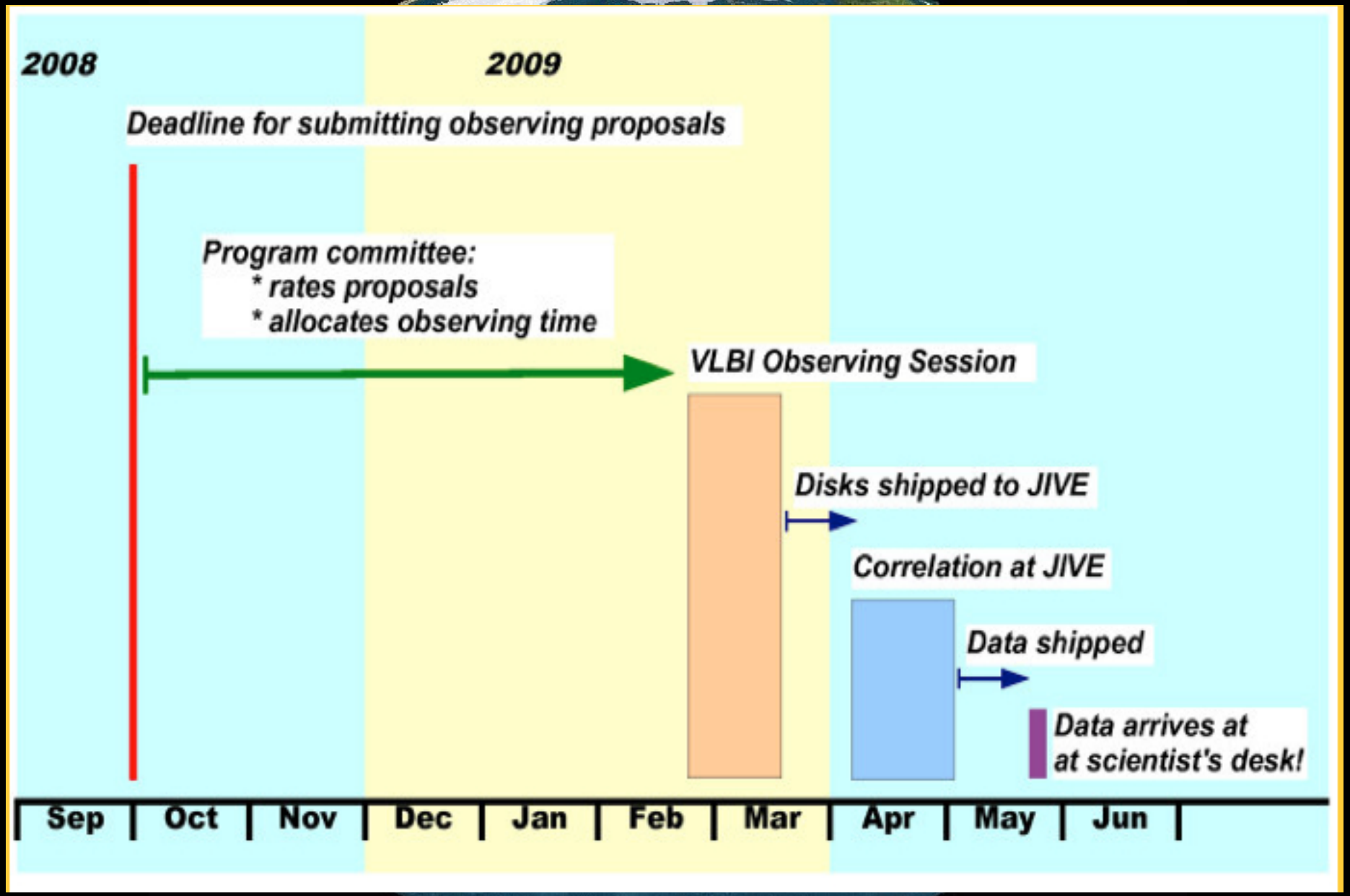
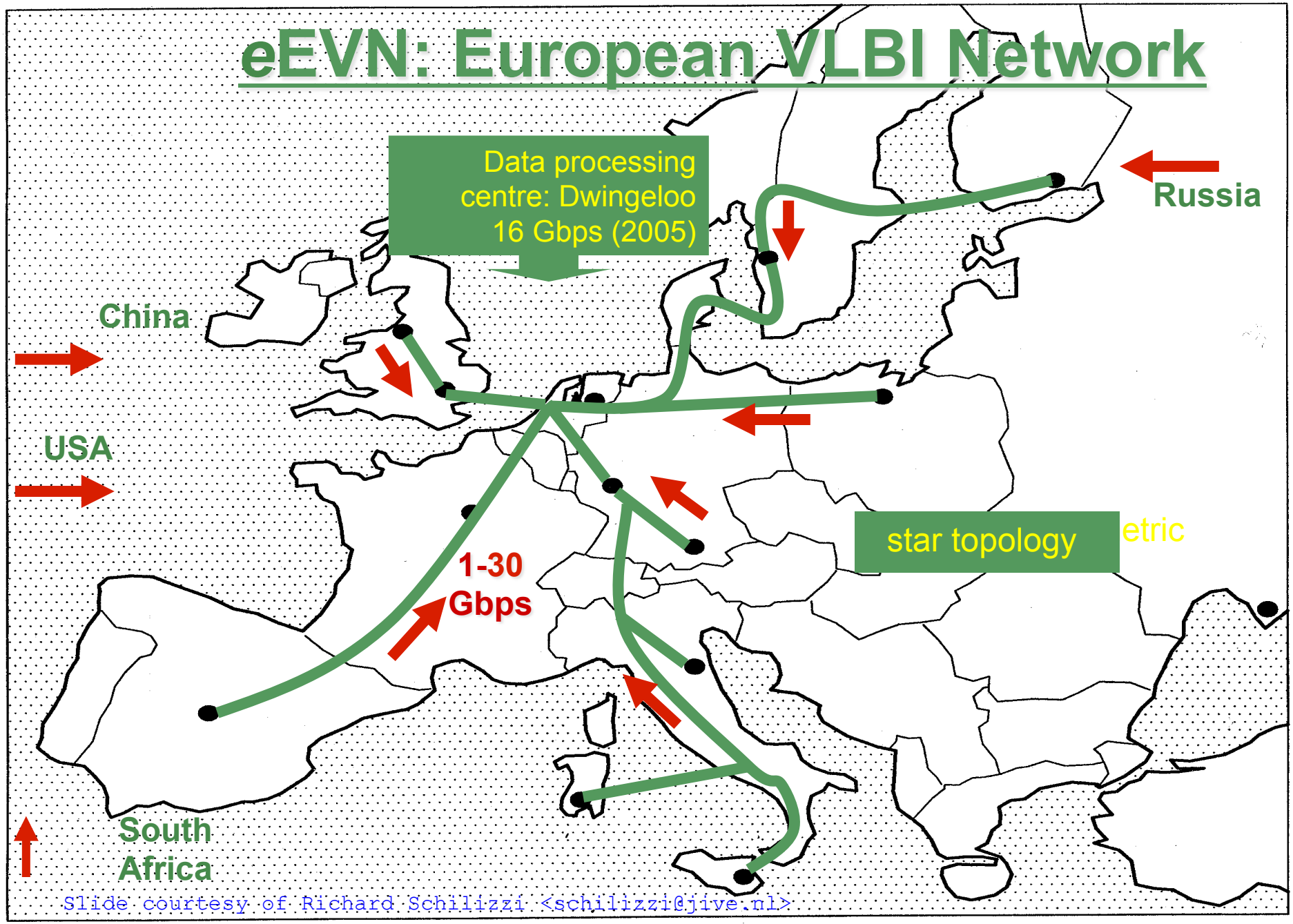

2008
2009
Deadline for submitting observing proposals
Program committee:
* rates proposals
* allocates observing time
VLBI Observing Session
Disks shipped to JIVE
Correlation at JIVE
Data shipped
Data arrives at
at scientist's desk!
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun

2008

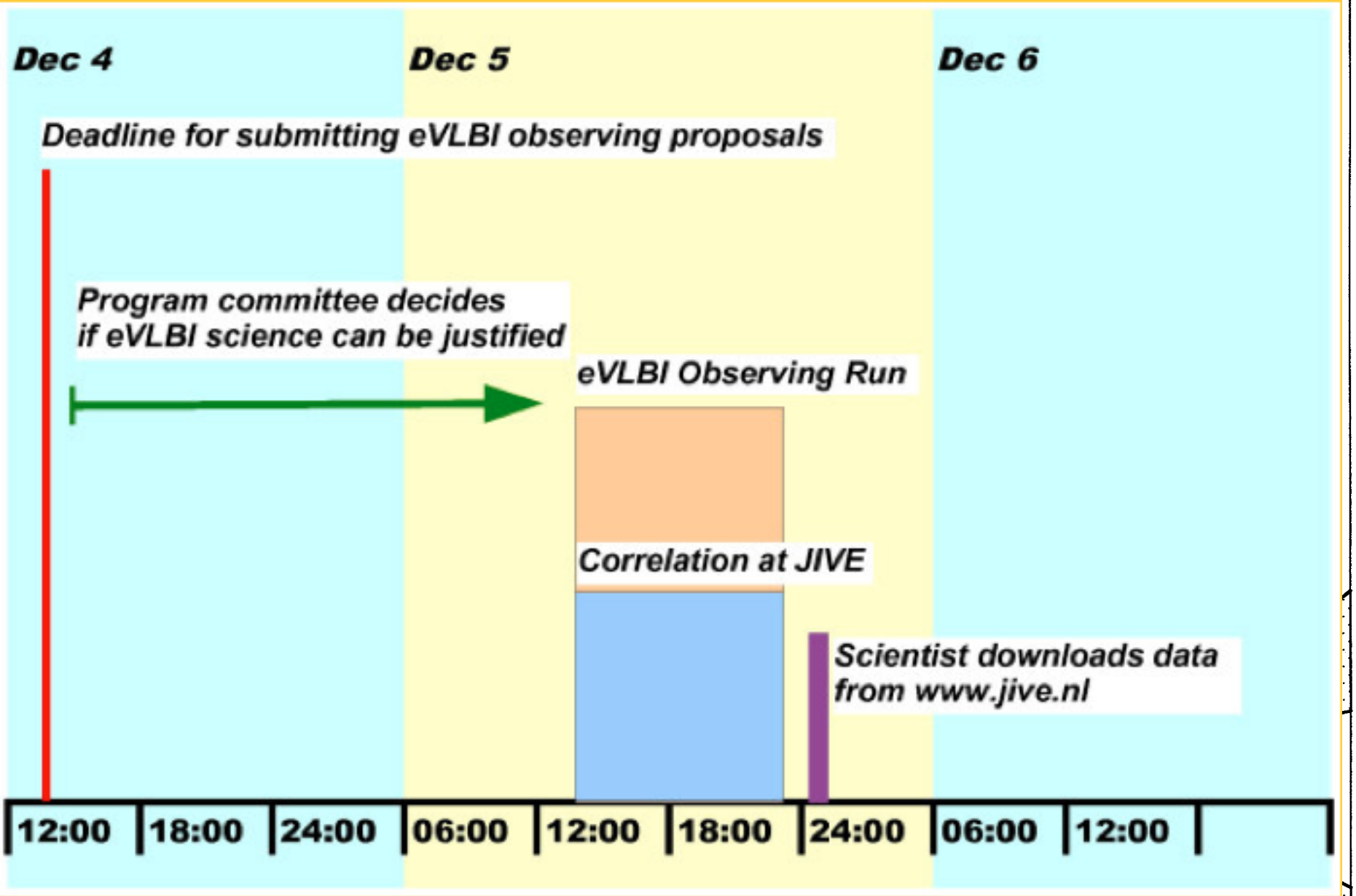
2009

eEVN: European VLBI Network



Slide courtesy of Richard Schilizzi <schilizzi@jive.nl>

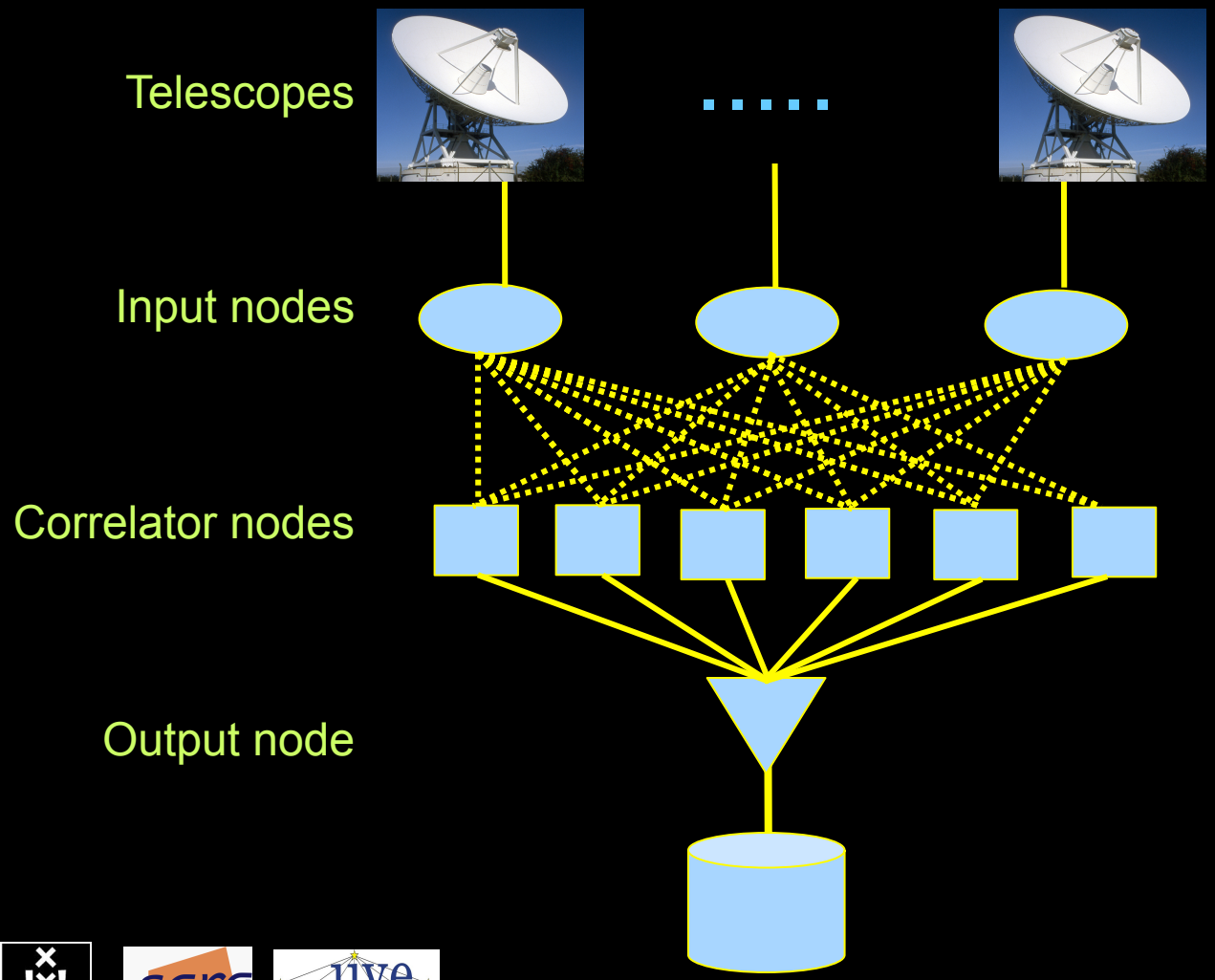
eEVN: European VLBI Network



Slide courtesy of Richard Schilizzi <schilizzi@jive.nl>

The SCARIe project

SCARIe: a research project to create a Software Correlator for e-VLBI.
VLBI Correlation: signal processing technique to get high precision image from spatially distributed radio-telescope.



16 Gbit/s - 2 Tflop ➔
THIS IS A DATA FLOW PROBLEM !!!

Research:

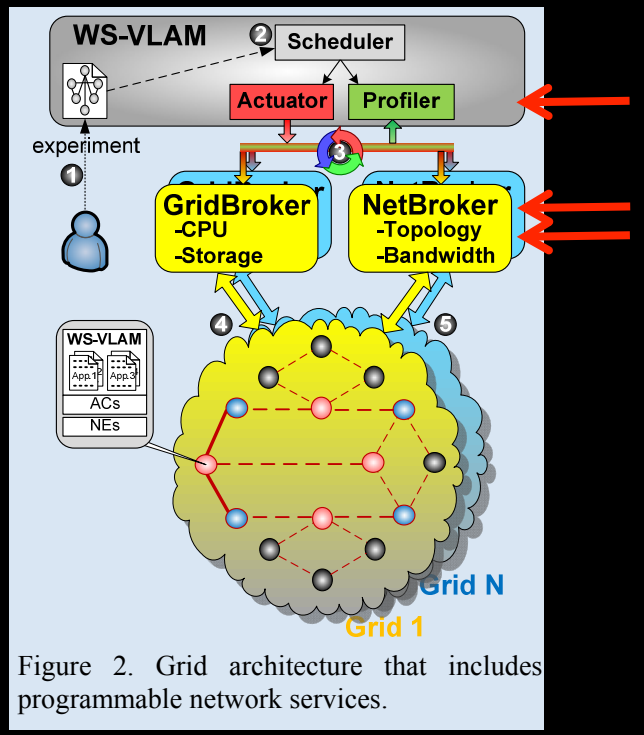


Figure 2. Grid architecture that includes programmable network services.

LOFAR as a Sensor Network

20 flops/byte

- LOFAR is a large distributed research infrastructure:

2 Tflops/s

  - Astronomy:
    - >100 phased array stations
    - Combined in aperture synthesis array
    - 13,000 small “LF” antennas
    - 13,000 small “HF” tiles
  - Geophysics:
    - 18 vibration sensors per station
    - Infrasound detector per station
  - >20 Tbit/s generated digitally
  - >40 Tflop/s supercomputer
  - innovative software systems
    - new calibration approaches
    - full distributed control
    - VO and Grid integration
    - datamining and visualisation

Why is more resolution is better?

1. More Resolution Allows Closer Viewing of Larger Image

2. Closer Viewing of Larger Image Increases Viewing Angle

3. Increased Viewing Angle Produces Stronger Emotional Response

HDTV (2K)

1920

1080

30°

3.0 × Picture Height

UHDTV(8K)

7680

4320

0.75 × Picture Height

100°

UHDTV(4K)

3840

2160

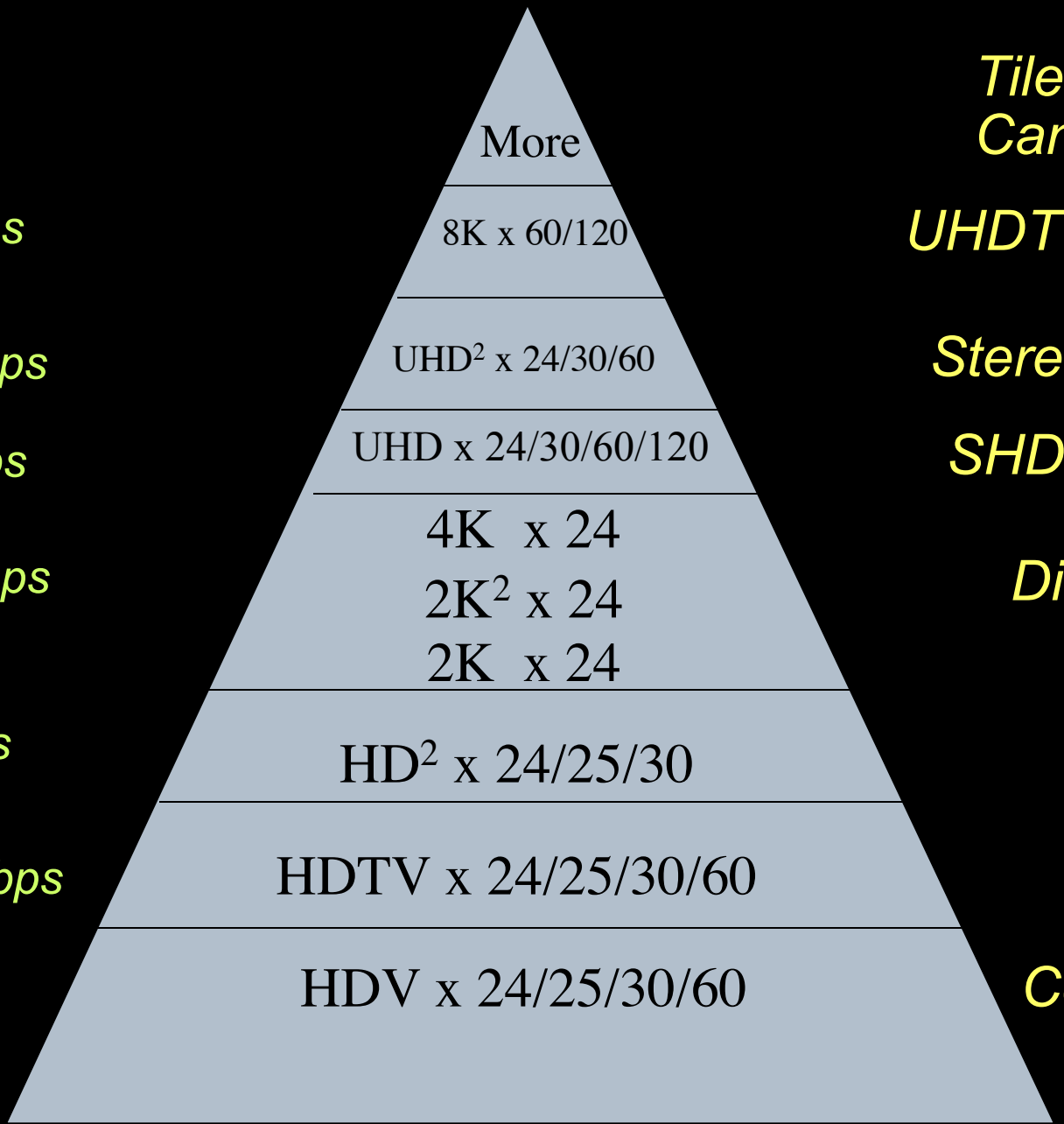
60°

1.5 × Picture Height

CineGrid

Yutaka TANAKA
SHARP CORPORATION
Advanced Image Research Laboratories

CineGrid: A Scalable Approach



Tiled Displays
Camera Arrays

20 - 192 Gbps

UHDTV (far future)

0.02 – 96 Gbps

Stereo 4K (future)

0.-2 - 48 Gbps

SHD (Quad HD)

0.25 - 7.6 Gbps

Digital Cinema

0.02 - 3 Gbps

Stereo HD

12 – 1500 Mbps

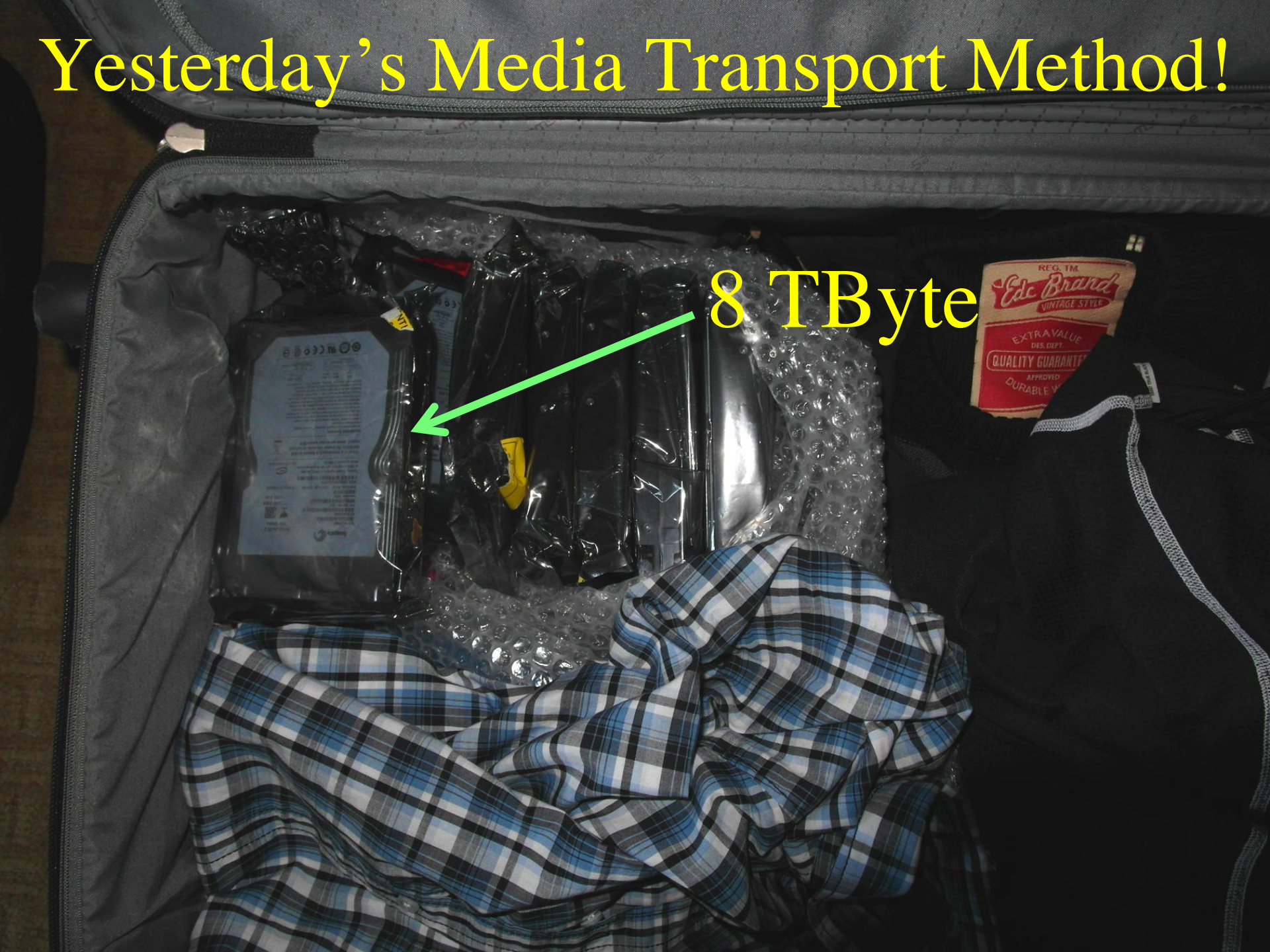
HDTV

4 - 25 Mbps

Consumer HD

Moving Big Data Objects Globally

- **Digital Motion Picture for Audio Post-Production**
  - 1 TV Episode Dubbing Reference ~ 1 GB
  - 1 Theatrical 5.1 Final Mix ~ 8 GB
  - 1 Theatrical Feature Dubbing reference ~ 30 GB
- **Digital Motion Picture Acquisition**
  - 4K RGB x 24 FPS x 10bit/color: ~ 48MB/Frame uncompressed *(ideal)*
  - 6:1 ~ 20:1 shooting ratios => 48TB ~ 160TB digital camera originals
- **Digital Dailies**
  - HD compressed MPEG-2 @ 25 ~ 50 Mb/s
- **Digital Post-production and Visual Effects**
  - Gigabytes - Terabytes to Select Sites Depending on Project
- **Digital Motion Picture Distribution**
  - Film Printing in Regions
    - Features ~ 8TB
    - Trailers ~ 200GB
  - Digital Cinema Package to Theatres
    - Features ~ 100 - 300GB per DCP
    - Trailers ~ 2 - 4GB per DCP


Yesterday's Media Transport Method!
8 TByte
REG. TM.
Ede Brand
VINTAGE STYLE
EXTRA VALUE
QUALITY GUARANTEE
APPROVED
DURABLE

What Happens in an **Internet Minute?**

And **Future Growth** is **Staggering**

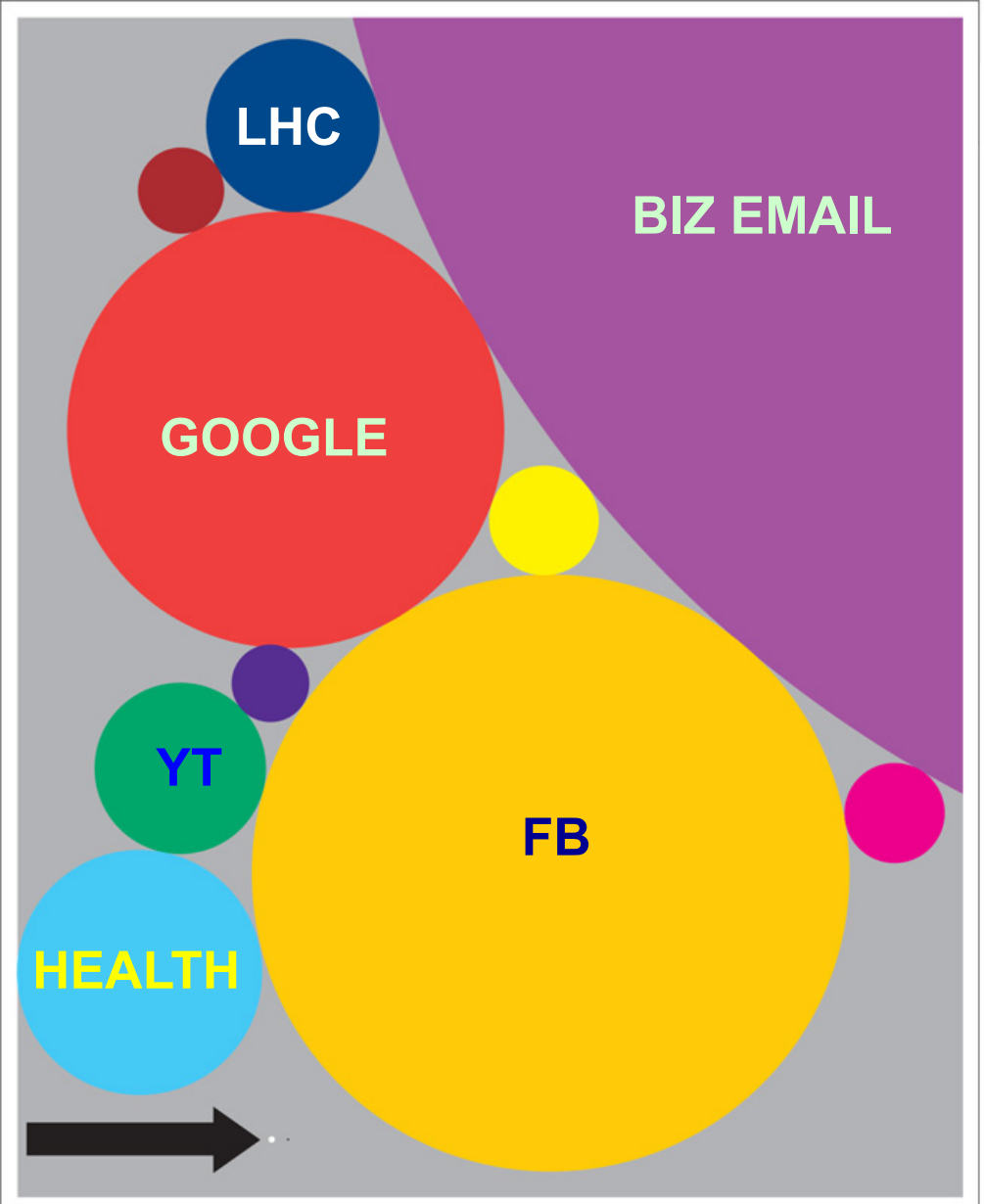
Today, the number of networked devices = the global population

By **2015**, the number of networked devices = 2x the global population

In **2015**, it would take you **5 years**

to view all video crossing IP networks each **second**

intel



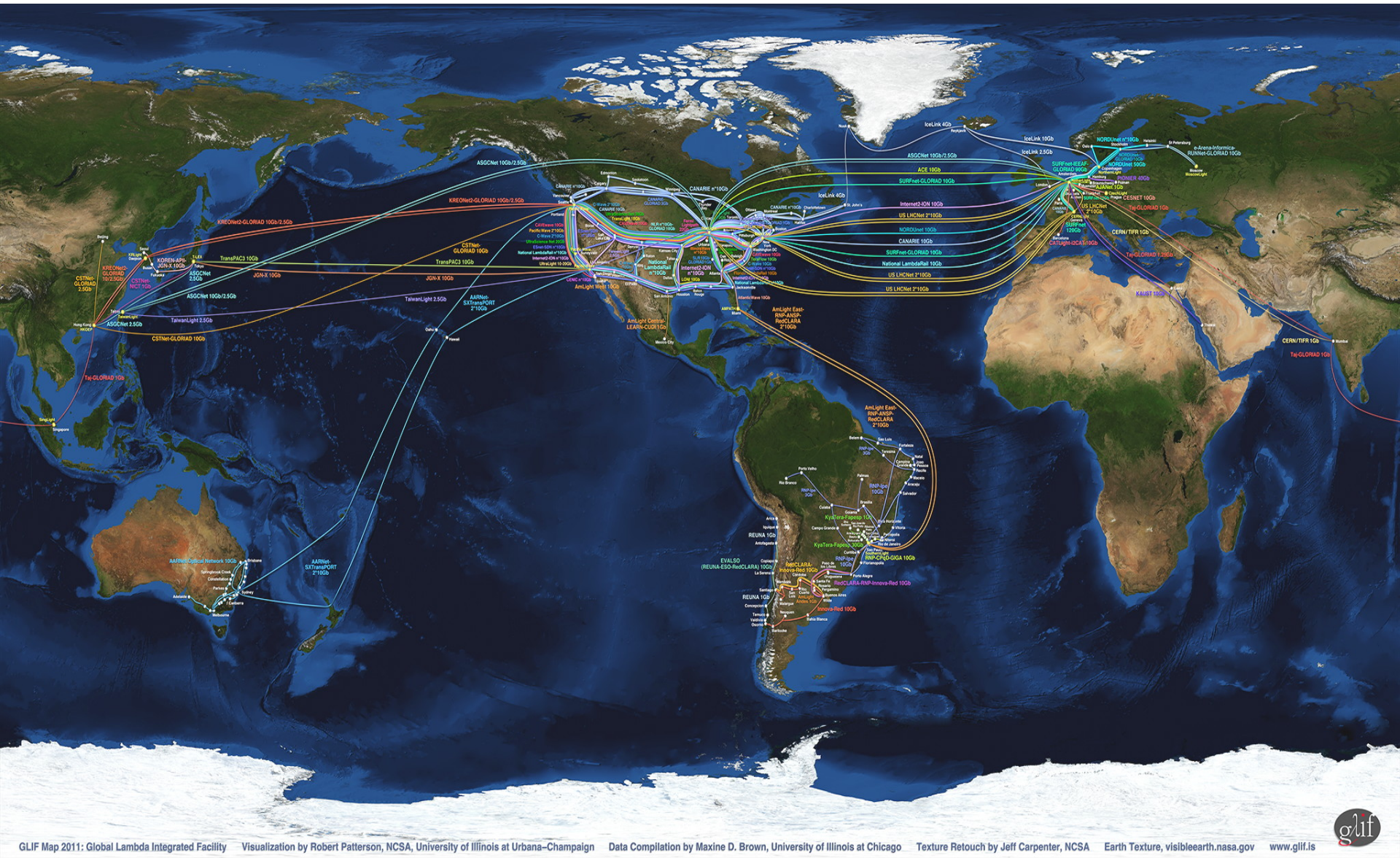
Size of data sets in terabytes

Business email sent per year	2,986,100	National Climactic Data Center database	6,144
Content uploaded to Facebook each year	182,500	Library of Congress' digital collection	5,120
Google's search index	97,656	US Census Bureau data	3,789
Kaiser Permanente's digital health records	30,720	Nasdaq stock market database	3,072
Large Hadron Collider's annual data output	15,360	Tweets sent in 2012	19
Videos uploaded to YouTube per year	15,000	Contents of every print issue of WIRED	1.26

There
is
always
a
bigger
fish

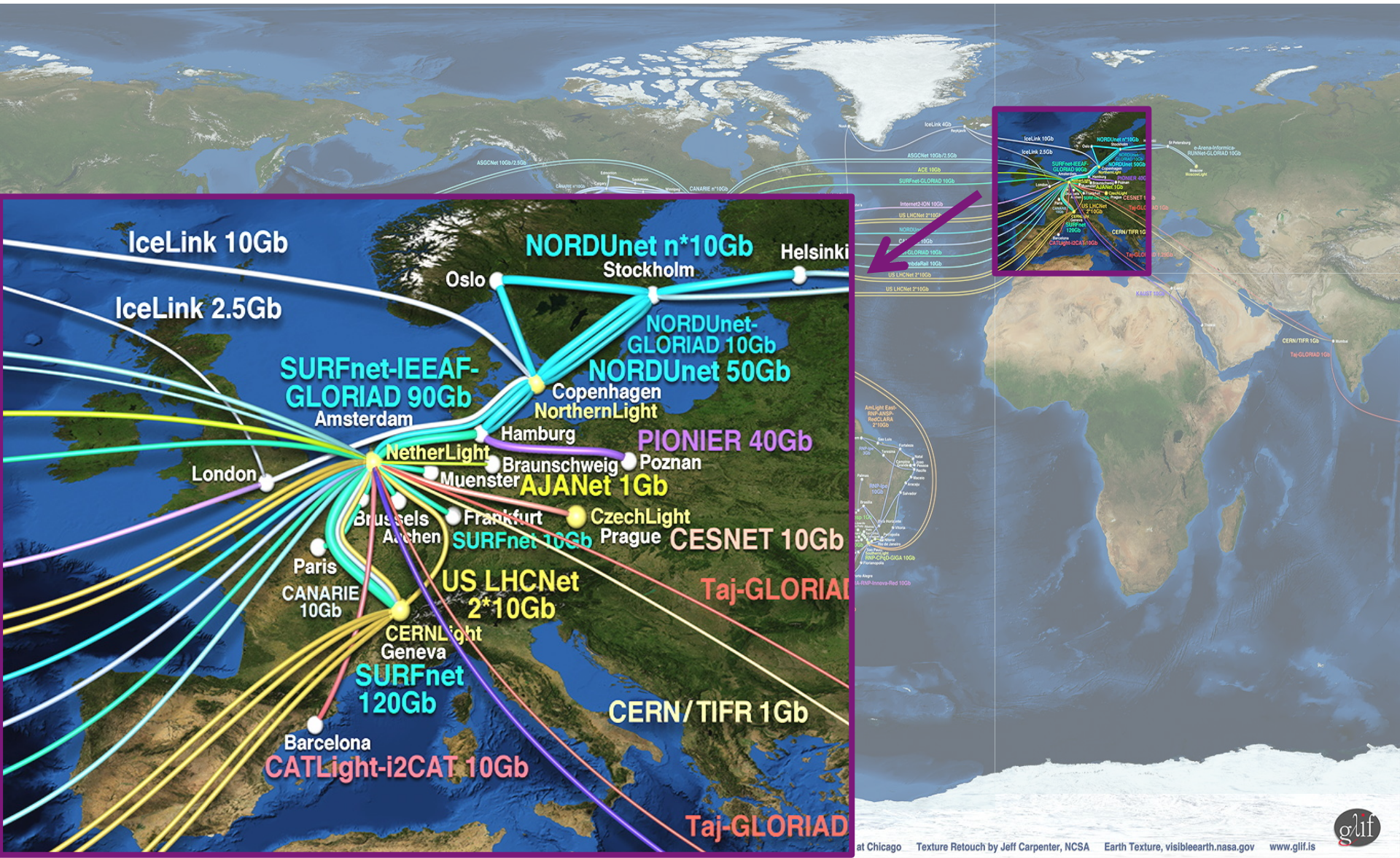
The GLIF – LightPaths around the World

F Dijkstra, J van der Ham, P Grosso, C de Laat, “A path finding implementation for multi-layer networks”, Future Generation Computer Systems 25 (2), 142-146.

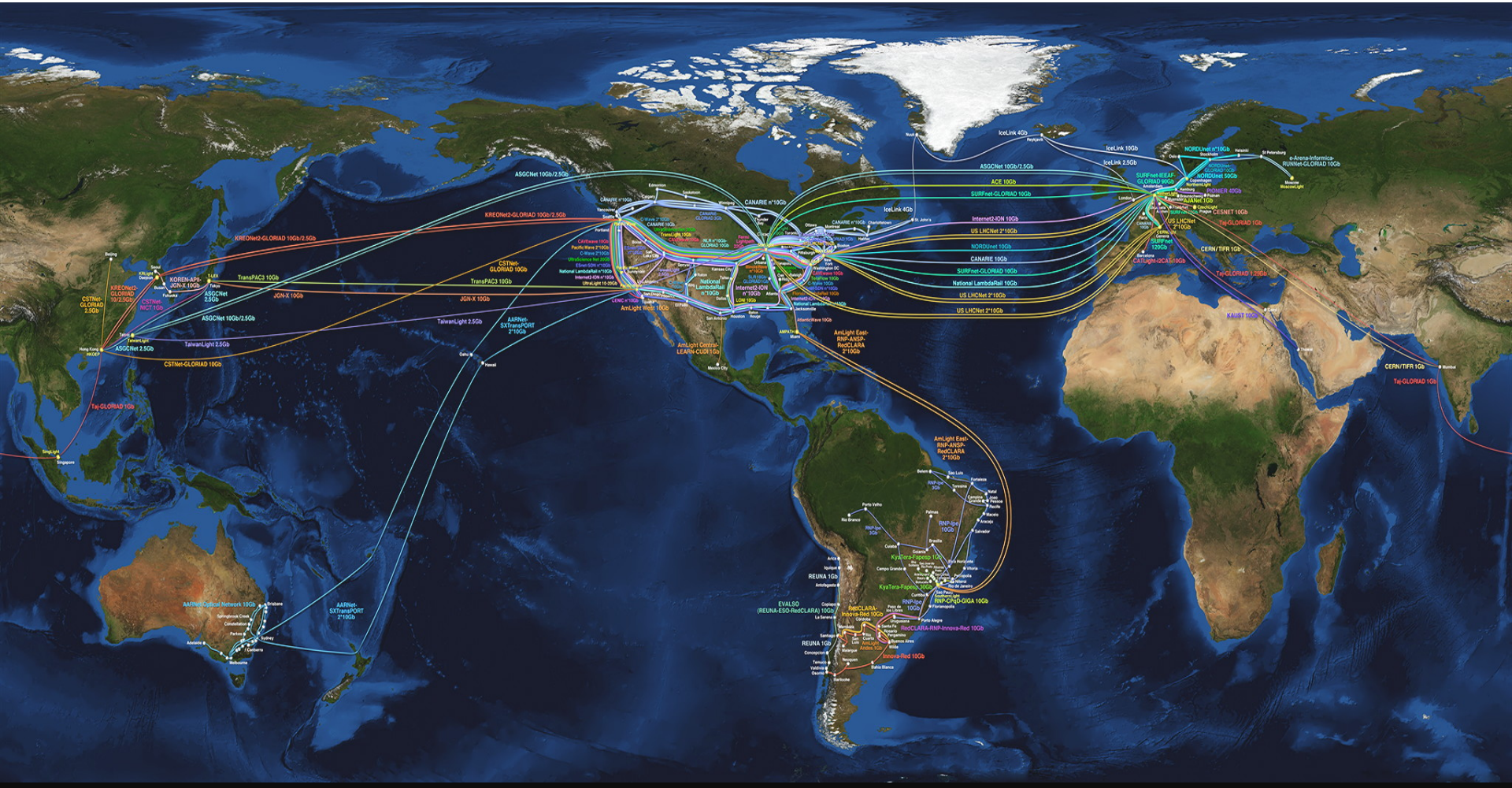


The GLIF – LightPaths around the World

F Dijkstra, J van der Ham, P Grosso, C de Laat, “A path finding implementation for multi-layer networks”, Future Generation Computer Systems 25 (2), 142-146.



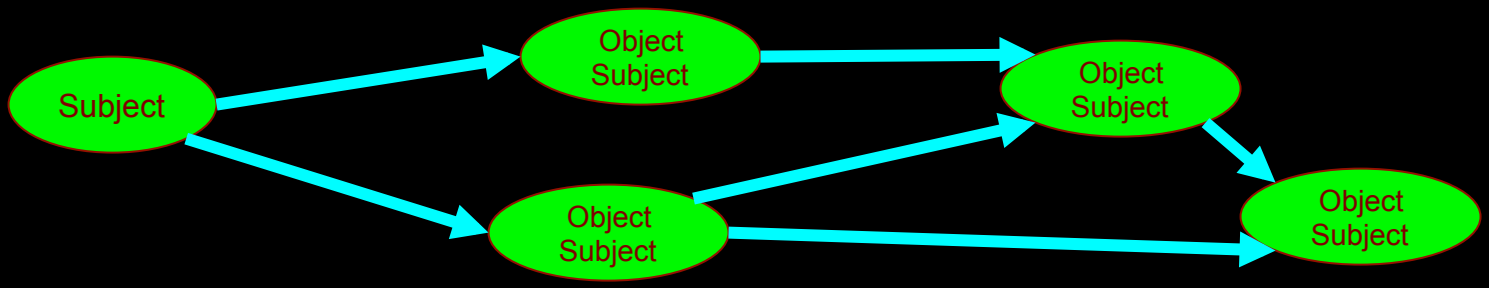
The GLIF – LightPaths around the World

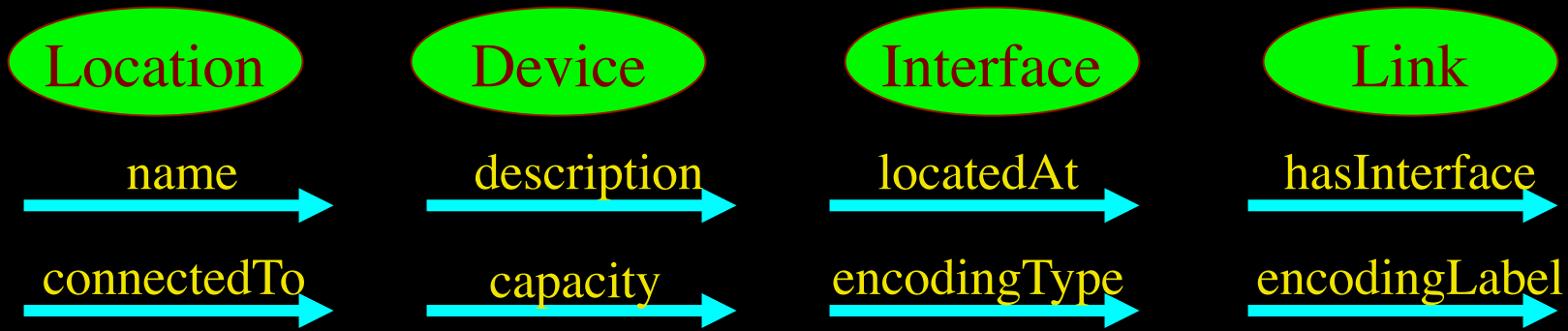


We investigate: TOMTOM for complex networks!

LinkedIN for Infrastructure

- From semantic Web / Resource Description Framework.
- The RDF uses XML as an interchange syntax.
- Data is described by triplets (Friend of a Friend):





NetherLight in RDF

```
<?xml version="1.0" encoding="UTF-8"?>
<rdf:RDF xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
      xmlns:ndl="http://www.science.uva.nl/research/air/ndl#">
<!-- Description of Netherlight -->
<ndl:Location rdf:about="#Netherlight">
      <ndl:name>Netherlight Optical Exchange</ndl:name>
</ndl:Location>
<!-- TDM3.amsterdam1.netherlight.net -->
<ndl:Device rdf:about="#tdm3.amsterdam1.netherlight.net">
      <ndl:name>tdm3.amsterdam1.netherlight.net</ndl:name>
      <ndl:locatedAt rdf:resource="#amsterdam1.netherlight.net"/>
      <ndl:hasInterface rdf:resource="#tdm3.amsterdam1.netherlight.net:501/1"/>
      <ndl:hasInterface rdf:resource="#tdm3.amsterdam1.netherlight.net:501/3"/>
      <ndl:hasInterface rdf:resource="#tdm3.amsterdam1.netherlight.net:501/4"/>
      <ndl:hasInterface rdf:resource="#tdm3.amsterdam1.netherlight.net:503/1"/>
      <ndl:hasInterface rdf:resourc
      <ndl:hasInterface rdf:resourc
      <ndl:hasInterface rdf:resourc
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      <ndl:hasInterface rdf:resourc
      <ndl:hasInterface rdf:resourc
      <ndl:hasInterface rdf:resourc
```
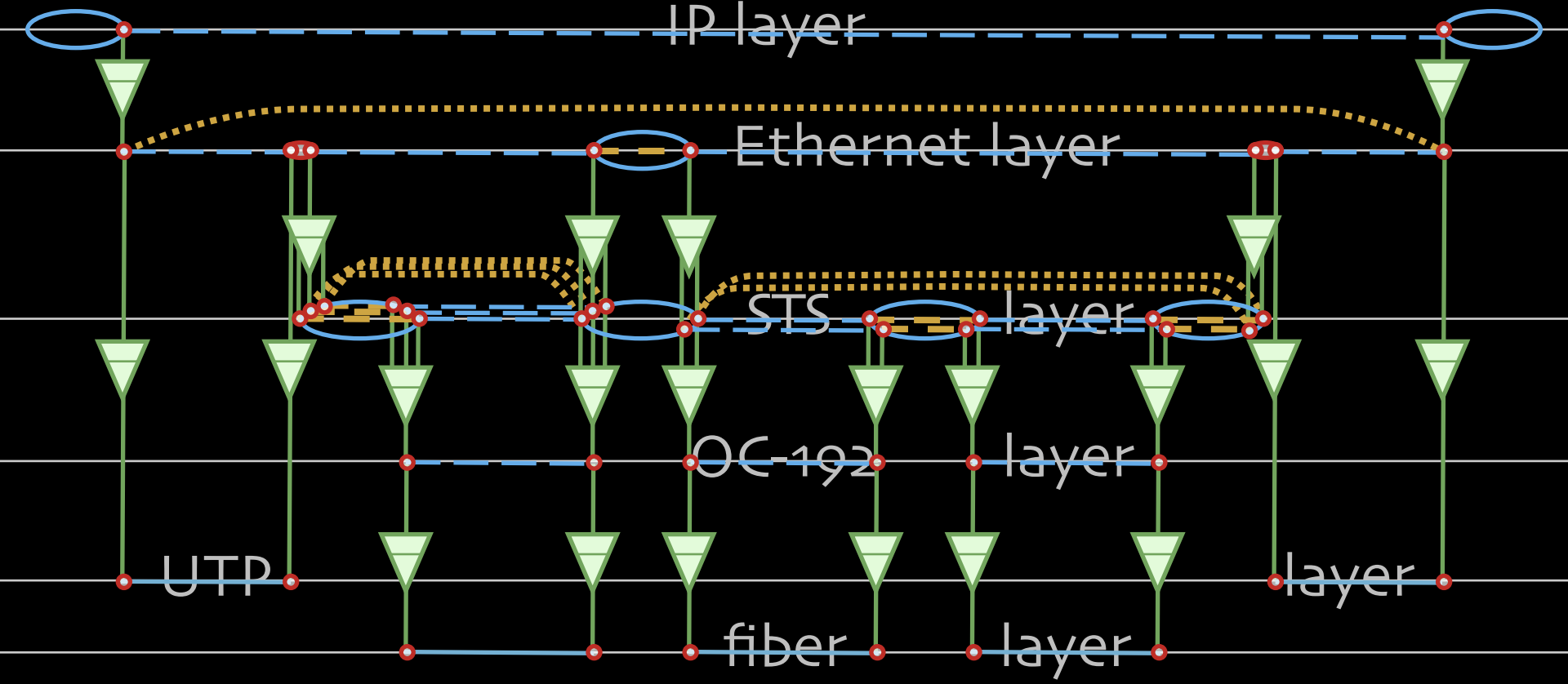
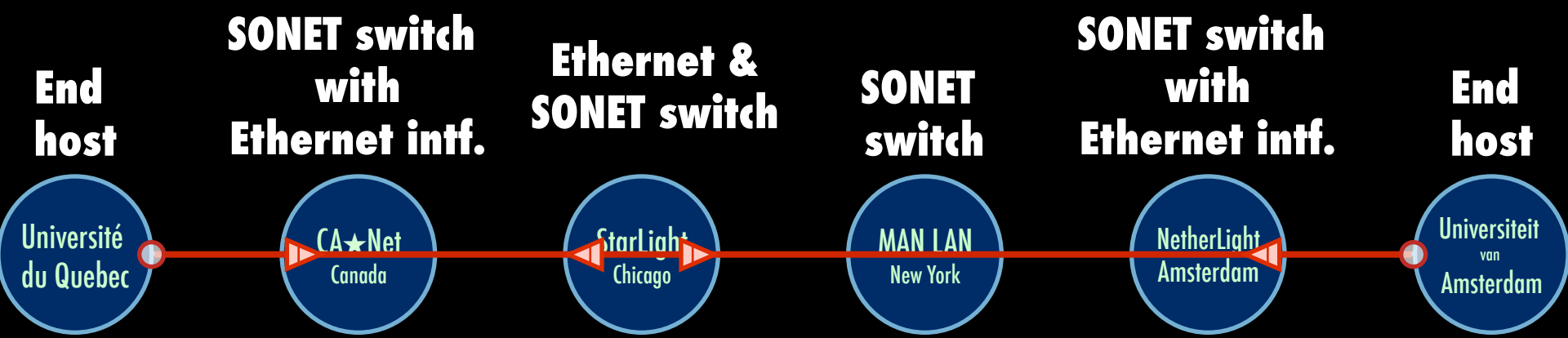
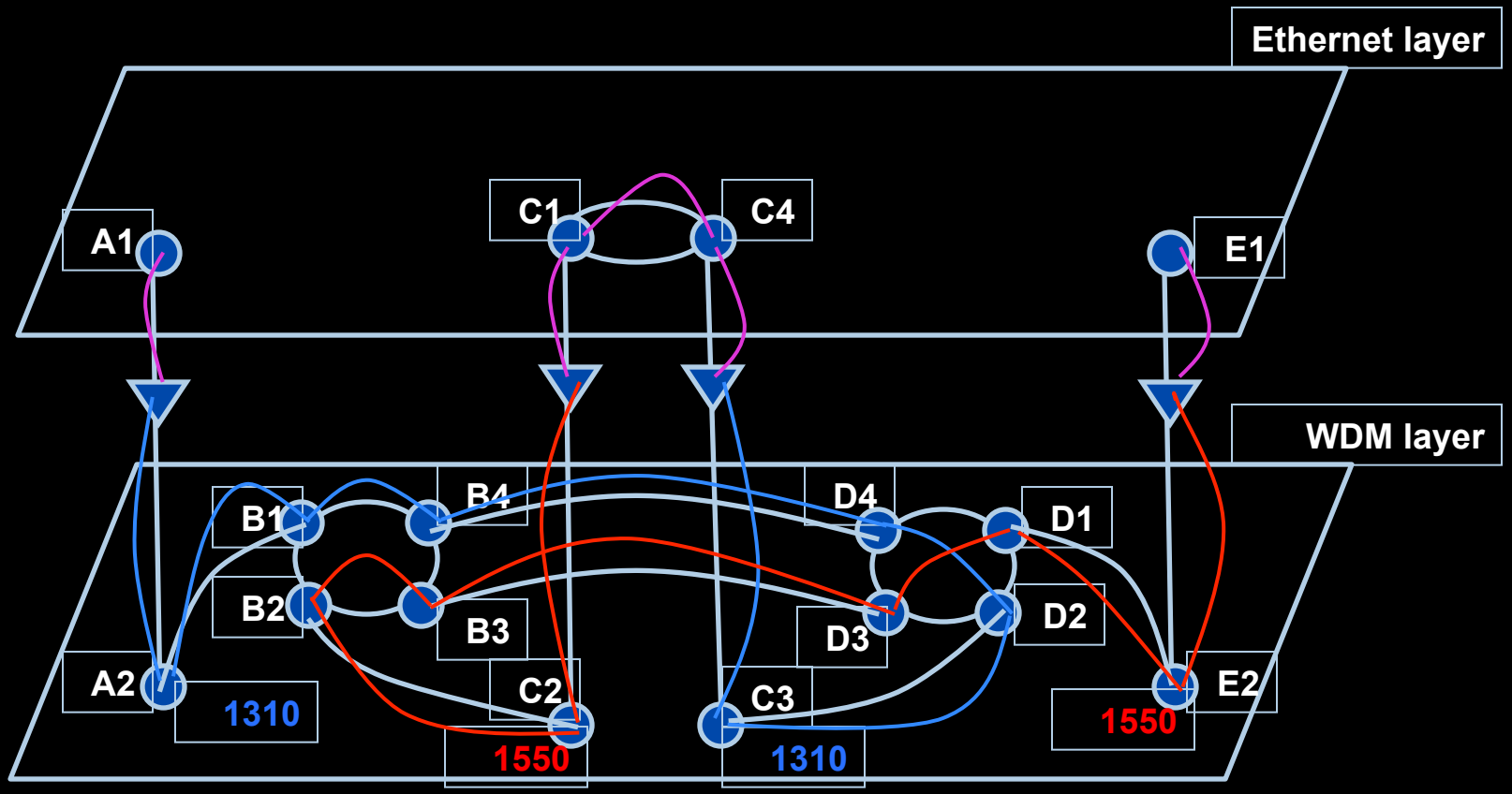

```
<!-- all the interfaces of TDM3.amsterdam1.netherlight.net -->

<ndl:Interface rdf:about="#tdm3.amsterdam1.netherlight.net:501/1">
<ndl:name>tdm3.amsterdam1.netherlight.net:POS501/1</ndl:name>
<ndl:connectedTo rdf:resource="#tdm4.amsterdam1.netherlight.net:5/1"/>
</ndl:Interface>
<ndl:Interface rdf:about="#tdm3.amsterdam1.netherlight.net:501/2">
<ndl:name>tdm3.amsterdam1.netherlight.net:POS501/2</ndl:name>
<ndl:connectedTo rdf:resource="#tdm1.amsterdam1.netherlight.net:12/1"/>
</ndl:Interface>
```

Multi-layer descriptions in NDL





Multi-layer Network PathFinding



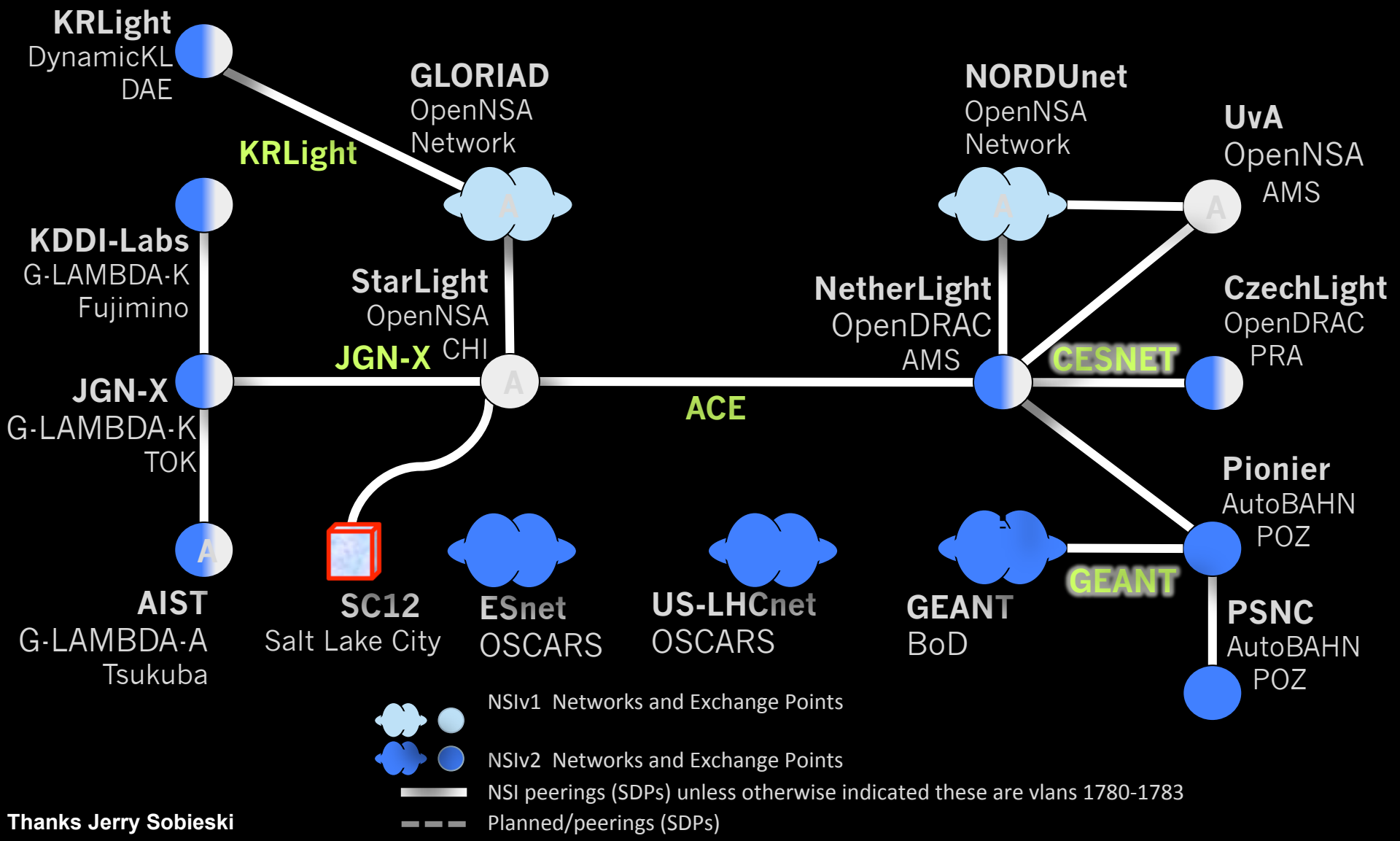
Path between interfaces A1 and E1:
A1-A2-B1-B4-D4-D2-C3-C4-C1-C2-B2-B3-D3-D1-E2-E1

Scaling: Combinatorial problem

Automated GOLE + NSI

Joint NSI v1+v2 Beta Test Fabric Nov 2012

Ethernet Transport Service

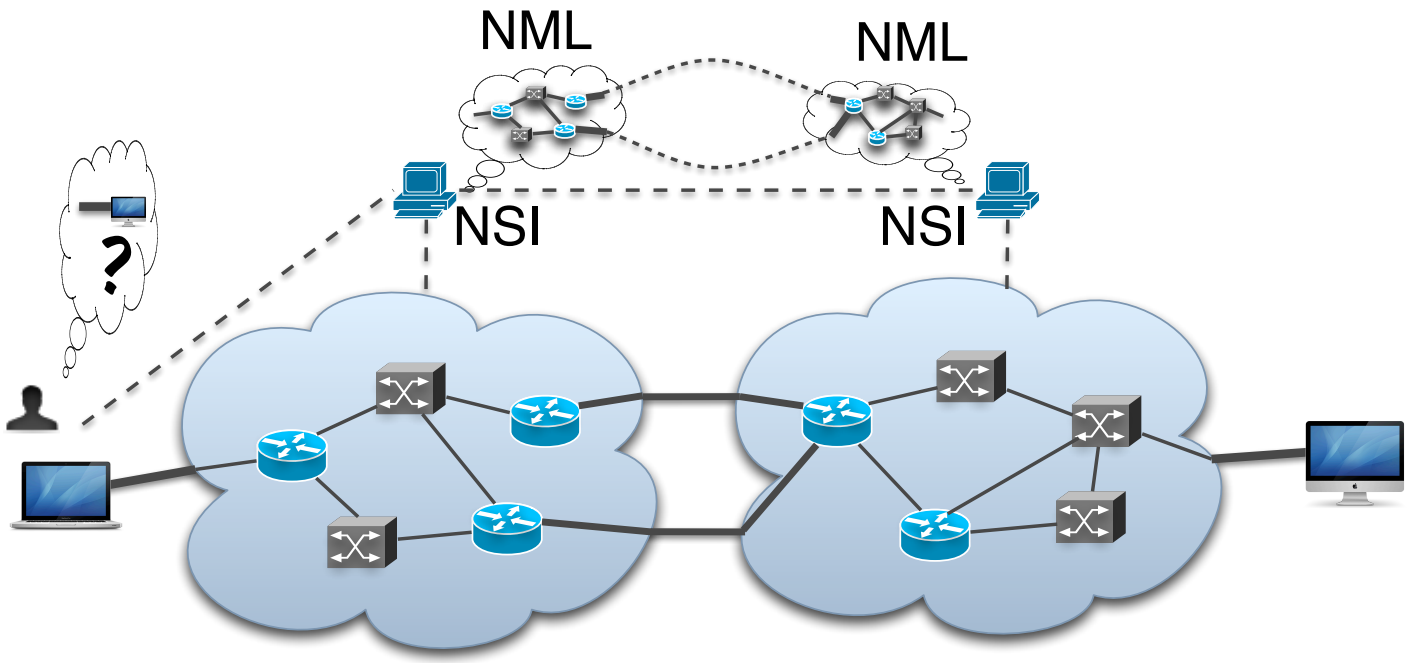


Thanks Jerry Sobieski

Network Topology Description

Network topology research supporting automatic network provisioning

- Inter-domain networks
- Multiple technologies
- Based on incomplete information
- Possibly linked to other resources

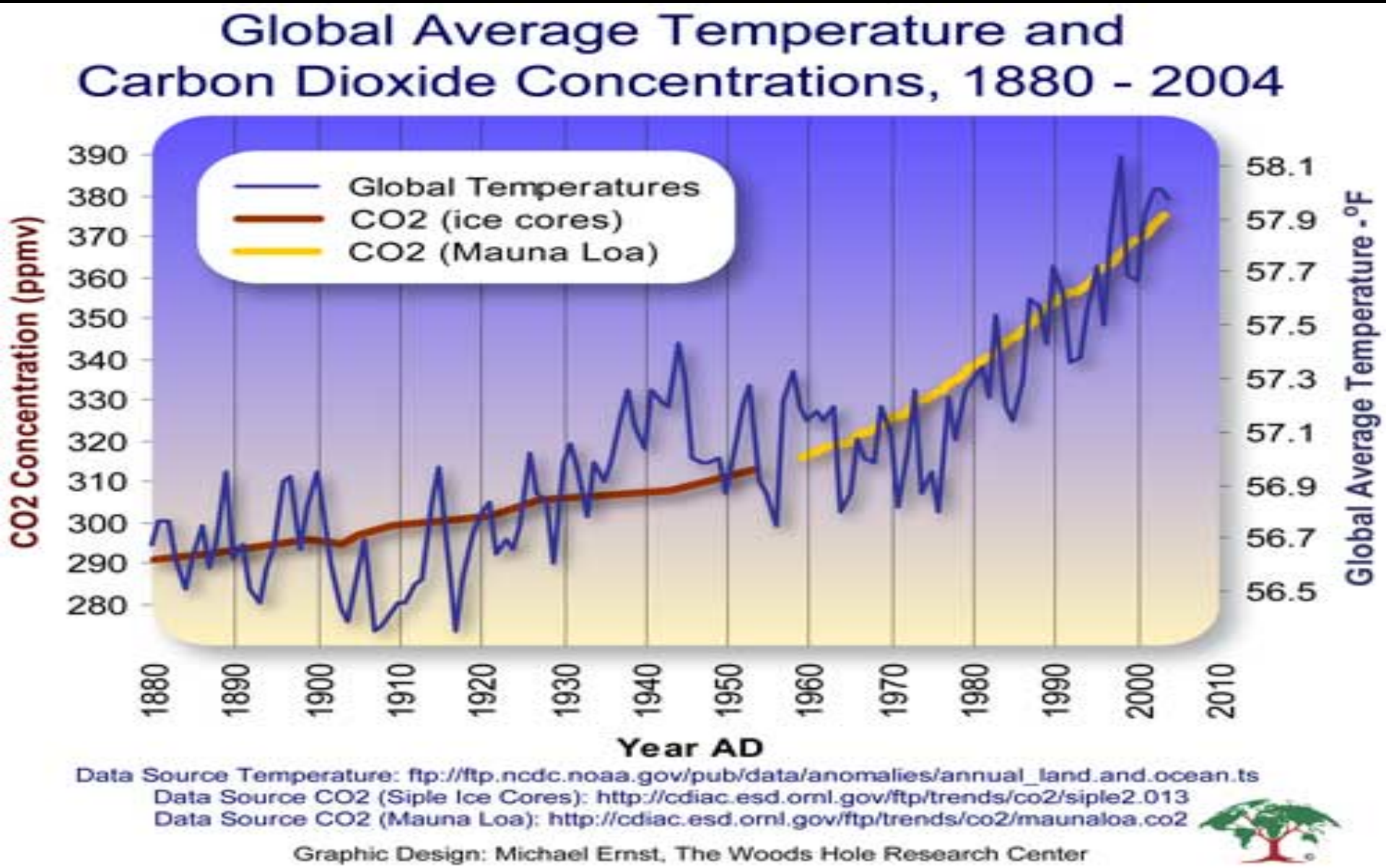


http://redmine.ogf.org/projects/nml-wg
http://redmine.ogf.org/projects/nsi-wg

http://sne.science.uva.nl/ndl

OpenGridForum
OPEN FORUM | OPEN STANDARDS

Need for GreenIT

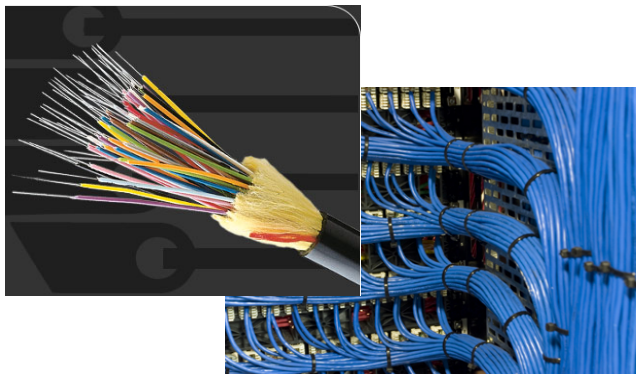


Greening the Processing System

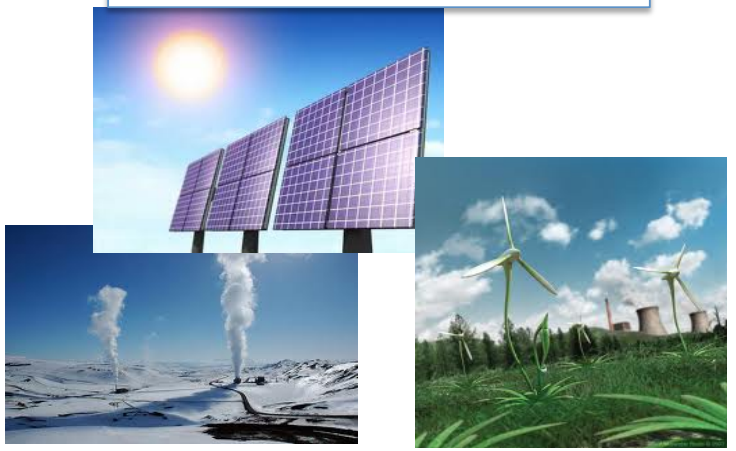
ECO-Scheduling

Green scheduling

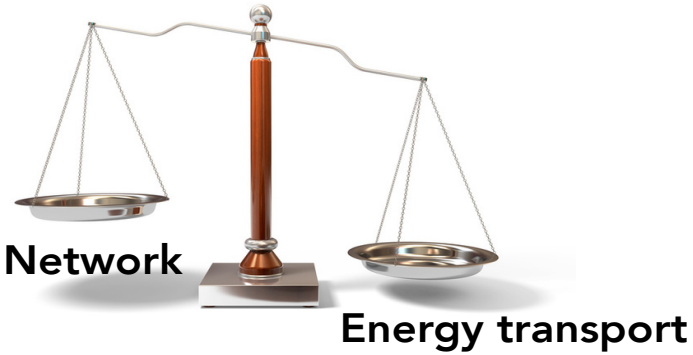
Network infrastructures



Green energy sources

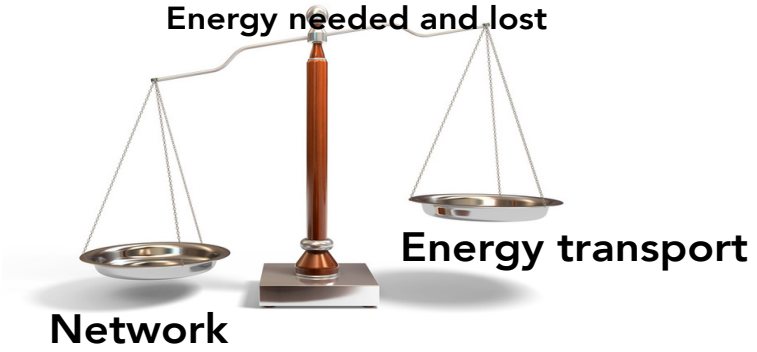


CO_2 footprint;
Energy needed and lost



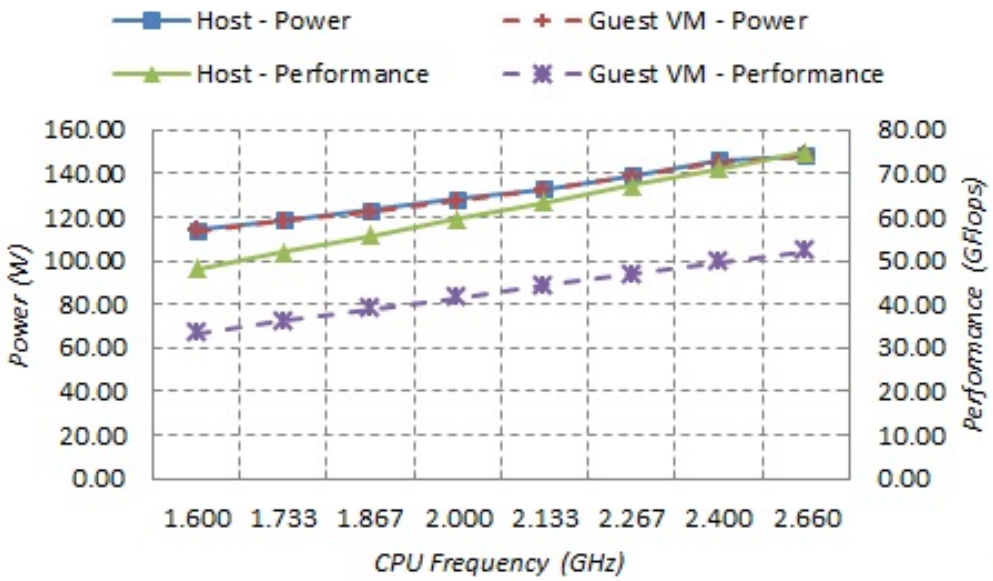
Bits to energy

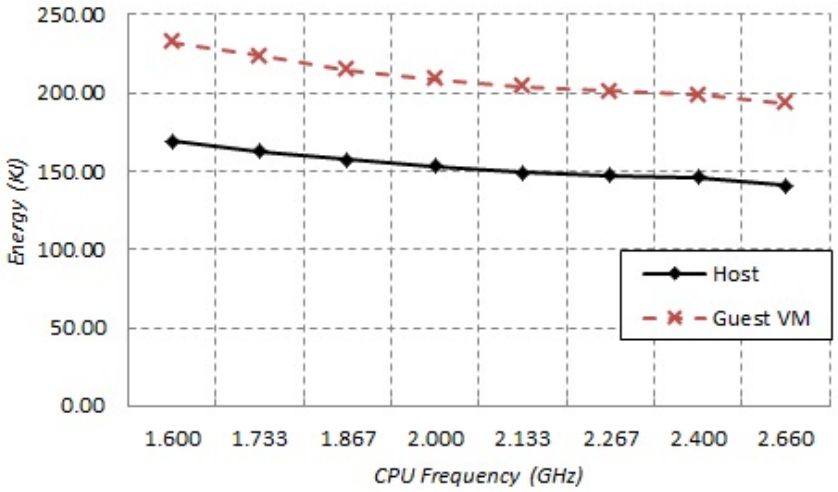
CO_2 footprint;
Energy needed and lost



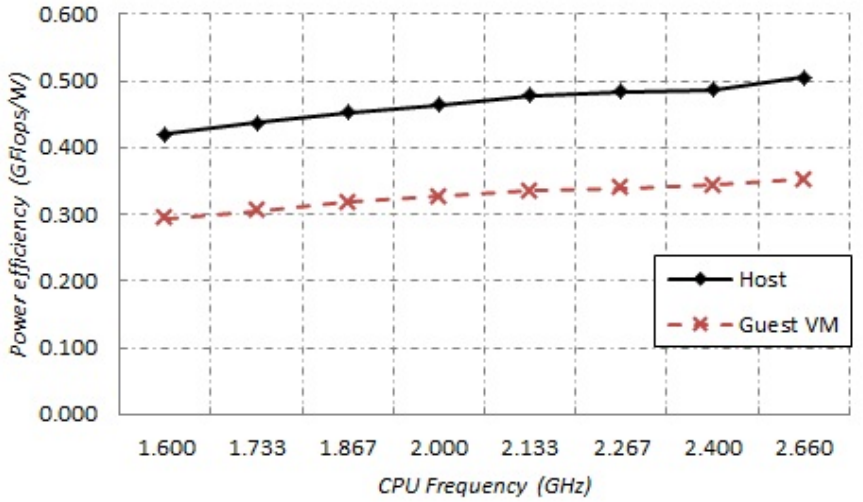
Energy to bits

Energy saving in clouds





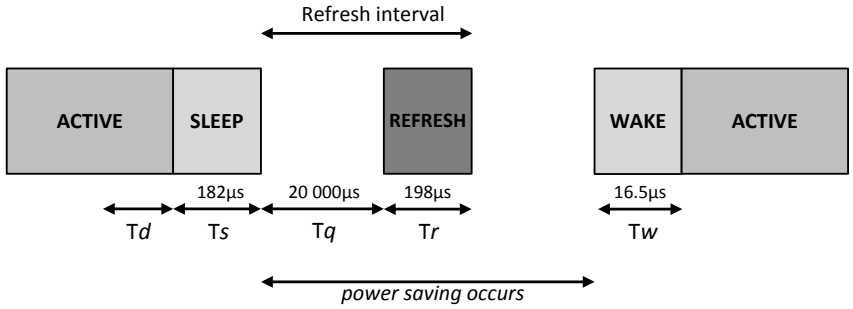
Quantifying the energy performance of VMs is the first step toward energy-aware job scheduling.

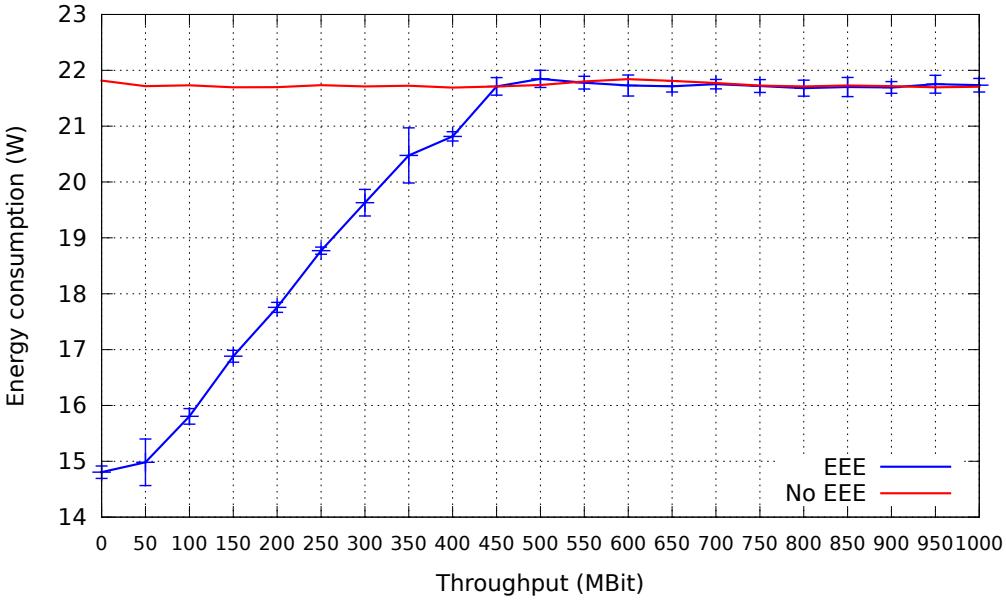


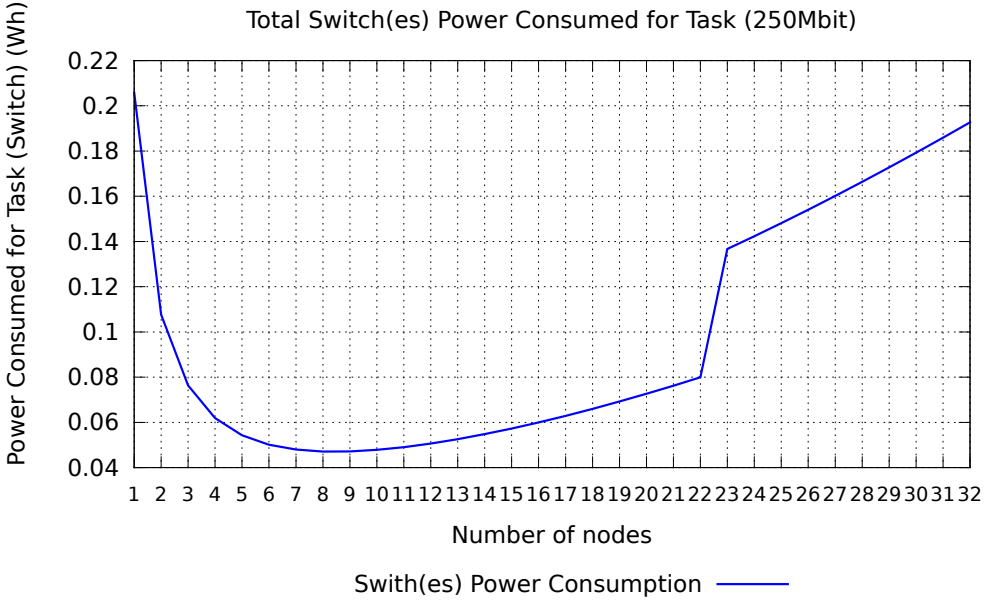
Q. Chen, P. Grosso, K. van der Veldt, C. de Laat, R. Hofman and H.Bal.
Profiling energy consumption of VMs for green cloud computing
In: International Conference on Cloud and Green Computing (CGC2011), Sydney December 2011

Energy Efficient Ethernet (802.3az)

Power savings techniques in hardware can be leveraged in architecturing communication patterns in data centra



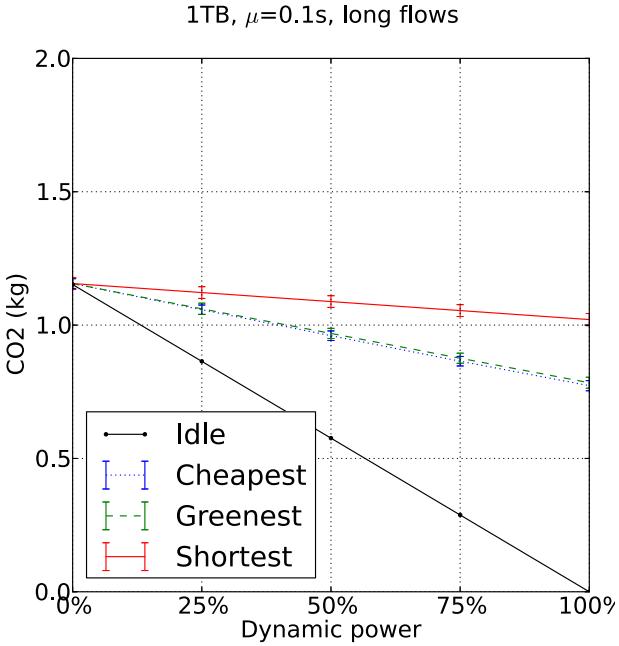


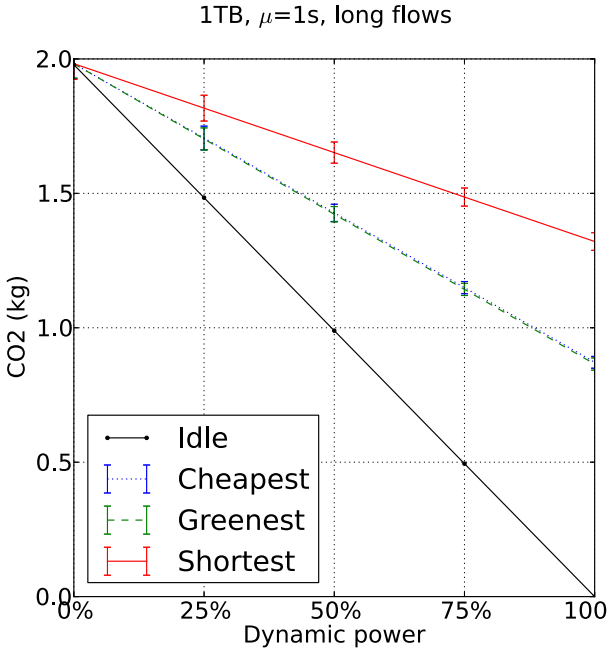


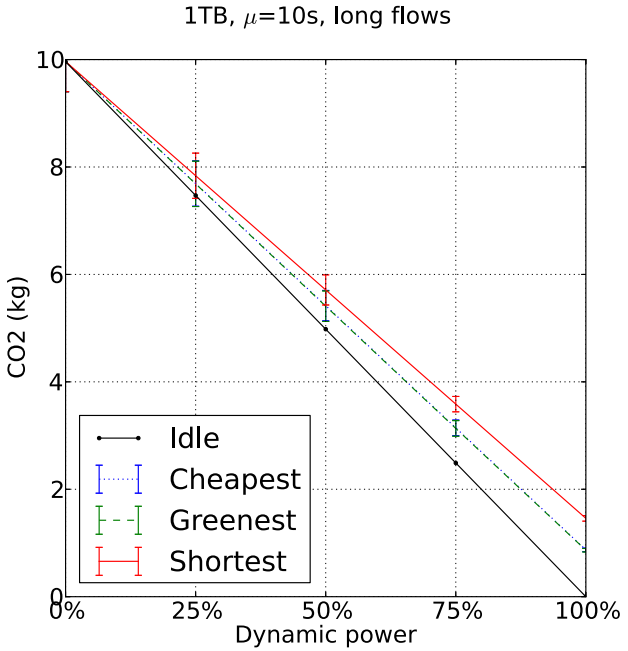
D. Pavlov and J. Soert and P. Grosso and Z. Zhao and K. van der Veldt and H. Zhu and C.de Laat
Towards energy efficient data intensive computing using IEEE 802.3az
In: DISCS 2012 workshop - Nov 2012

Networks and CO2

- Take a network (Esnet, working on using SURFnet data)
- Define the traffic model running on it
- Use the energy monitoring information and energy costs data
- Compare path selection strategies : shortest, cheapest and greenest







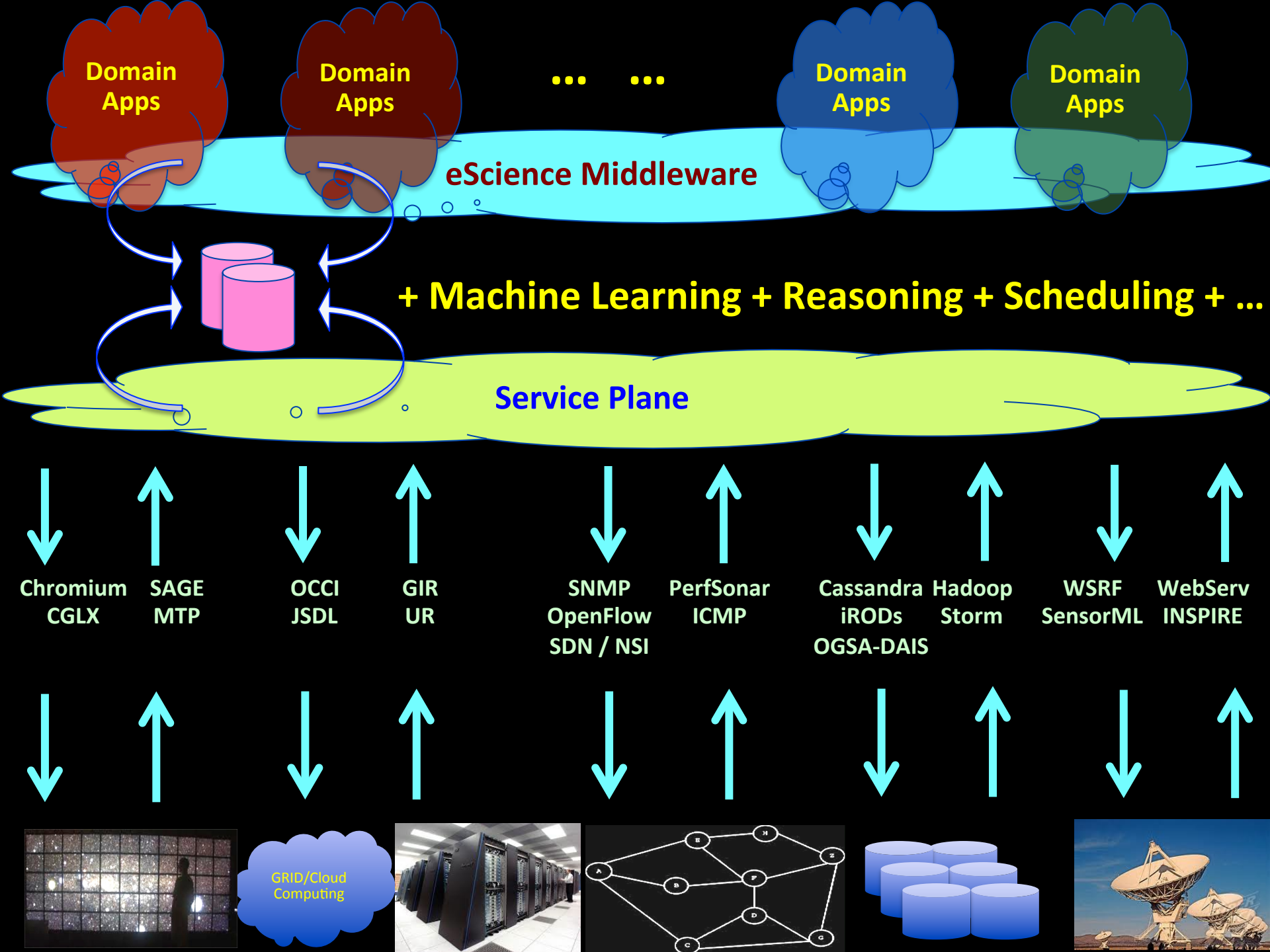
"A motivation for carbon aware path provisioning for NRENs" (submitted to eEnergy2014)

I want to

"Show Big Bug Bunny in 4K on my Tiled Display using green Infrastructure"

- Big Bugs Bunny can be on multiple servers on the Internet.
- Movie may need processing / recoding to get to 4K for Tiled Display.
- Needs deterministic Green infrastructure for Quality of Experience.
- Consumer / Scientist does not want to know the underlying details.

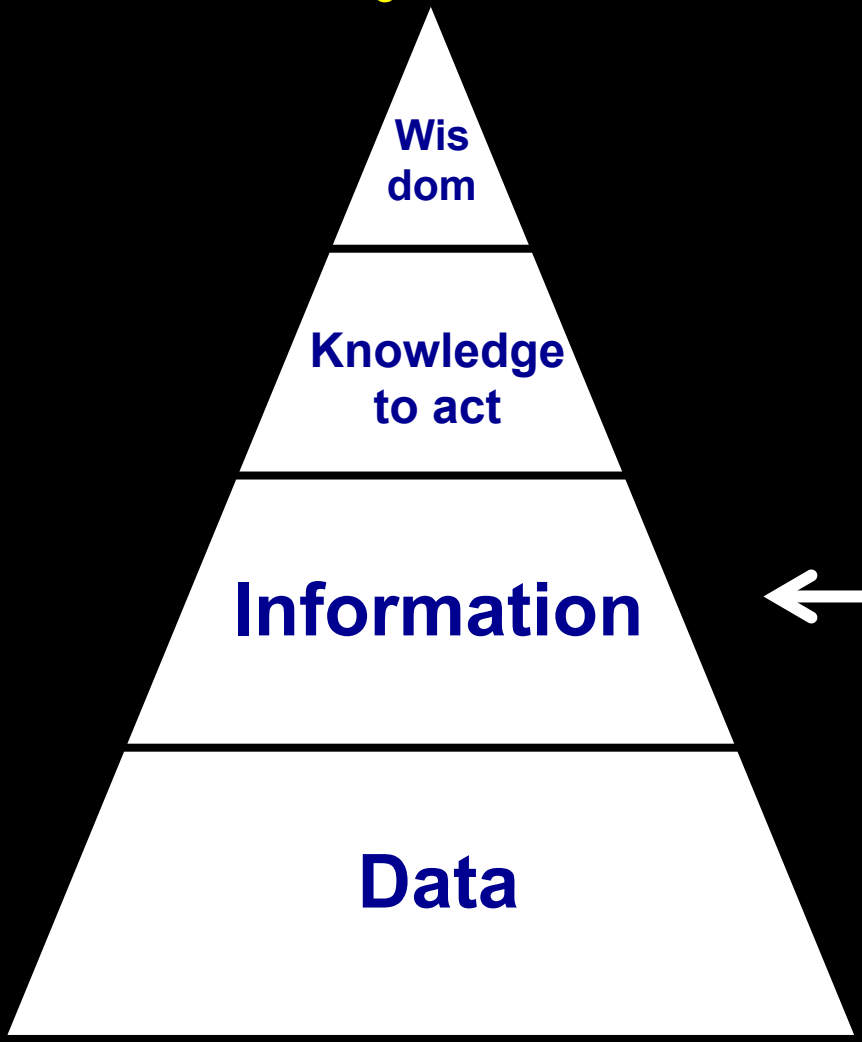
➔ His refrigerator also just works!

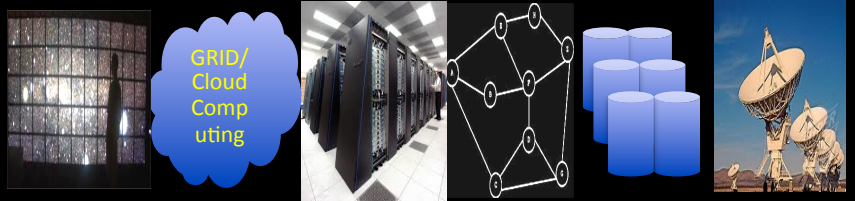

Domain Apps
Domain Apps
... ...
Domain Apps
Domain Apps
eScience Middleware
+ Machine Learning + Reasoning + Scheduling + …
Service Plane
Chromium CGLX
SAGE MTP
OCCI JSDL
GIR UR
SNMP OpenFlow SDN / NSI
PerfSonar ICMP
Cassandra iRODs OGSA-DAIS
Hadoop Storm
WSRF SensorML
WebServ INSPIRE
GRID/Cloud Computing

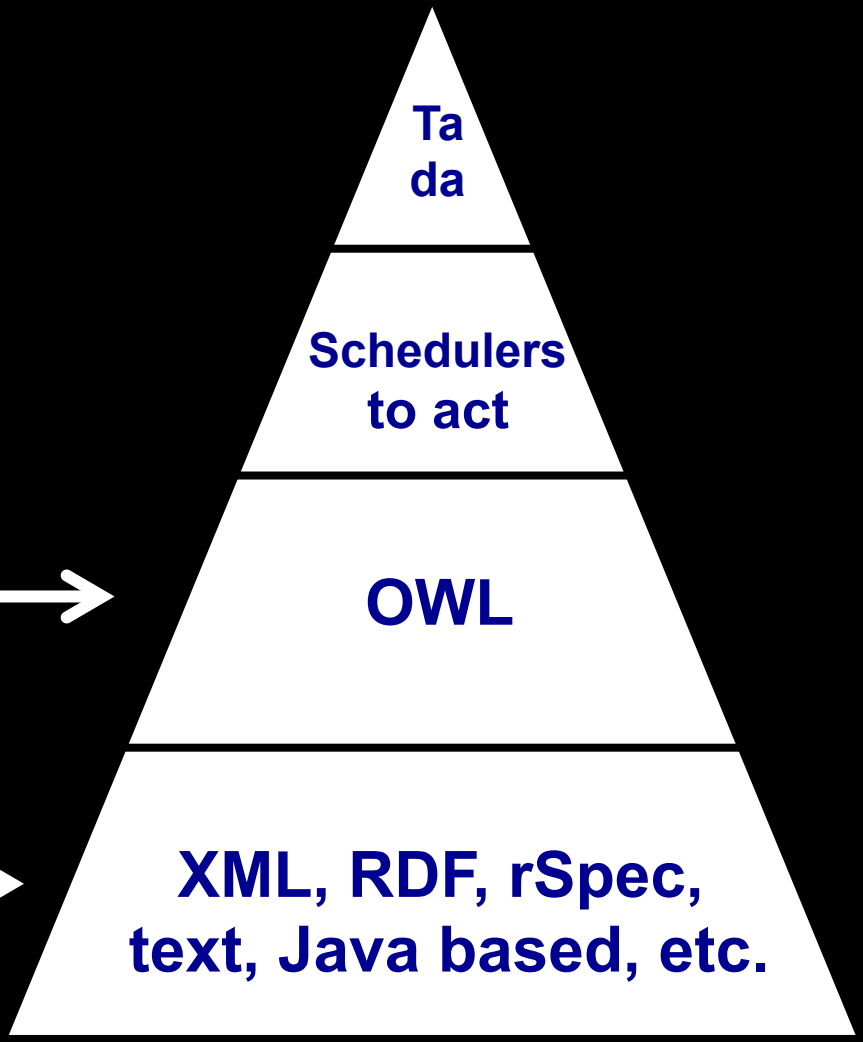
Layers

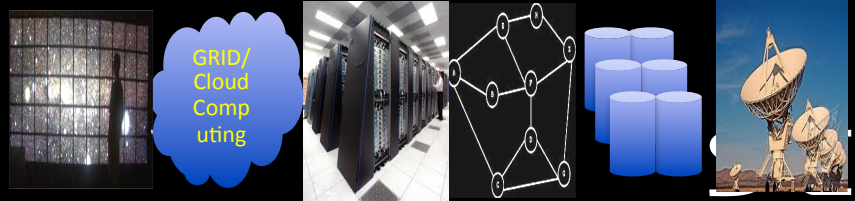
Doing Science

ICT to enable Science









The Big Data Challenge

Doing Science

ICT to enable Science

Wis
dom

Knowledge

Data

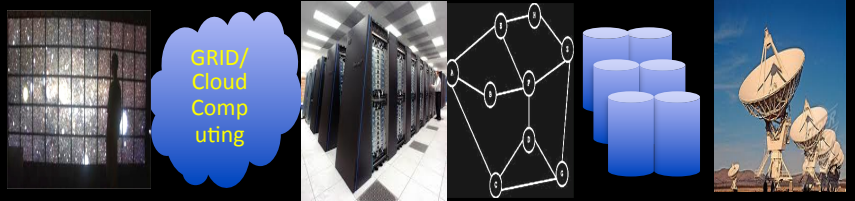
Ta
da

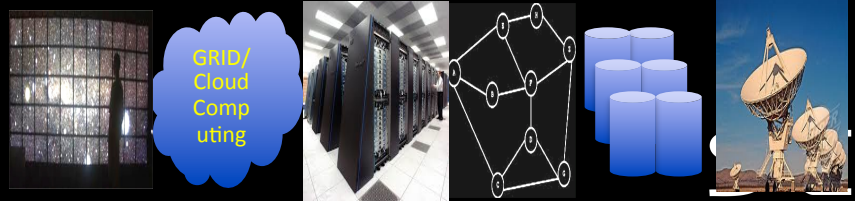
Schedulers

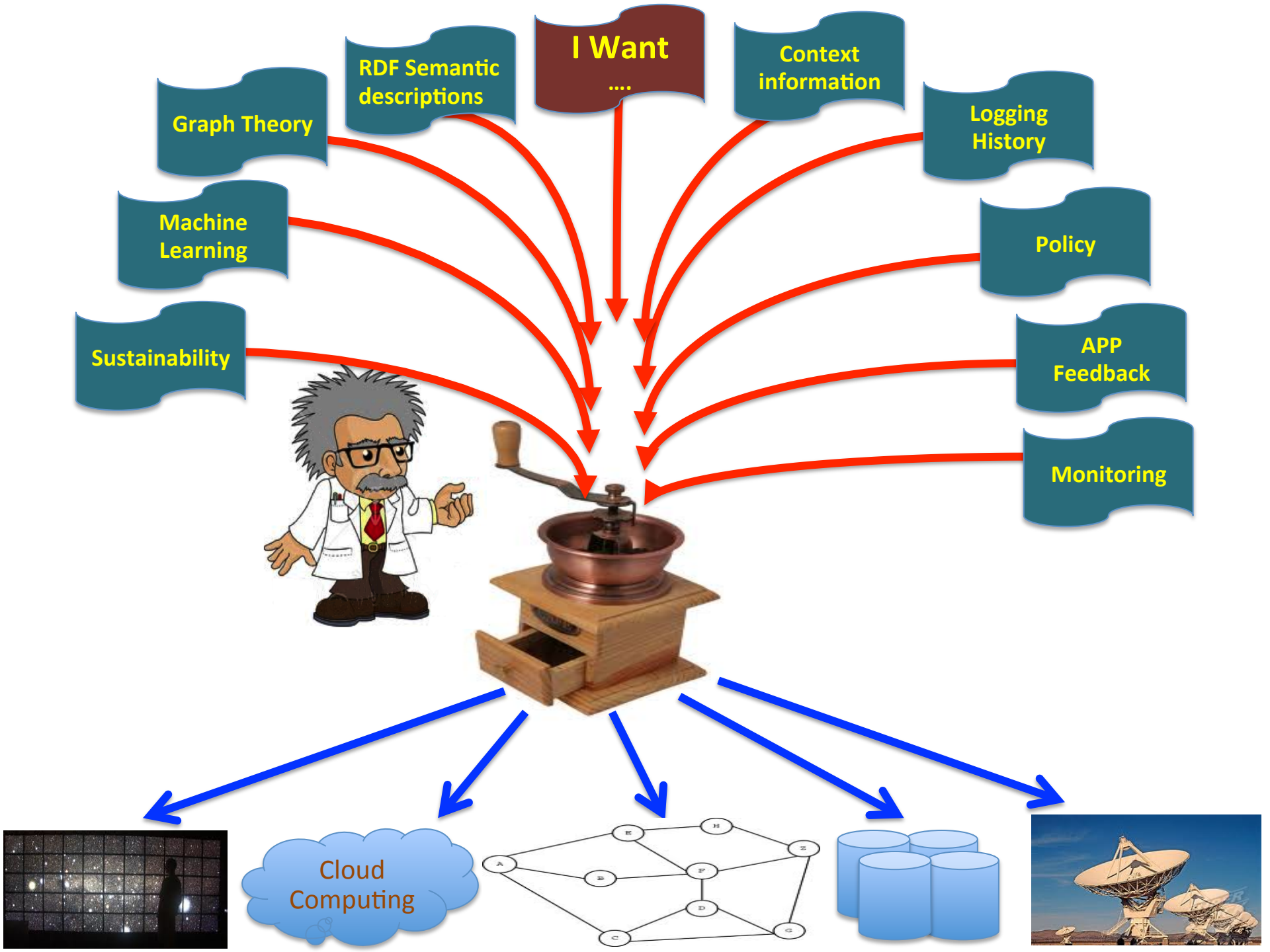
XML, RDF, rSpec,
text, Java based, etc.

MAGIC DATA CARPET

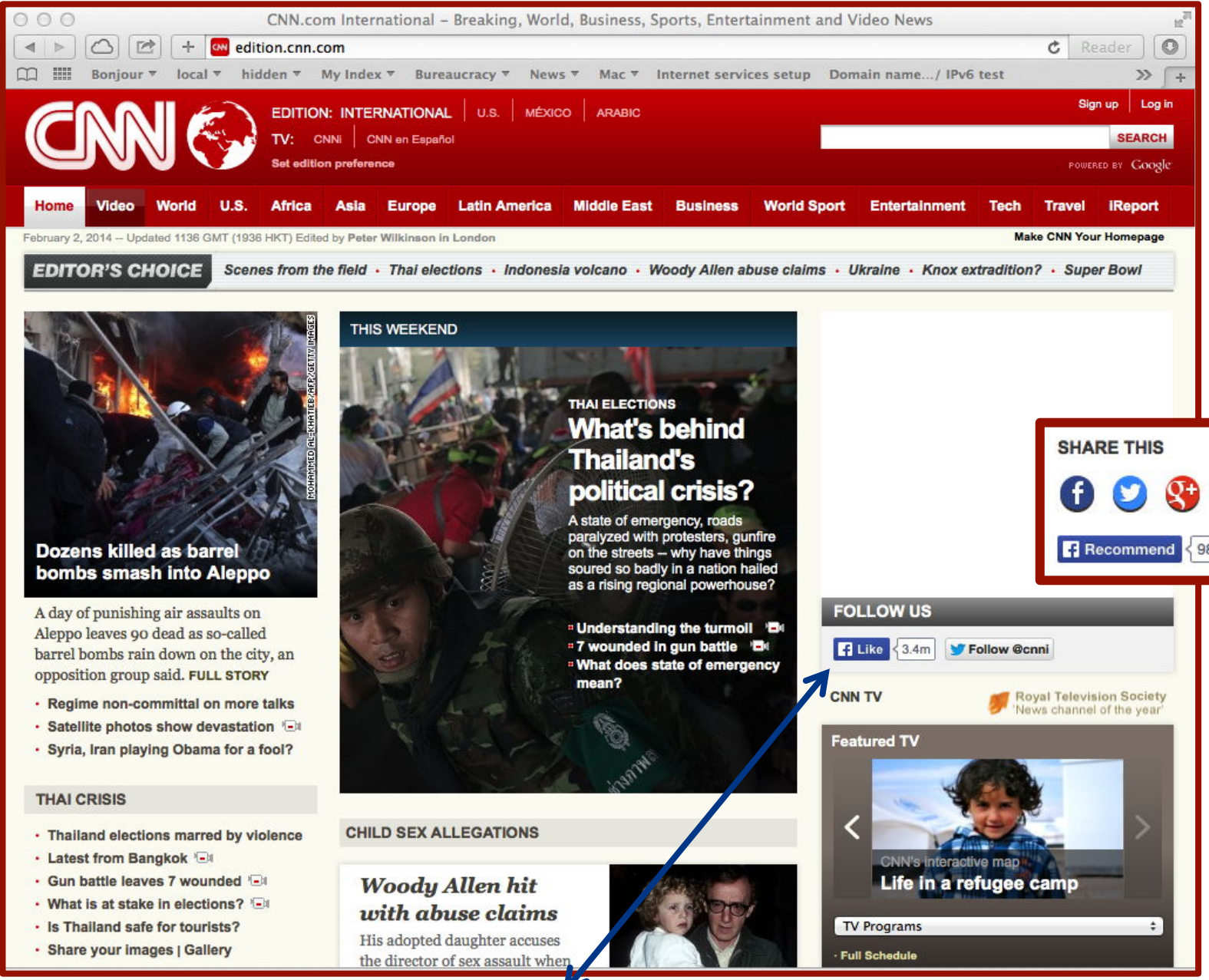
curation – description – security – policy – integrity - storage





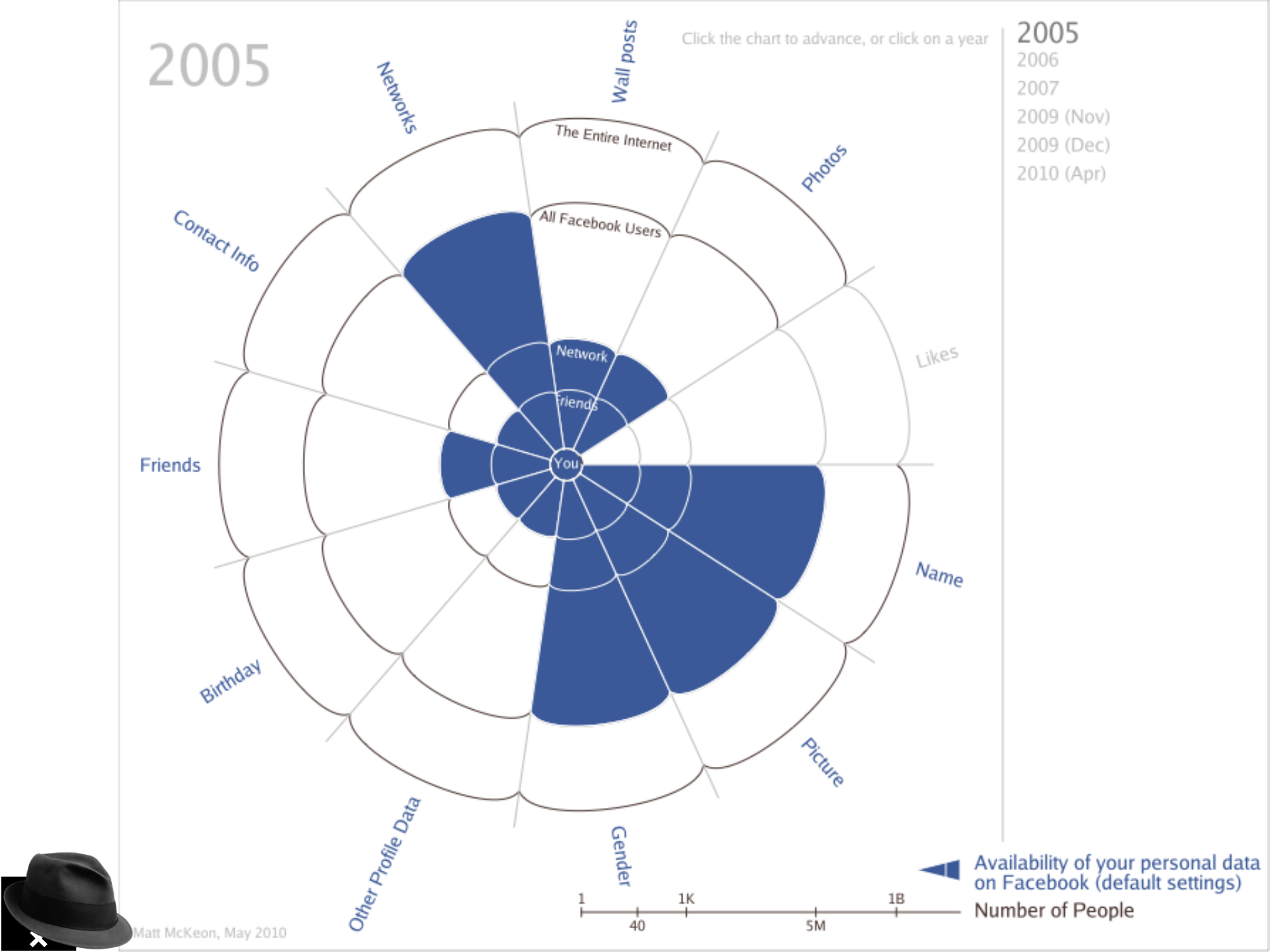

I Want
....
Graph Theory
RDF Semantic descriptions
Context information
Logging History
Machine Learning
Policy
Sustainability
APP Feedback
Monitoring
Cloud Computing

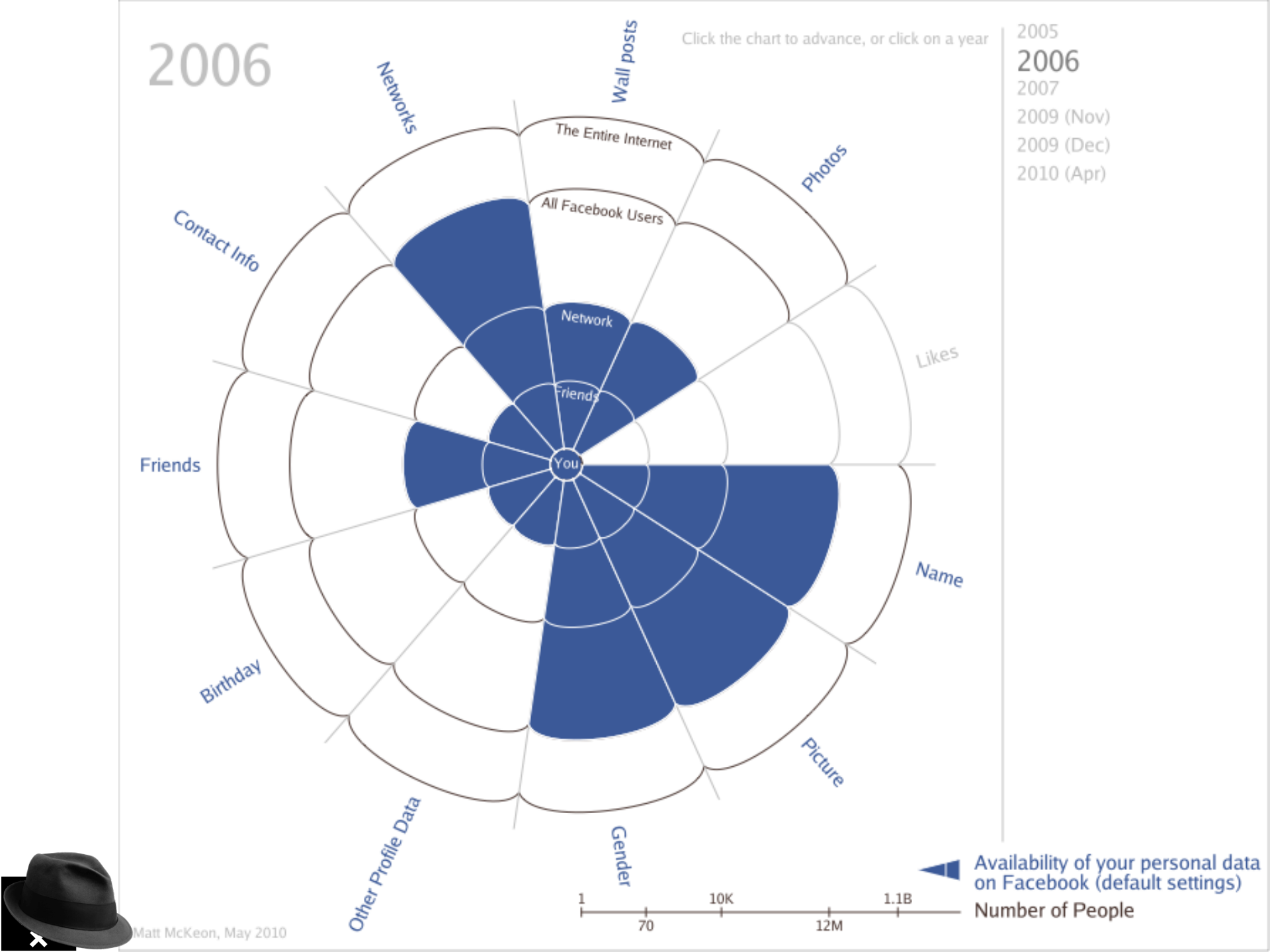

MERKEL ON THE PHONE, SHE'S VERY ANGRY
NSA
CHAPPATTE
International New York Times

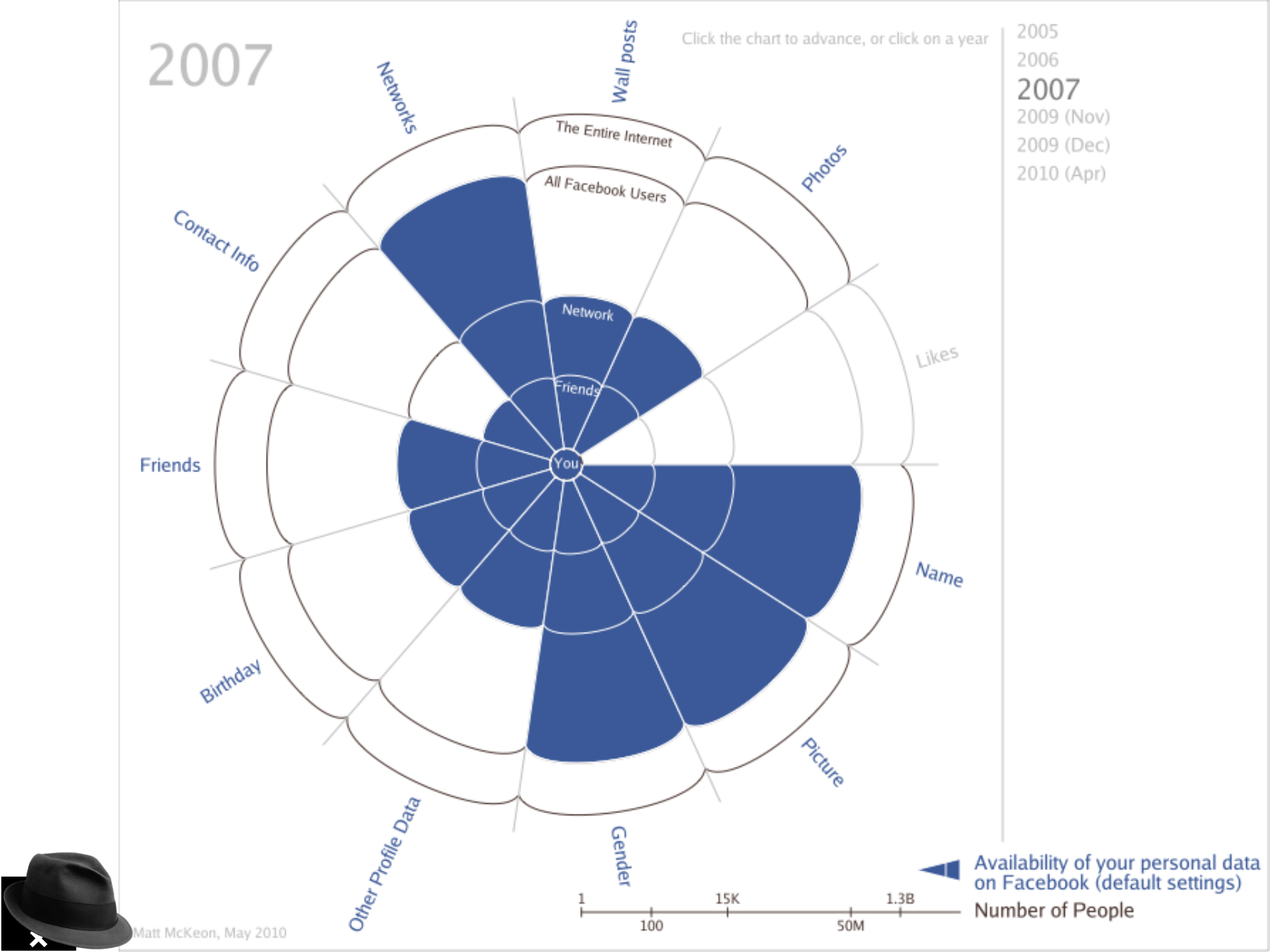


I will follow you!

<iframe src="//www.facebook.com/plugins/like.php?href=http%3A%2F%2Fwww.facebook.com%2Fcnninternational&send=false&layout=button_count&width=450&show_faces=false&action=like&colorscheme=light&font=arial&height=21" …></iframe>


2005
Click the chart to advance, or click on a year
2005
2006
2007
2009 (Nov)
2009 (Dec)
2010 (Apr)
Wall posts
Photos
Likes
Name
Picture
Gender
Other Profile Data
Birthday
Friends
Contact Info
Networks
The Entire Internet
All Facebook Users
Network
Friends
You
Availability of your personal data on Facebook (default settings)
1
40
1K
5M
1B
Number of People
Matt McKeon, May 2010


2006
Click the chart to advance, or click on a year
2005
2006
2007
2009 (Nov)
2009 (Dec)
2010 (Apr)
Wall posts
Networks
Photos
Contact Info
Likes
Friends
Name
Birthday
Picture
Other Profile Data
Gender
The Entire Internet
All Facebook Users
Network
Friends
You
Availability of your personal data on Facebook (default settings)
1
10K
1.1B
70
12M
Number of People
Matt McKeon, May 2010


2007
Click the chart to advance, or click on a year
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2009 (Dec)
2010 (Apr)
Wall posts
Photos
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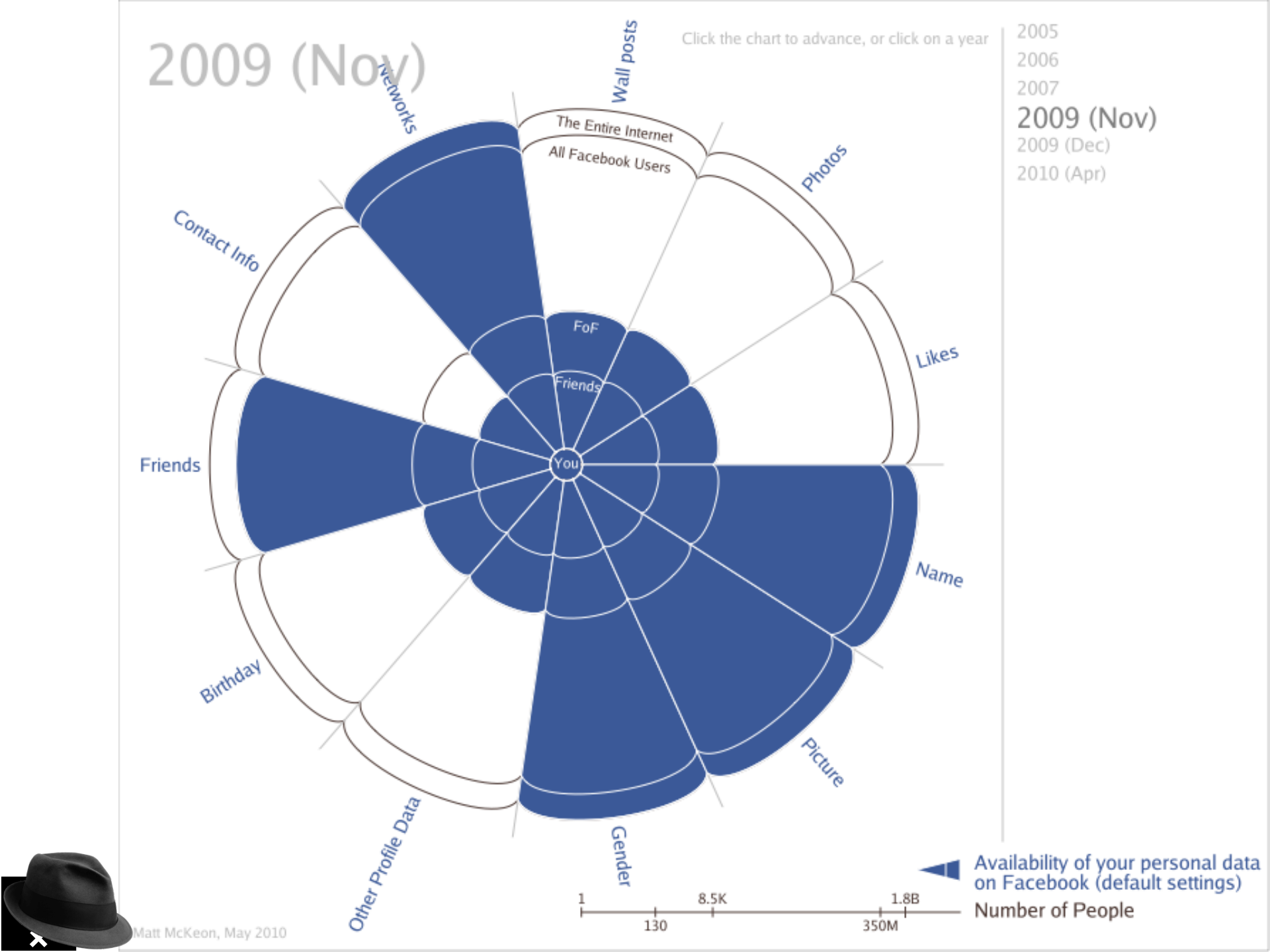
Name
Picture
Gender
Other Profile Data
Birthday
Friends
Contact Info
Networks
The Entire Internet
All Facebook Users
Network
Friends
You
Availability of your personal data on Facebook (default settings)
1
100
15K
50M
1.3B
Number of People
Matt McKeon, May 2010


2009 (Nov)
Click the chart to advance, or click on a year
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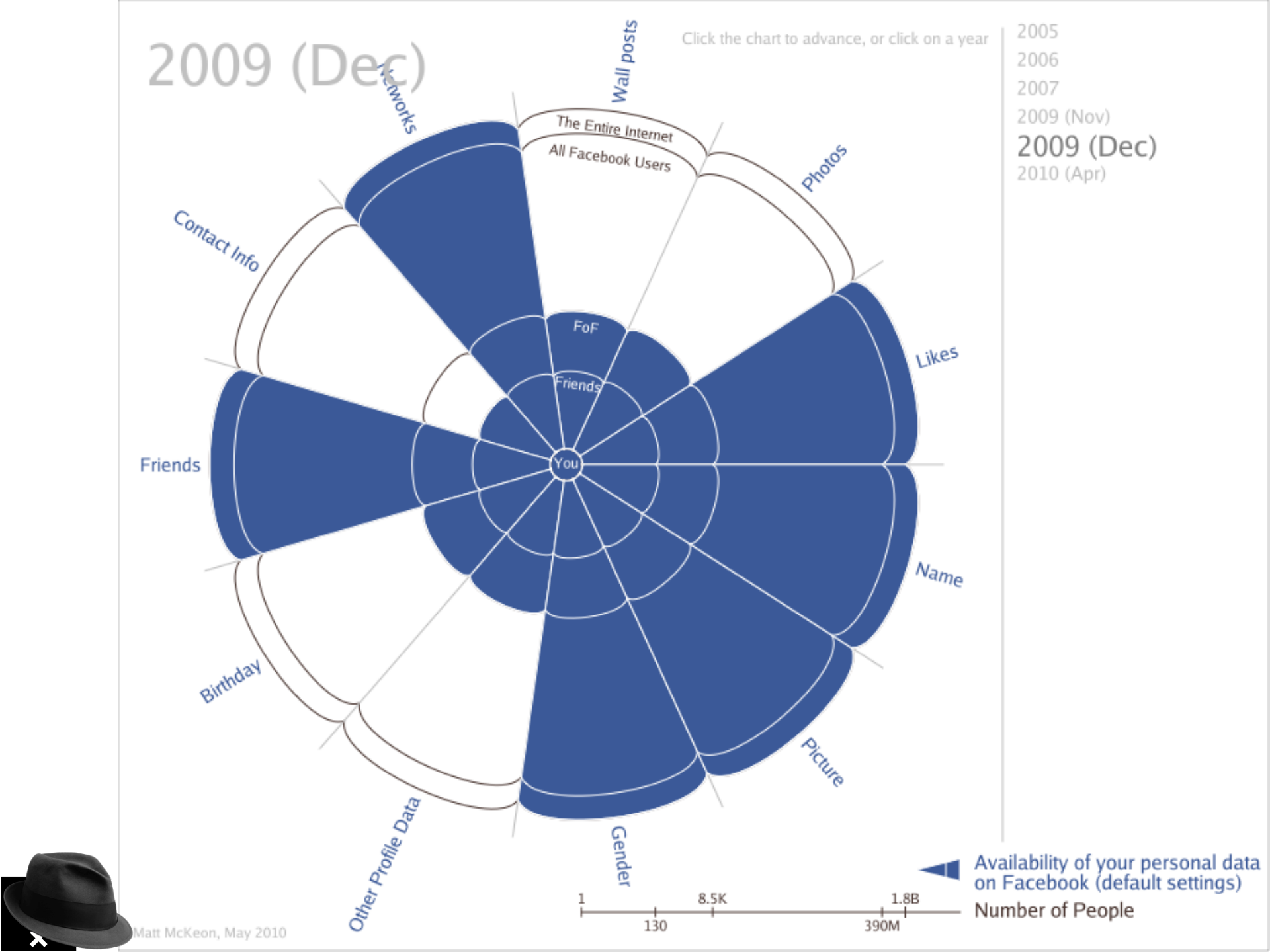
Networks
Wall posts
Photos
Likes
Name
Picture
Gender
Other Profile Data
Birthday
Friends
Contact Info
The Entire Internet
All Facebook Users
FoF
Friends
You
Availability of your personal data on Facebook (default settings)
1
130
8.5K
350M
1.8B
Number of People
Matt McKeon, May 2010


2009 (Dec)
Click the chart to advance, or click on a year
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2009 (Dec)
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Networks
Wall posts
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Name
Picture
Gender
Other Profile Data
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Friends
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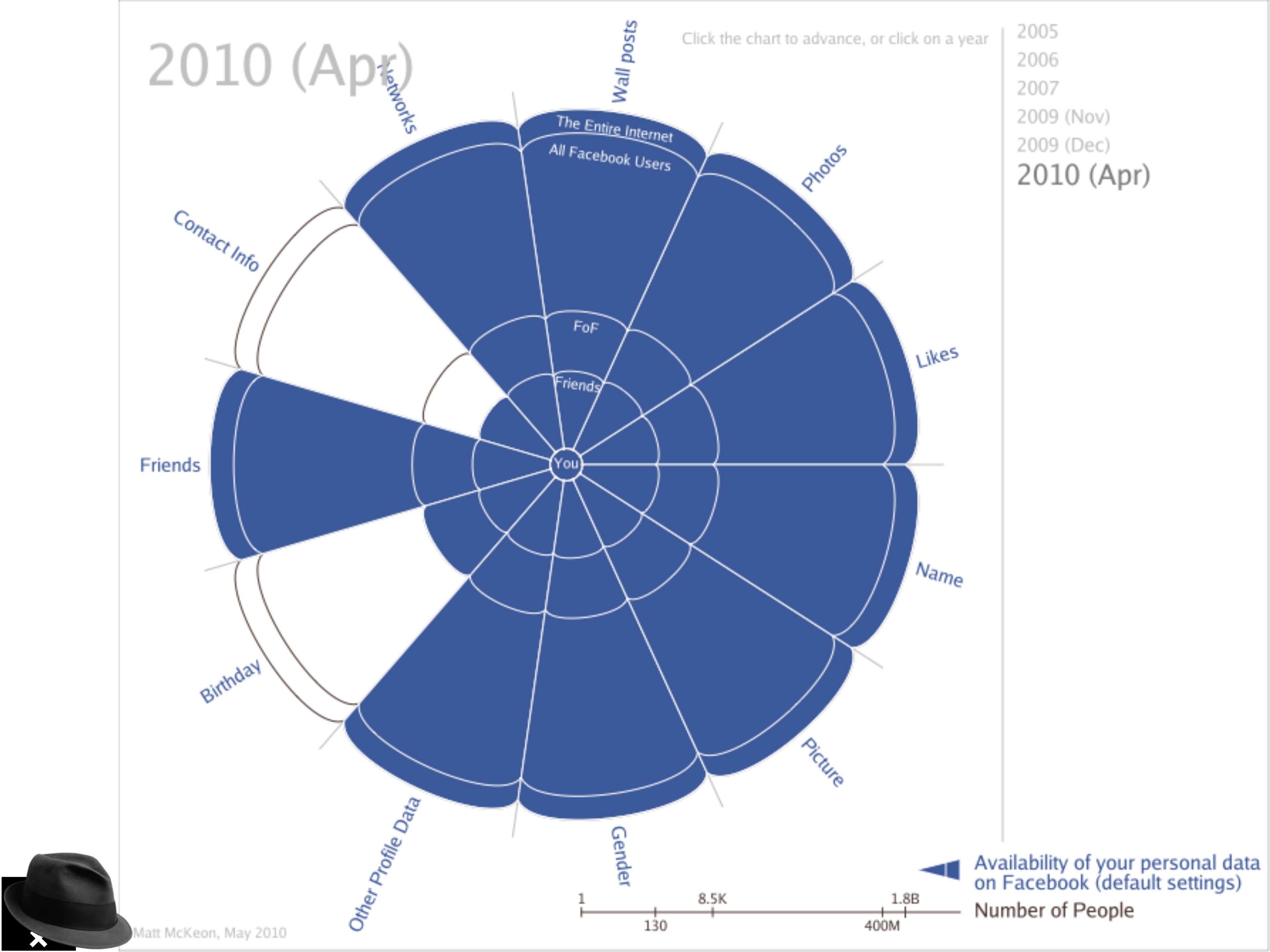
The Entire Internet
All Facebook Users
FoF
Friends
You
Availability of your personal data on Facebook (default settings)
1
130
8.5K
390M
1.8B
Number of People
Matt McKeon, May 2010



2010 (Apr)
Click the chart to advance, or click on a year
2005
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Networks
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Friends
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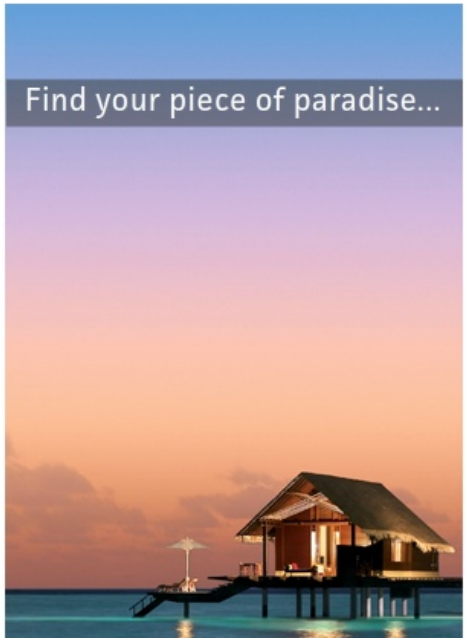
Friends
You
Availability of your personal data on Facebook (default settings)
1
130
8.5K
400M
1.8B
Number of People
Matt McKeon, May 2010

WIRED

You are Facebook's product, not customer

TECHNOLOGY / 21 SEPTEMBER 11 / by OLIVIA SOLON

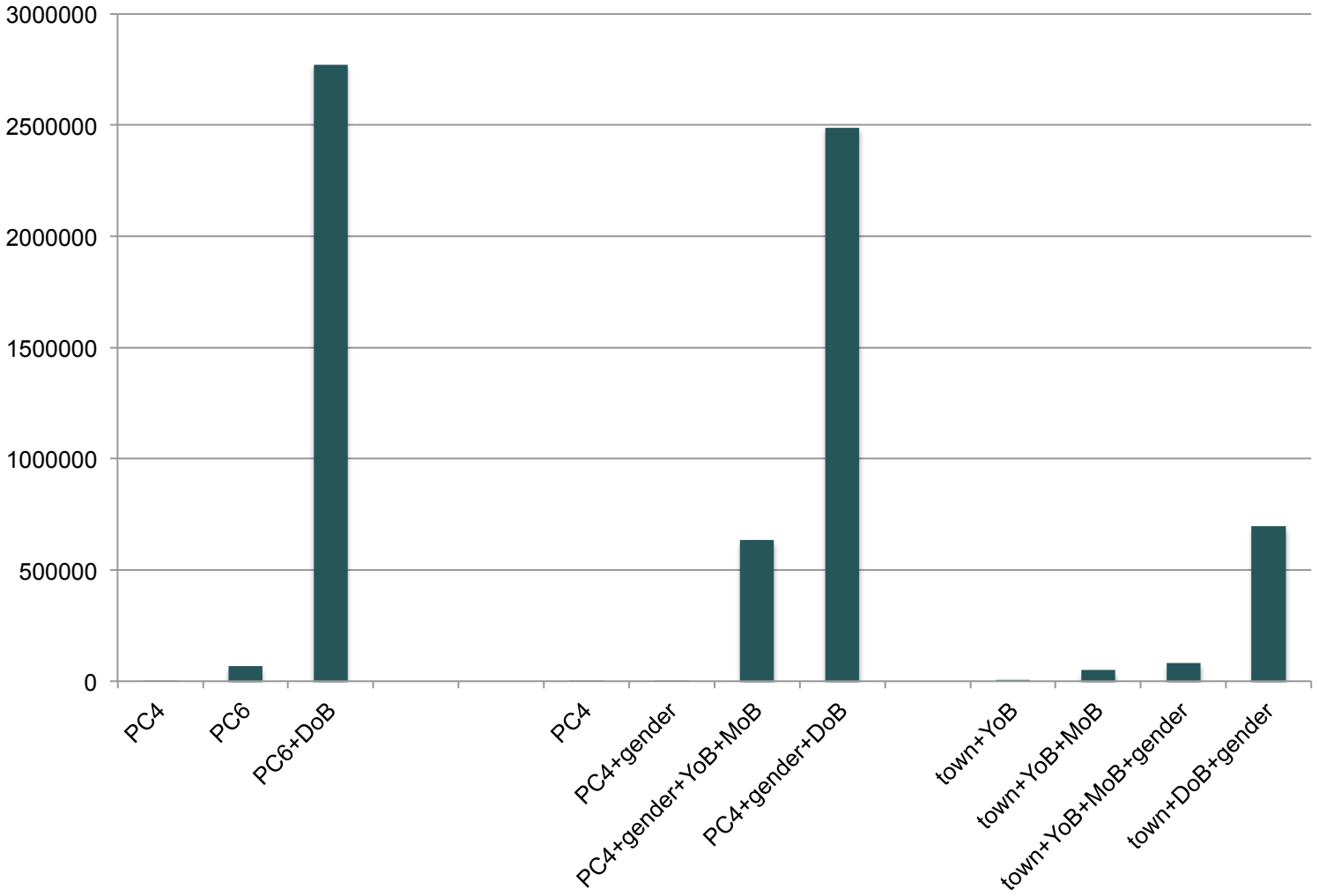


People need to understand that they are the product of Facebook and not the customer, according to media theorist and writer Douglas Rushkoff.

Speaking at the inaugural Hello Etsy conference in Berlin, the author of *Program or Be Programmed* said: "Ask a kid what Facebook is for and they'll answer 'it's there to help me make friends'. Facebook's boardroom isn't talking about how to make Johnny more friends. It's talking about how to monetise Johnnny's social graph."

Flickr.com/designbyfront

Thesis Matthijs Koot



Why?

Because we can!

Paper #1 + Q's

TRANSLIGHT

A GLOBAL-SCALE LAMBDAGRID FOR E-SCIENCE

This global experiment wants to see if high-end applications needing transport capacities of multiple Gbps for up to hours at a time can be handled through an optical bypass network.

Tom DeFanti, Cees de Laat, Joe Mambretti, Kees Neggers, Bill St. Arnaud.

Communications of the ACM, Volume 46, Issue 11 (November 2003), Pages: 34 – 41.

http://delaat.net/pubs/2003-j-6.pdf

Paper #1 + Q's

- Q1: This article is now 10 years old. Back then Twitter did not exist. What do you think will be the drivers for network capacity demand in Science and Society 10 years from now?

- Q2: List arguments why one would use photonic networks directly in science applications and arguments why not tu use photonics directly but use current Internet.

- Q3: This question is not directly from this paper but fun to figure out via search on the web: Fiber cable systems under the ocean are very expensive and cost 100's of millions to put in place. How many fibers do they put in one cable and why that amount?

Paper #2 + Q's

A distributed topology information system for optical networks based on the semantic web.

Jeroen van der Ham, Freek Dijkstra, Paola Grosso, Ronald van der Pol, Andree Toonk, Cees de Laat

Elsevier Journal on Optical Switching and Networking, Volume 5, Issues 2-3, June 2008, pp 85-93.

http://delaat.net/pubs/2008-j-4.pdf

Paper #2 + Q's

- Q1: Suppose this method of describing networks is a total worldwide success and allows to find superfast networking paths through the CI (CyberInfrastructure). The question becomes: Does it scale? Can you find reasons why and/or why not it could scale up to the size of the internet?

- Q2: Are the described methods and framework fault tolerant? If not, then list the issues in your view. What do you see best ways to do something about it.

- Q3: List advantages of NDL, or more generically, using semantic web methods for describing cyber infrastructure?

The constant factor in our field is Change!

The 50 years it took Physicists to find one particle, the Higgs, we came from:

"Fortran goto", Unix, c, SmallTalk, DECnet, TCP/IP, c++, Internet, WWW, Semantic Web, Photonic networks, Google, grid, cloud, Data^3, App

to:

DDOS attacks destroying Banks and Bitcoins.

Conclusion:

Need for Safe, Smart, Resilient Sustainable Infrastructure.