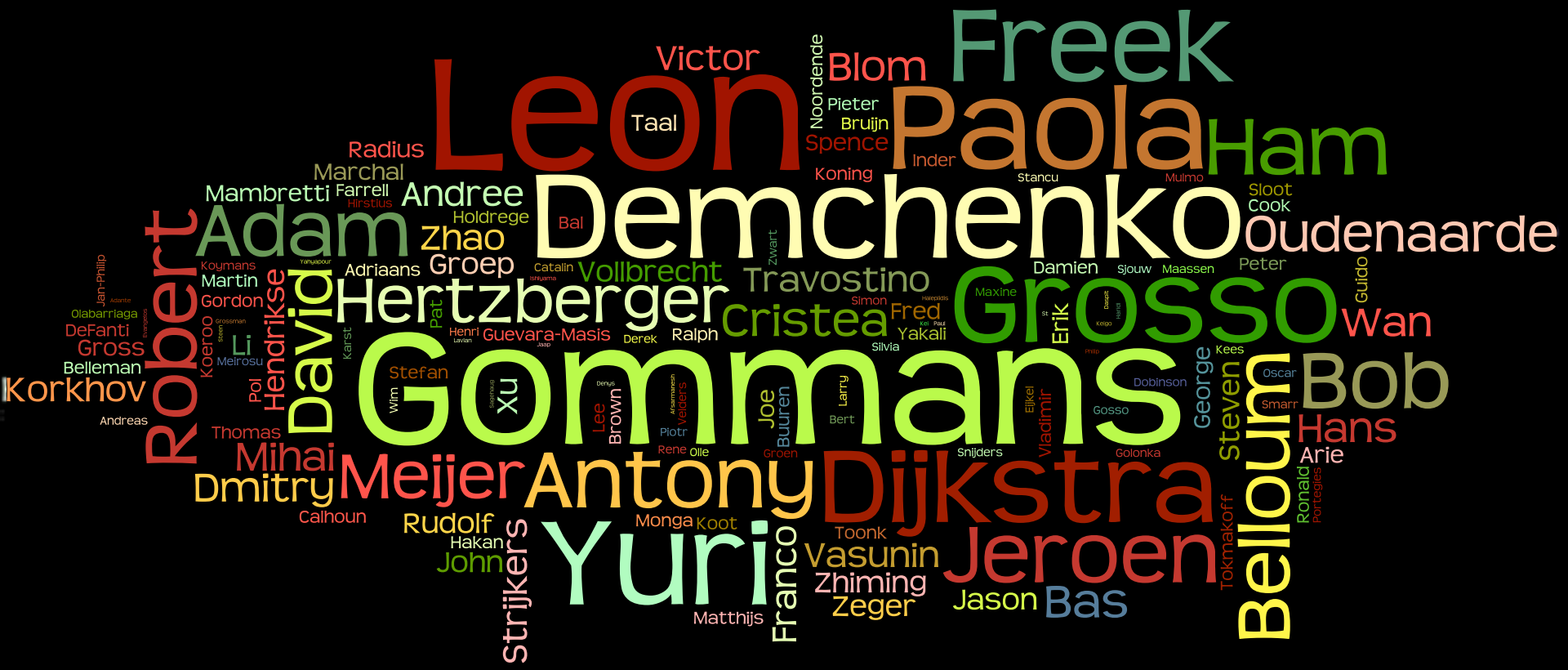
Smart distributed Cyber Infrastructure for Secure Big Data Sharing and Processing.

Cees de Laat

contributions by Rob van Nieuwpoort & Ana Varbanescu



Science Faculty @ UvA

Informatics Institute

- AMLAB: Machine Learning (Prof. dr. M. Welling)
- CV: Computer Vision (Prof. dr. Theo Gevers)
- CSL: Computational Science Laboratory (Prof. dr. P.M.A. Sloot)
- FCN: Federated Collaborative Networks (Prof. dr. H. Afsarmanesh)
- ILPS: Information and Language Processing Systems (Prof. dr. M. de Rijke)
- ISIS: Intelligent Sensory Information Systems (Prof. dr. ir. A.W.M. Smeulders)
- SNE: System and Network Engineering (Prof. dr. ir. C.T.A.M. de Laat)
- TCS: Theory of Computer Science (Prof. dr. J.A. Bergstra)

SNE - Mission

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*
- *Capability*
  - *Programmability, virtualization, complexity, semantics, workflows*
- *Security*
  - *Policy, Trust, Anonymity, Privacy, Integrity*
- *Sustainability*
  - *Greening infrastructure, Awareness*
- *Resilience*
  - *Failures, Disasters, Systems under attack*

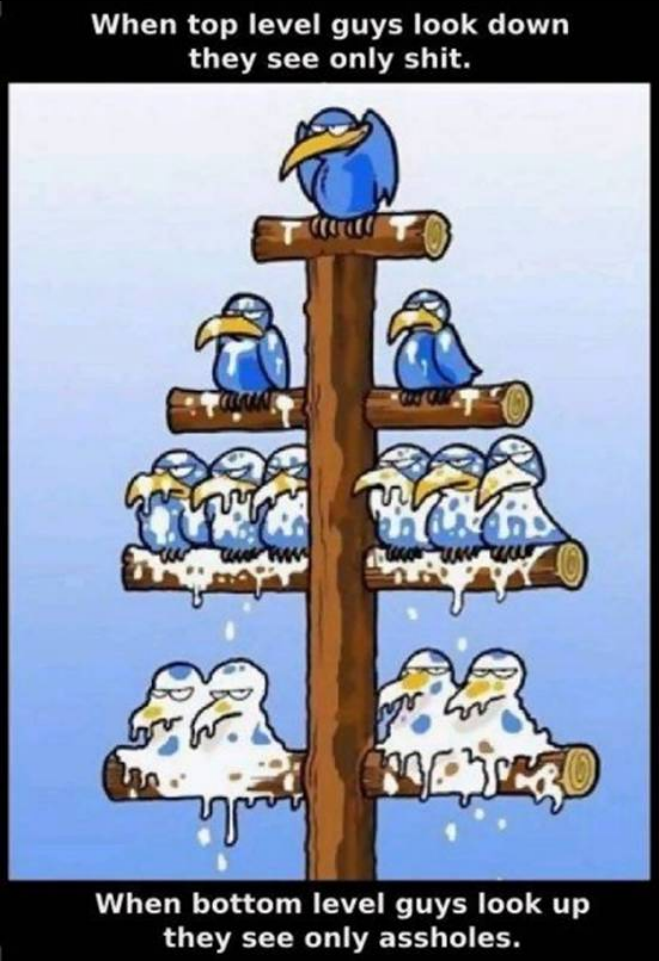
SNE - Staffing

Group leader: ***prof. C. de Laat***

Deputy group leaders: ***dr. Andy Pimentel, dr. Paola Grosso***

- 1 full prof (CdL)
- 2 part time professors
- 3 endowed professors
- *2 senior researchers*
- 1 associate prof
- 4 assistant professors
- ~12 postdoc's
- *About 15 phd students*
- ~10 guests

- *Yearly turnover ~ 3,5 MEuro*



SNE - Mission

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***
- *Capability*
  - *Programmability, virtualization, complexity, semantics, workflows*
- *Security*
  - *Policy, Trust, Anonymity, Privacy, Integrity*
- *Sustainability*
  - *Greening infrastructure, Awareness*
- *Resilience*
  - *Failures, Disasters, Systems under attack*

What Happens in an **Internet Minute?**

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

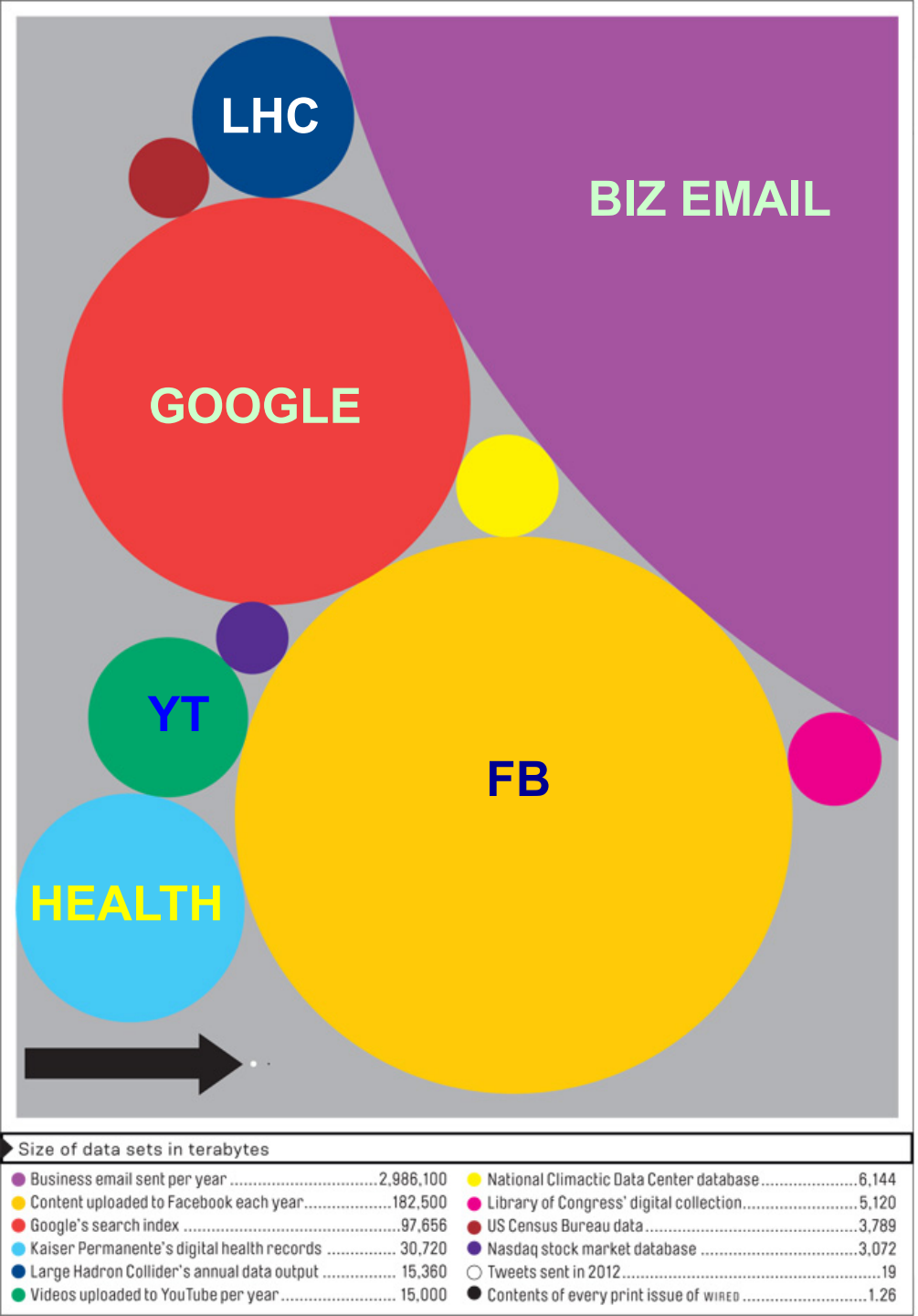
Today, the number of networked devices = the global population

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



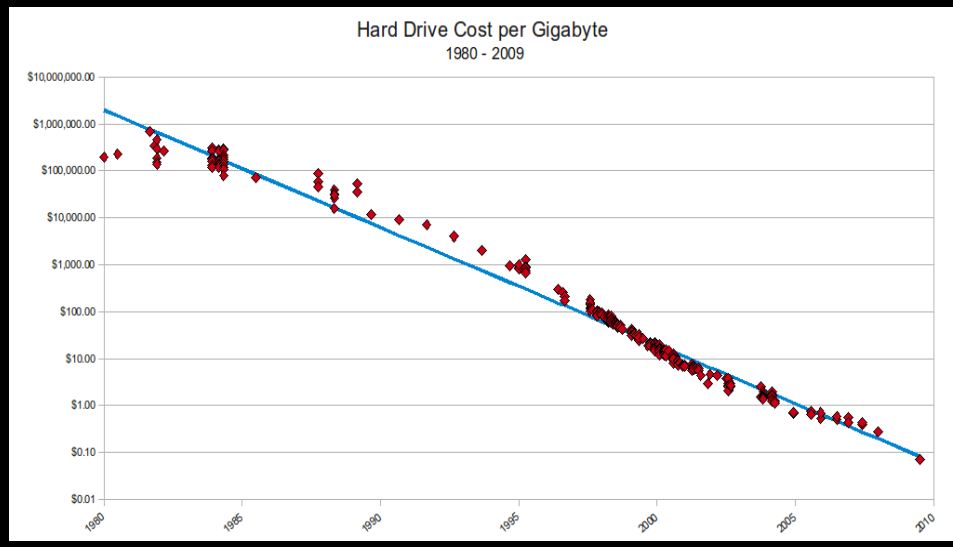
There
is
always
a
bigger
fish

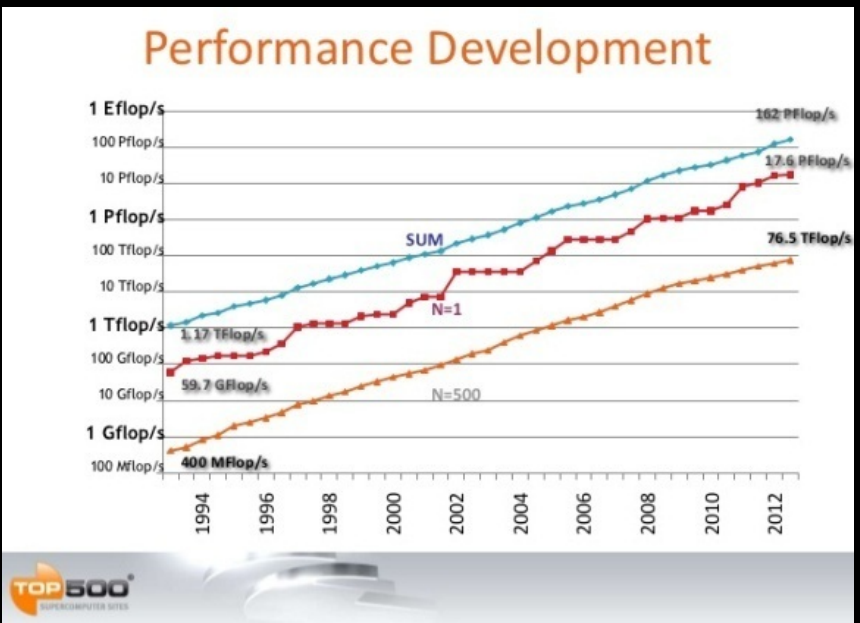
Reliable and Safe!

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.



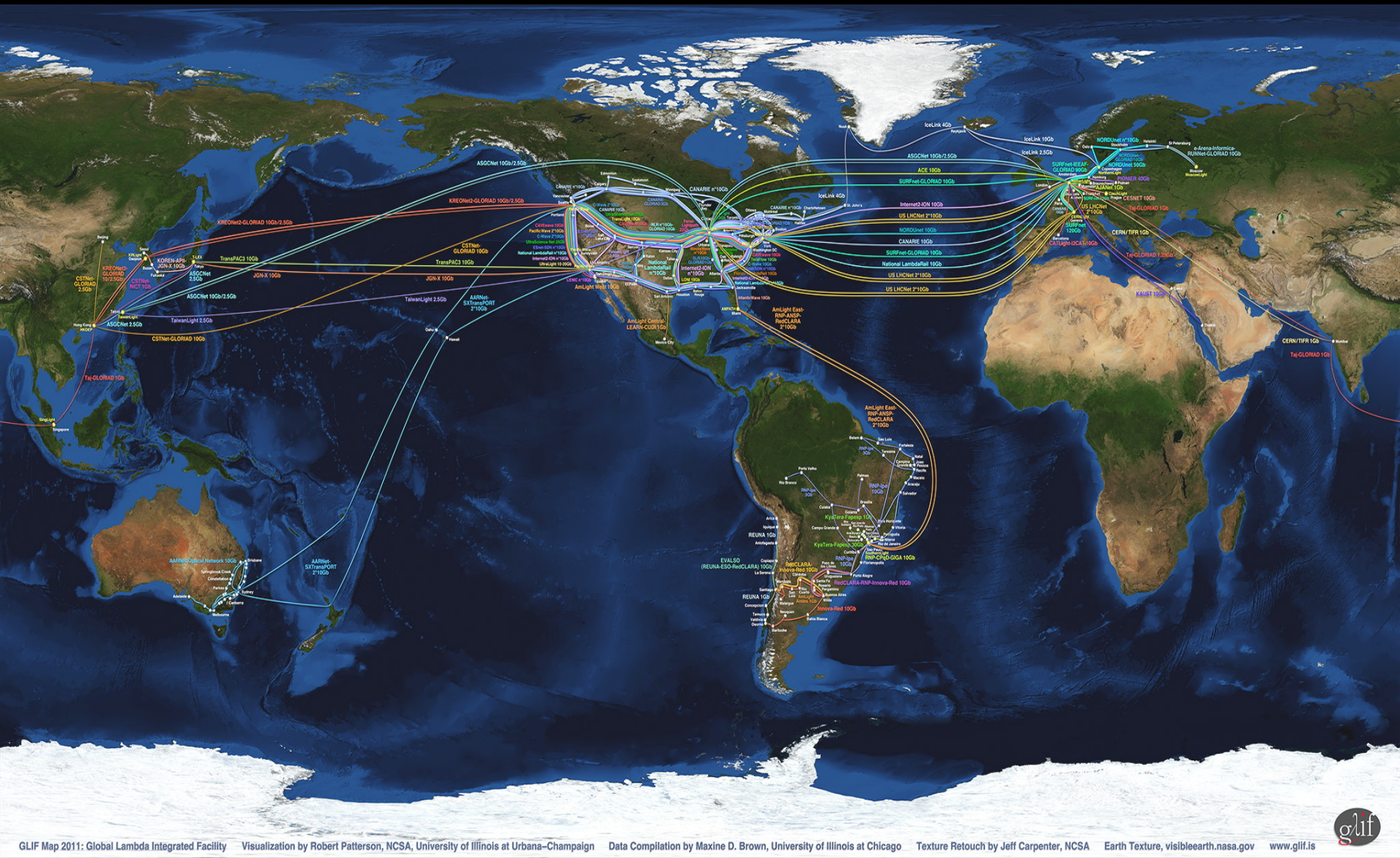


We will soon reach the limits of what is currently feasible and controllable.

https://www.knaw.nl/shared/resources/actueel/publicaties/pdf/20111029.pdf

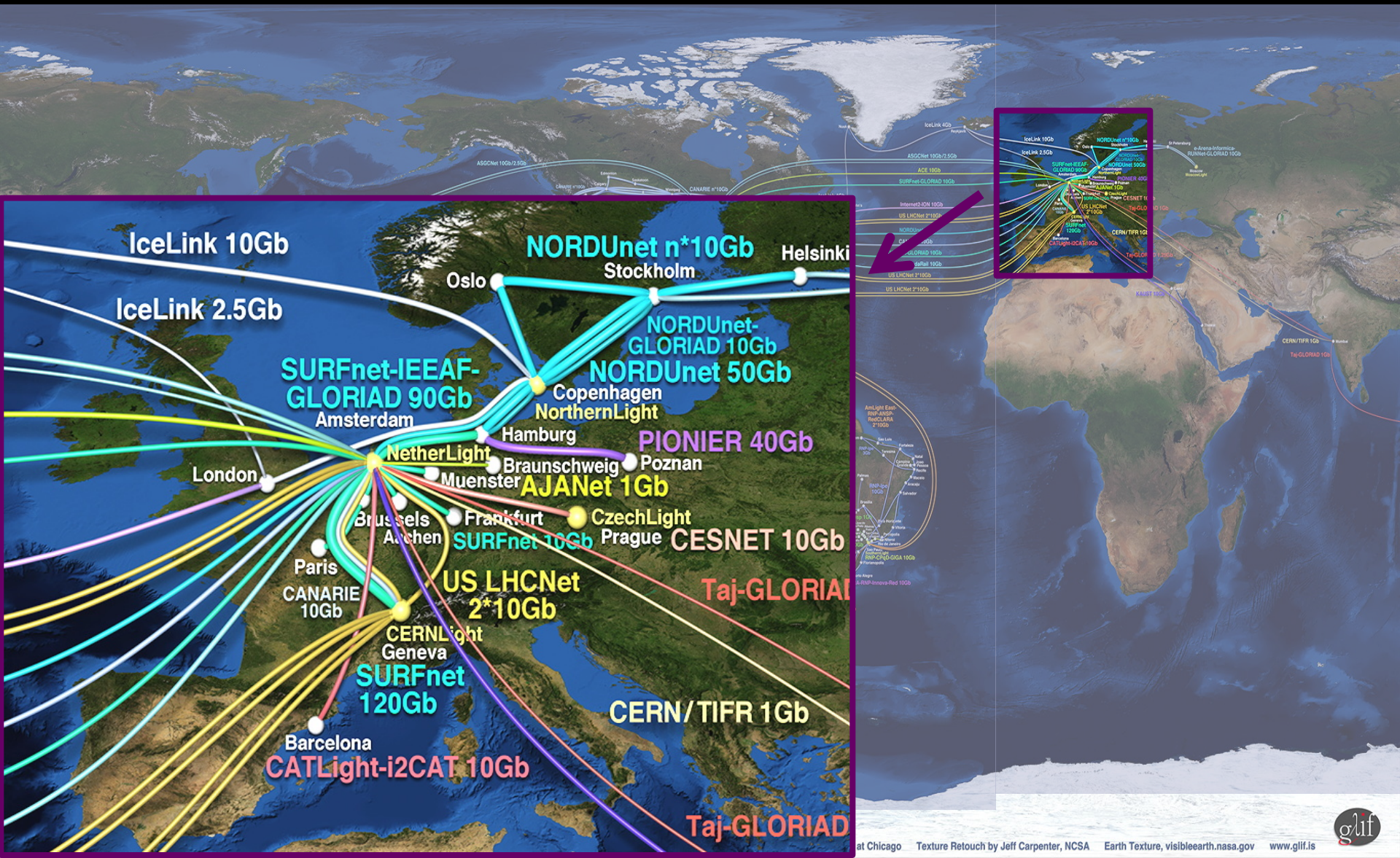
The GLIF – LightPaths around the World

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.



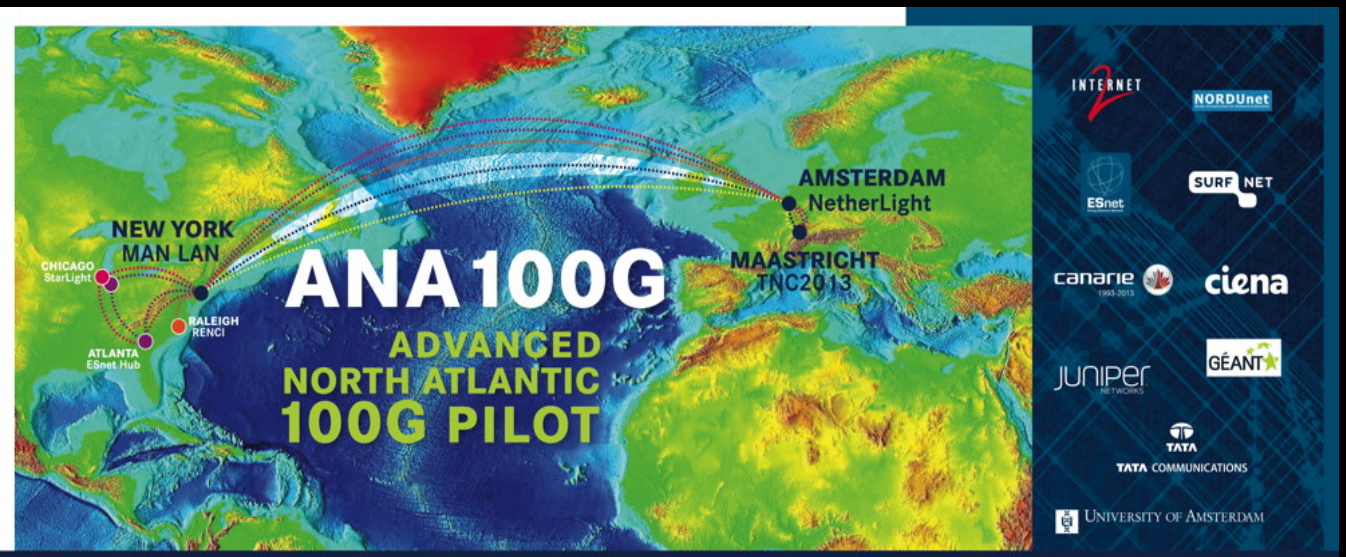
Amsterdam is a major hub in The GLIF

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.



ExoGeni @ OpenLab - UvA

Installed and up June 3th 2013



TNC2013 DEMOS JUNE, 2013

DEMO	TITLE	OWNER	AFFILIATION	E-MAIL	A-SIDE	Z-SIDE	PORTS(S) MAN LAN	PORTS(S) TNC2013	DETAILS
1	Big data transfers with multipathing, OpenFlow and MPTCP	Ronald van der Pol	SURFnet	ronald.vanderpol@surfnet.nl	TNC/MECC, Maastricht NL	Chicago, IL	Existing 100G link between internet2 and ESnet	2x40GE (Juniper)+ 2x 10GE (OME6500)	In this demonstration we show how multipathing, OpenFlow and Multipath TCP (MPTCP) can help in large file transfers between data centres (Maastricht and Chicago). An OpenFlow application provisions multiple paths between the servers and MPTCP will be used on the servers to simultaneously send traffic across all those paths. This demo uses 2x40G on the transatlantic 100G link. ESnet provides 2x40G between MAN LAN and StarLight, ACE and USLHCnet provide additional 10GEs.
2	Visualize 100G traffic	Inder Monga	ESnet	imonga@es.net					Using an SNMP feed from the Juniper switch at TNC2013,and/or Brocade AL2S node in MANLAN, this demo would visualize the total traffic on the link, of all demos aggregated. The network diagram will show the transatlantic topology and some of the demo topologies.
3	How many modern servers can fill a 100Gbps Transatlantic Circuit?	Inder Monga	ESnet	imonga@es.net	Chicago, Ill	TNC showfloor	1x 100GE	8x 10GE	In this demonstration, we show that with the proper tuning and tool, only 2 hosts on each continent can generate almost 80Gbps of traffic. Each server has 4 10G NICS connected to a 40G virtual circuit, and has iperf3 running to generate traffic. ESnet's new "iperf3" throughput measurement tool, still in 'beta', combines the best features from other tools such as iperf, nuttcp, and netperf. See: https://my.es.net/demos/tnc2013/
4	First European ExoGENI at Work	Jeroen van der Ham	UvA	vdham@uva.nl	RENCI, NC	UvA, Amsterdam, NL	1x 10GE	1x 10GE	The ExoGENI racks at RENCI and UvA will be interconnected over a 10G pipe and be on continuously, showing GENI connectivity between Amsterdam and the rest of the GENI nodes in the USA.
5	Up and down North Atlantic @ 100G	Michael Enrico	DANTE	michael.enrico@dante.net	TNC showfloor	TNC showfloor	1x 100GE	1x 100GE	The DANTE 100GE test set will be placed at the TNC2013 showfloor and connected to the Juniper at 100G. When this demo is running a loop @ MAN LAN's Brocade switch will ensure that the traffic sent to MAN LAN returns to the showfloor. On display is the throughput and RTT (to show the traffic traveled the Atlantic twice)

Connected via the new 100 Gb/s transatlantic To US-GENI

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.

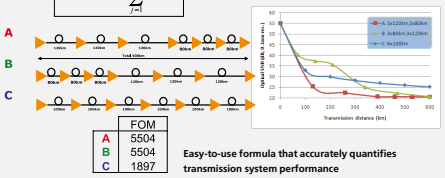
In this demonstration we will investigate the performance of a 40Gb/s PM-QPSK alien wavelength installed on a 10Gb/s DWDM infrastructure.

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

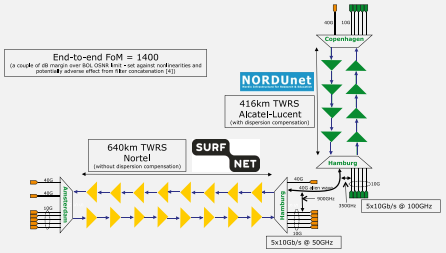


	FOM
A	5504
B	5504
C	1897

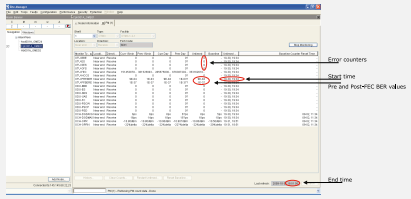
Easy-to-use formula that accurately quantifies transmission system performance

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

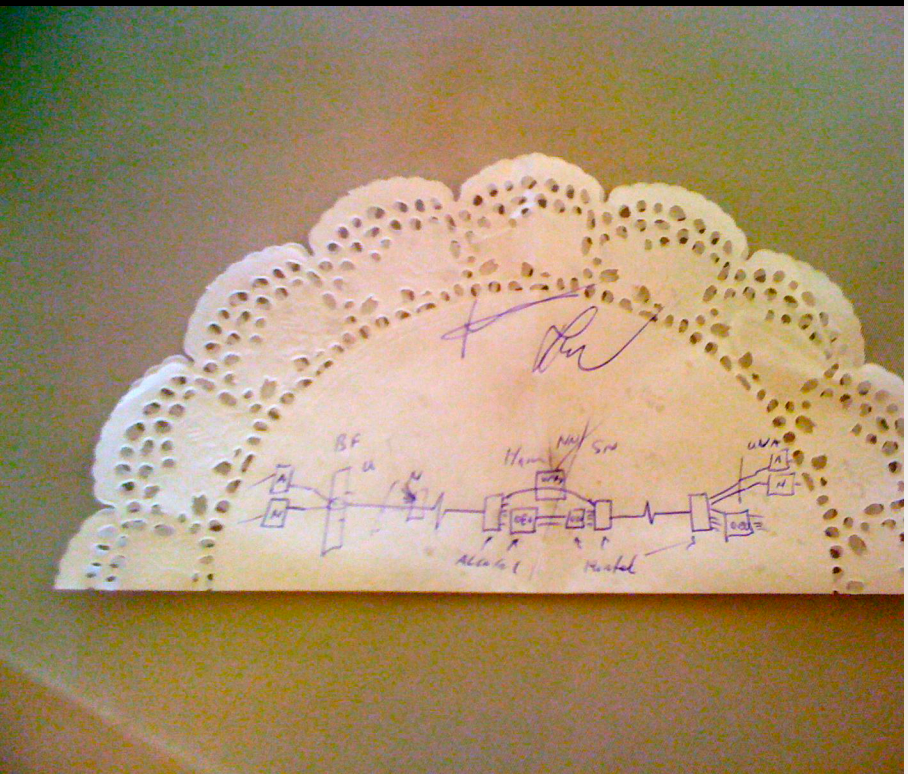
- We have investigated experimentally the all-optical transmission of a 40Gb/s PM-QPSK alien wavelength via a concatenated native and third party DWDM system that both were carrying live 10Gb/s wavelengths.
- The end-to-end transmission system consisted of 1056 km of TWRS (TrueWave Reduced Slope) transmission 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

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.

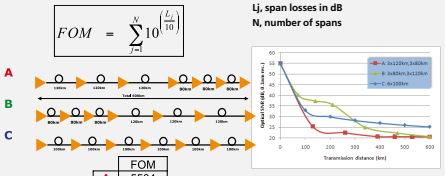
In this demonstration we will investigate the performance of a 40Gb/s PM-QPSK alien wavelength installed on a 10Gb/s DWDM infrastructure.

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

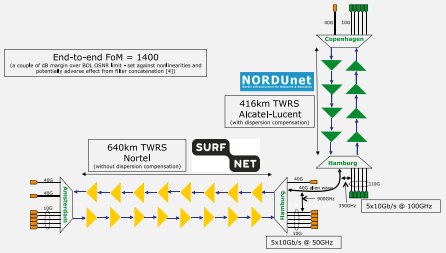


	FOM
A	5504
B	5504
C	1897

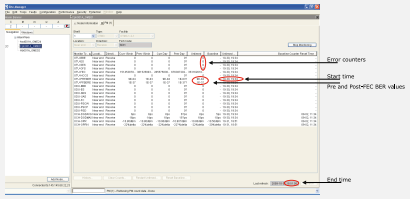
Easy-to-use formula that accurately quantifies transmission system performance

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

SNE - Mission

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*
- ***Capability***
  - ***Programmability, virtualization, complexity, semantics, workflows***
- ***Security***
  - ***Policy, Trust, Anonymity, Privacy, Integrity***
- *Sustainability*
  - *Greening infrastructure, Awareness*
- ***Resilience***
  - ***Failures, Disasters, Systems under attack***

SARNET: Security Autonomous Response with programmable NETworks

Cees de Laat
Leon Gommans, Rodney Wilson, Rob Meijer
Tom van Engers, Marc Lyonais, Paola Grosso, Frans Franken,
Ameneh Deljoo, Ralph Koning, Ben de Graaff, Stojan Trajanovski

UNIVERSITY OF AMSTERDAM

TNO

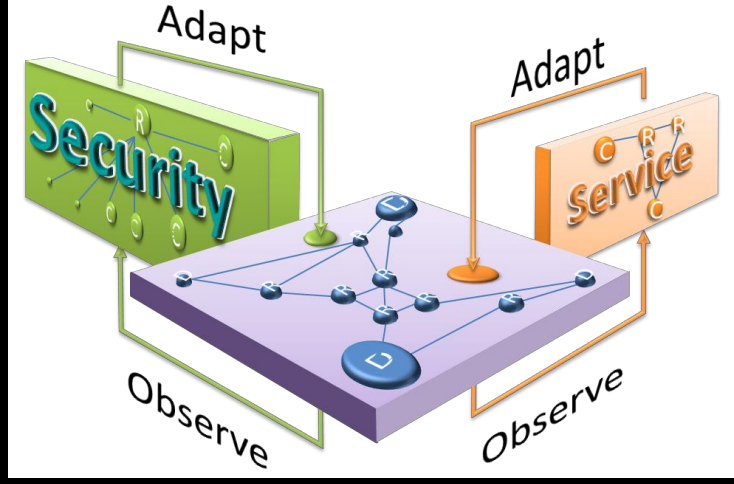
ciena

AIRFRANCE KLM

NWO
Netherlands Organisation for Scientific Research

COMMIT/

Cyber security program



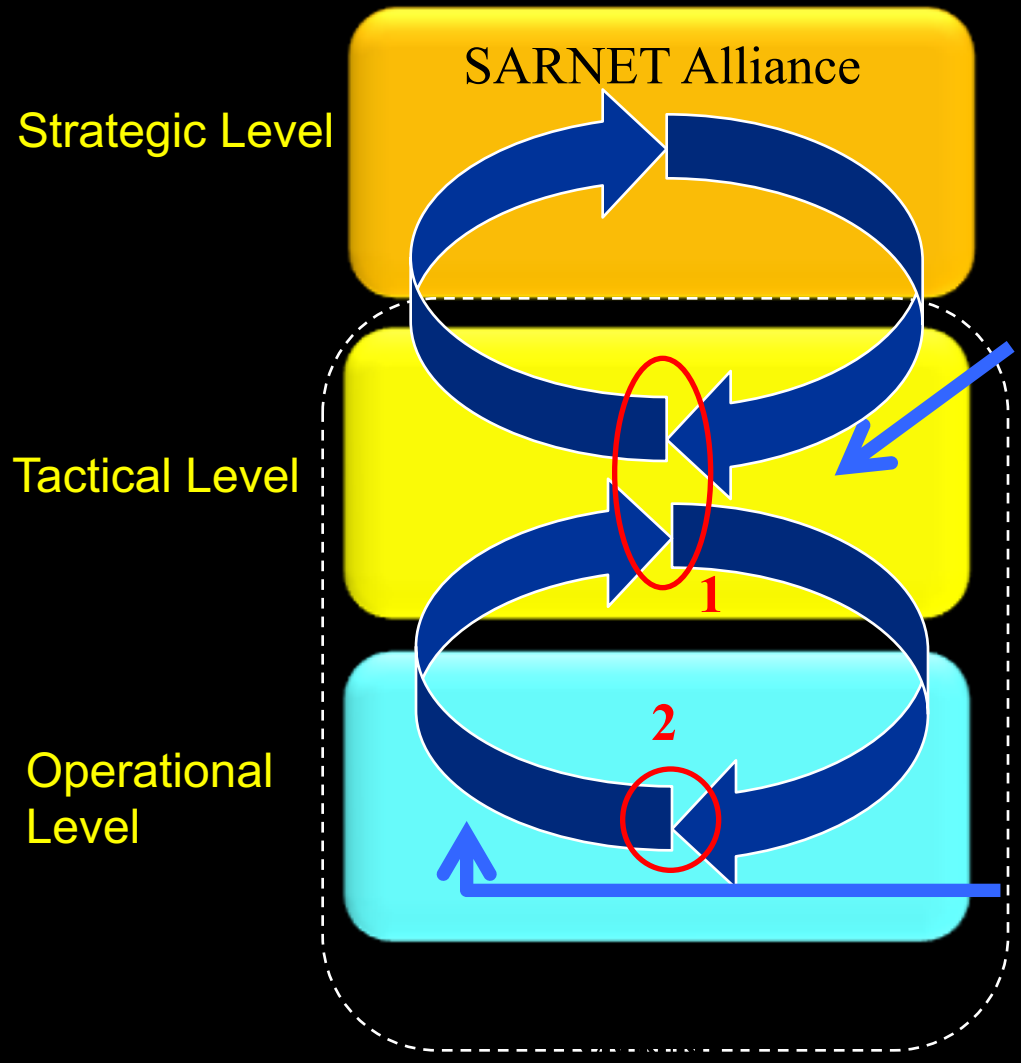
Research goal is to obtain the knowledge to create ICT systems that:

- model their state (situation)
- discover by observations and reasoning if and how an attack is developing and calculate the associated risks
- have the knowledge to calculate the effect of counter measures on states and their risks
- choose and execute one.

In short, we research the concept of networked computer infrastructures exhibiting SAR: Security Autonomous Response.

Context & Goal

Security Autonomous Response NETwork Research

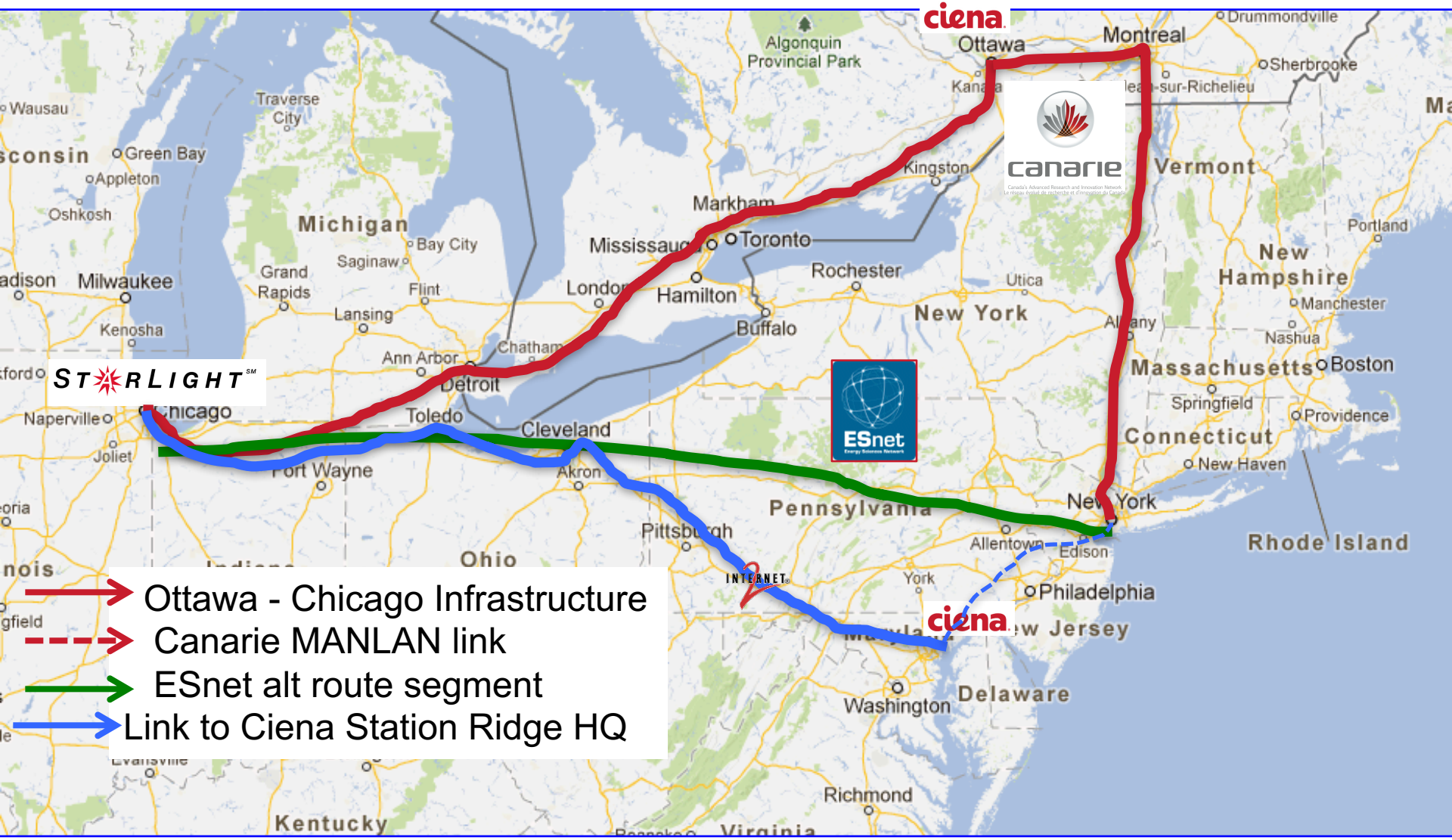


Ameneh Deljoo (PhD):
Why create SARNET Alliances?
Model autonomous SARNET behaviors to identify risk and benefits for SARNET stakeholders

Stojan Trajanovski (PD):
Determine best defense scenario against cyberattacks deploying SARNET functions (1) based on security state and KPI information (2).

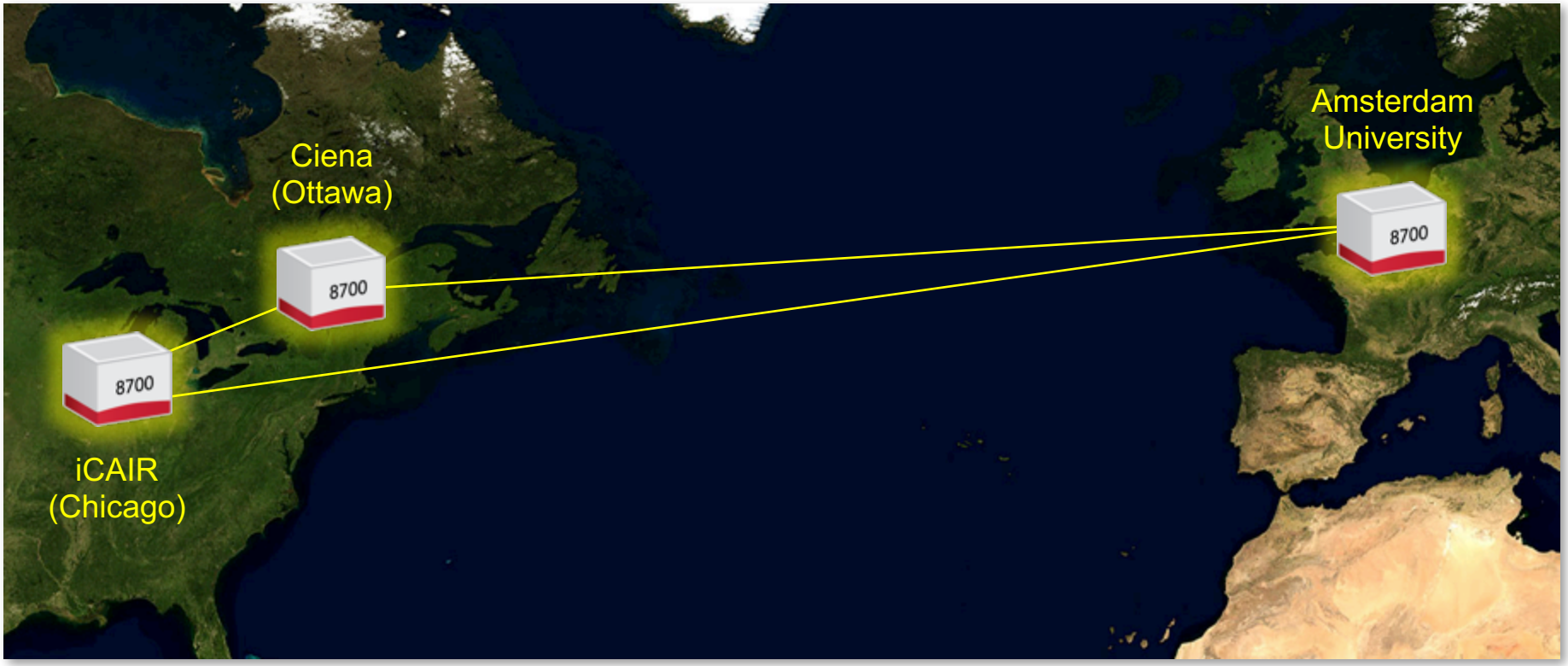
Ralph Koning (PhD)
Ben de Graaff (SP):
1. Design functionalities needed to operate a SARNET using SDN/NFV
2: deliver security state and KPI information (e.g cost)

Ciena's CENI topology



CENI, International extension to University of Amsterdam

Research Triangle Project. Operation Spring of 2015



National Science Foundations ExoGENI racks, installed at UvA (Amsterdam), Northwestern University (Chicago) and Ciena's labs (Ottawa), are connected via a high performance 100G research network and trans-Atlantic network facilities using the Ciena 8700 Packetwave platform. This equipment configuration is used to create a computational and storage test bed used in collaborative demonstrations.

Position of demo @ SC15

Objective

- To get a better understanding for cyber attack complexity by visually defend a network suffering from basic volumetric attacks.
- To find a way to visualize future research in automated response.

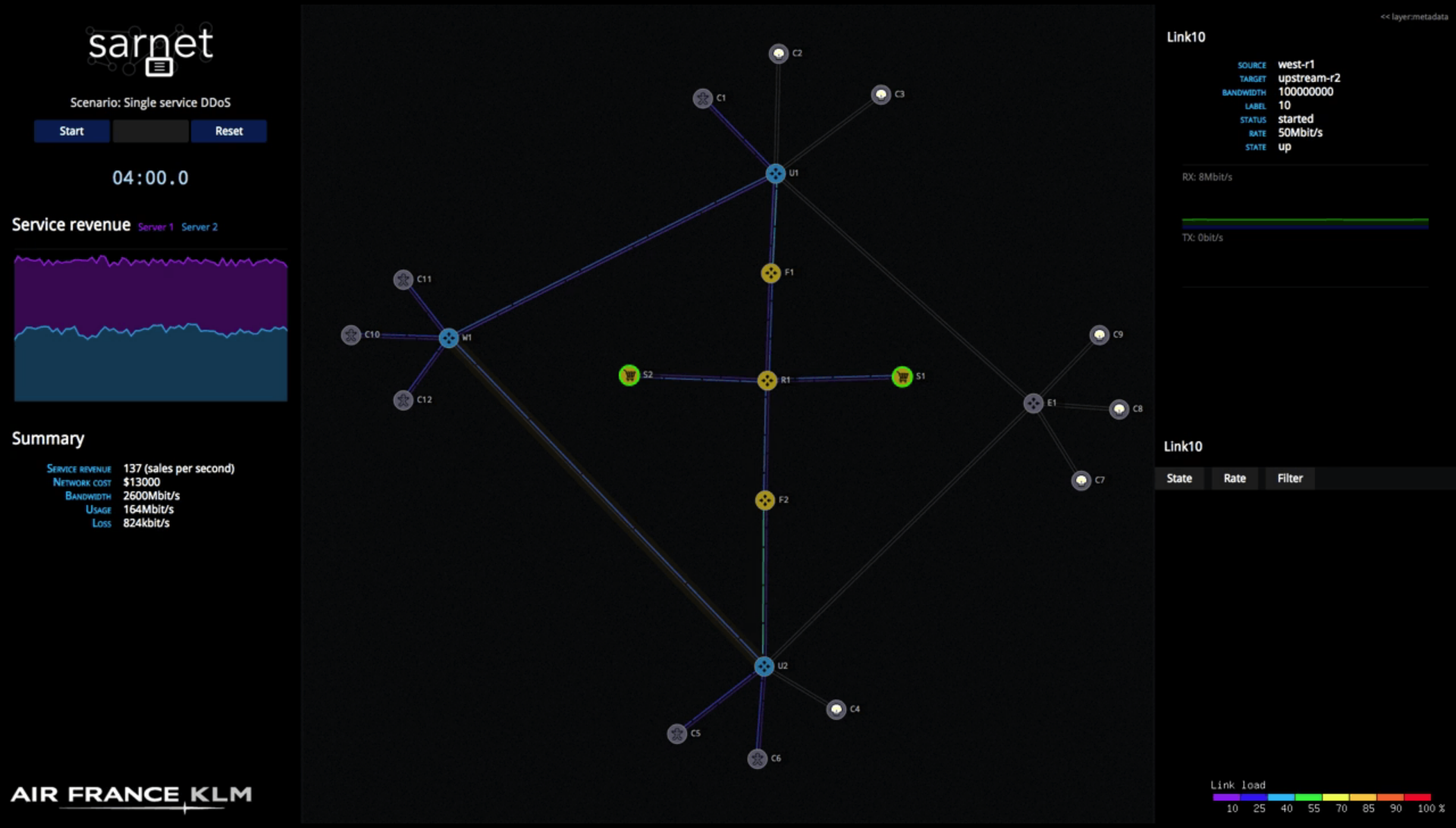
Demo highlights

- Pre-programmed attack scenarios that are able to show defense functions.
- Virtual sales + income from web services
- Defense cost

DDoS Defence functions.

- Filtering
- Blocking
- Resource Scaling

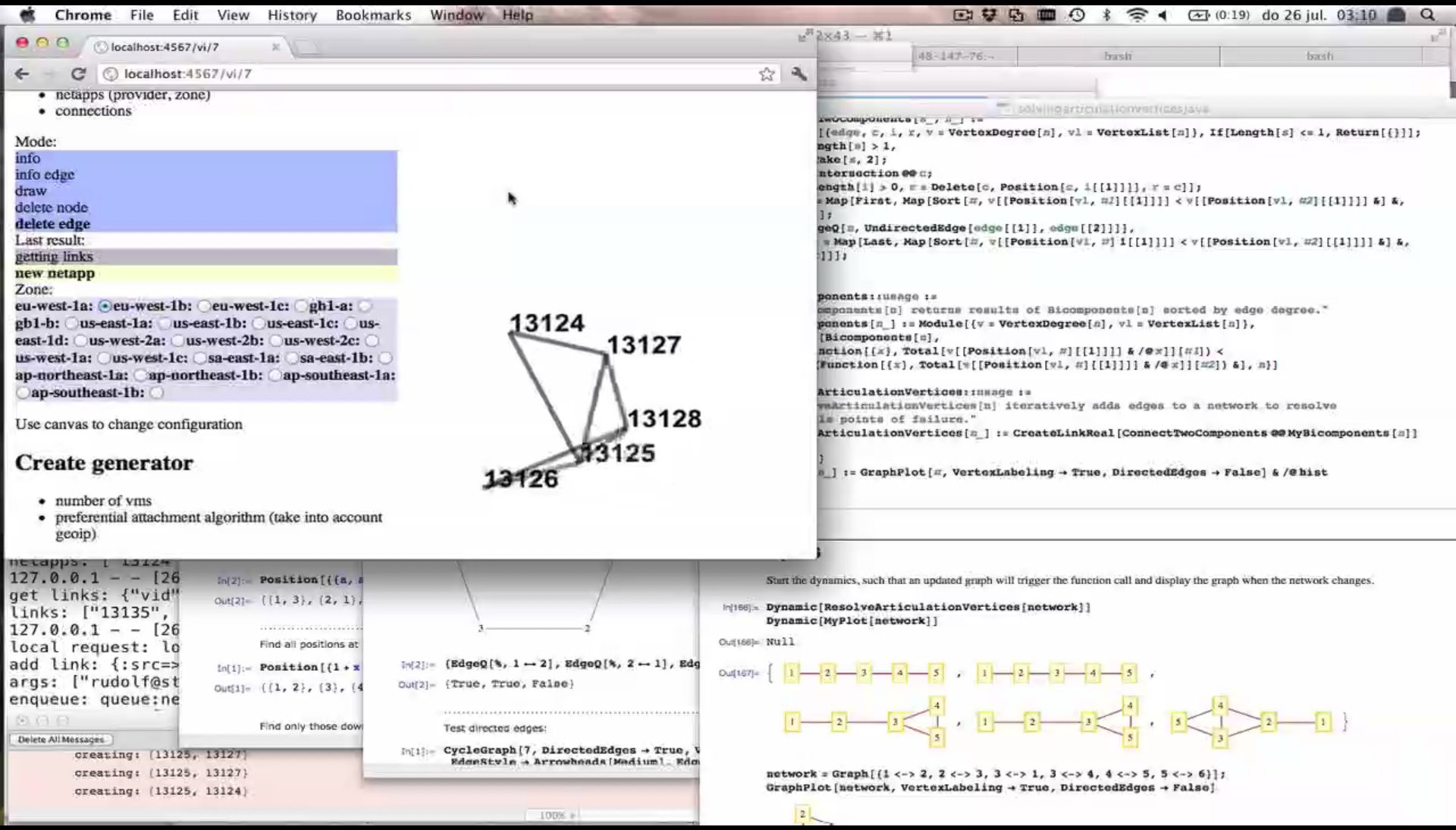
Demo



AIR FRANCE KLM

University of Amsterdam

Basic operating system loop



Service Provider Group framework

A Service Provider Group (SPG) is an organisation structure providing a defined service only available if its members collaborate.

Examples:

Internet2 NET+

SKYTEAM

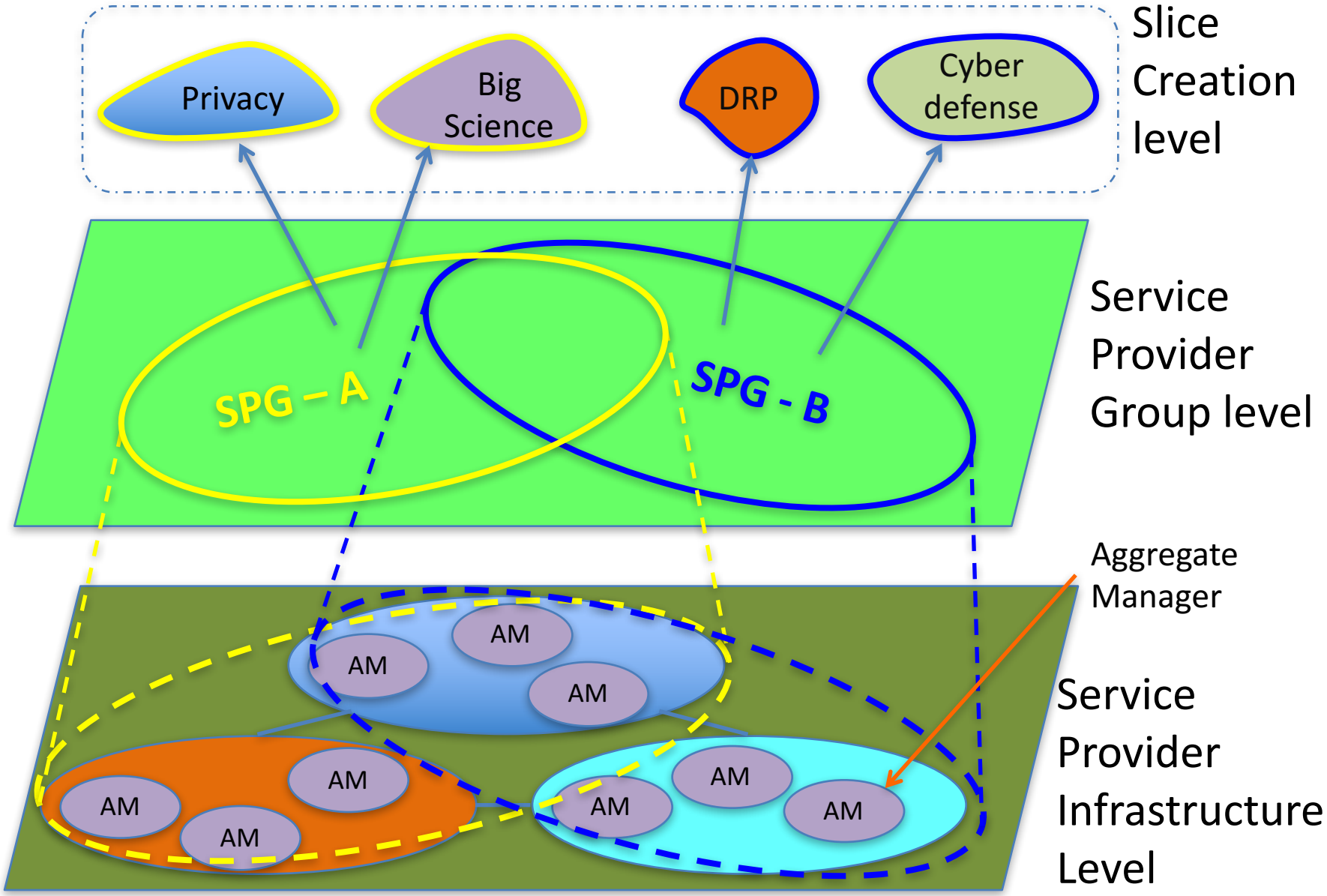
geni
Exploring Networks of the Future

glif

eduroam

MasterCard

Envisioned role of the SPG: define slice archetypes?



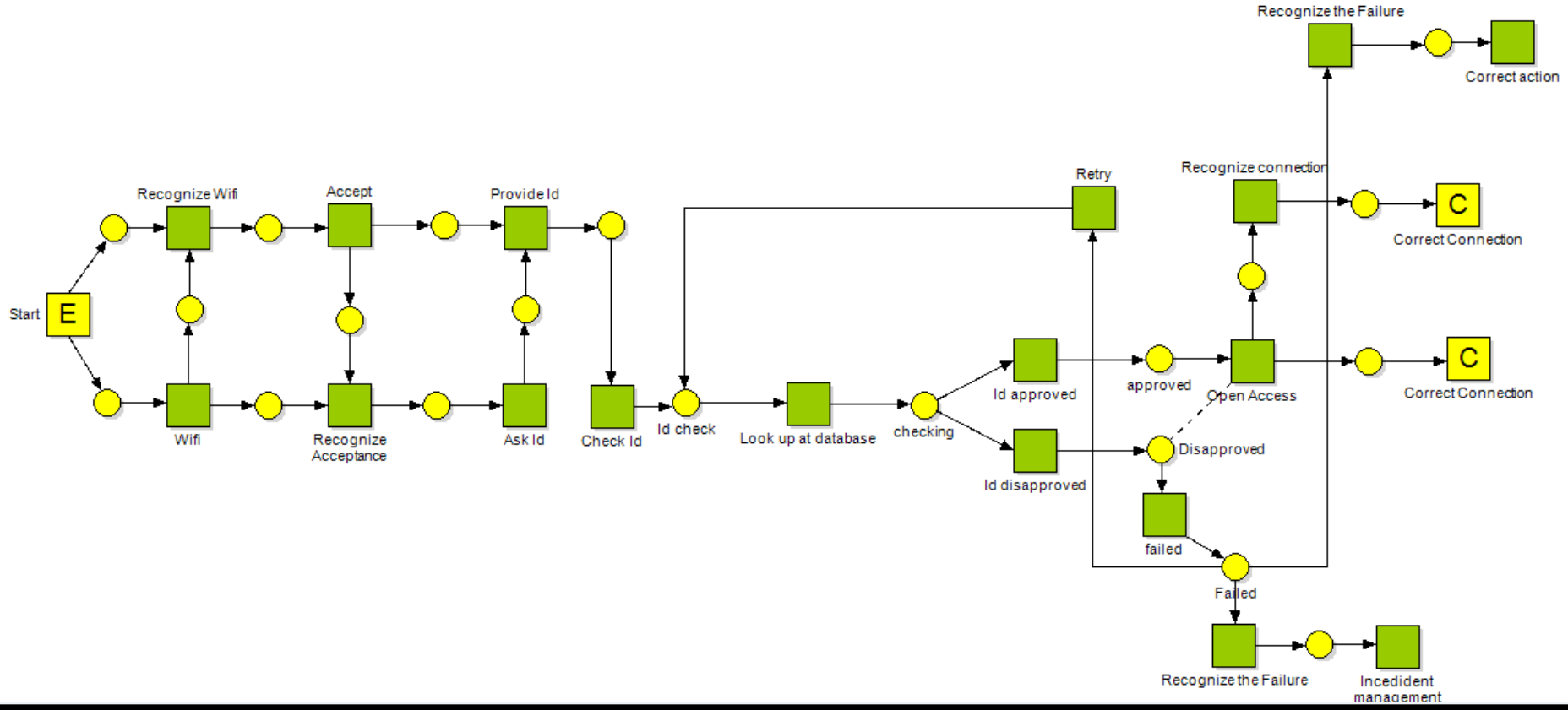
Agent Based Modelling Framework

	Main component
Signal layer	Message / Act
Action layer	Action / Activity
Intentional layer	Intention
Motivational layer	Motive

In our model, we refer to four layers of components:

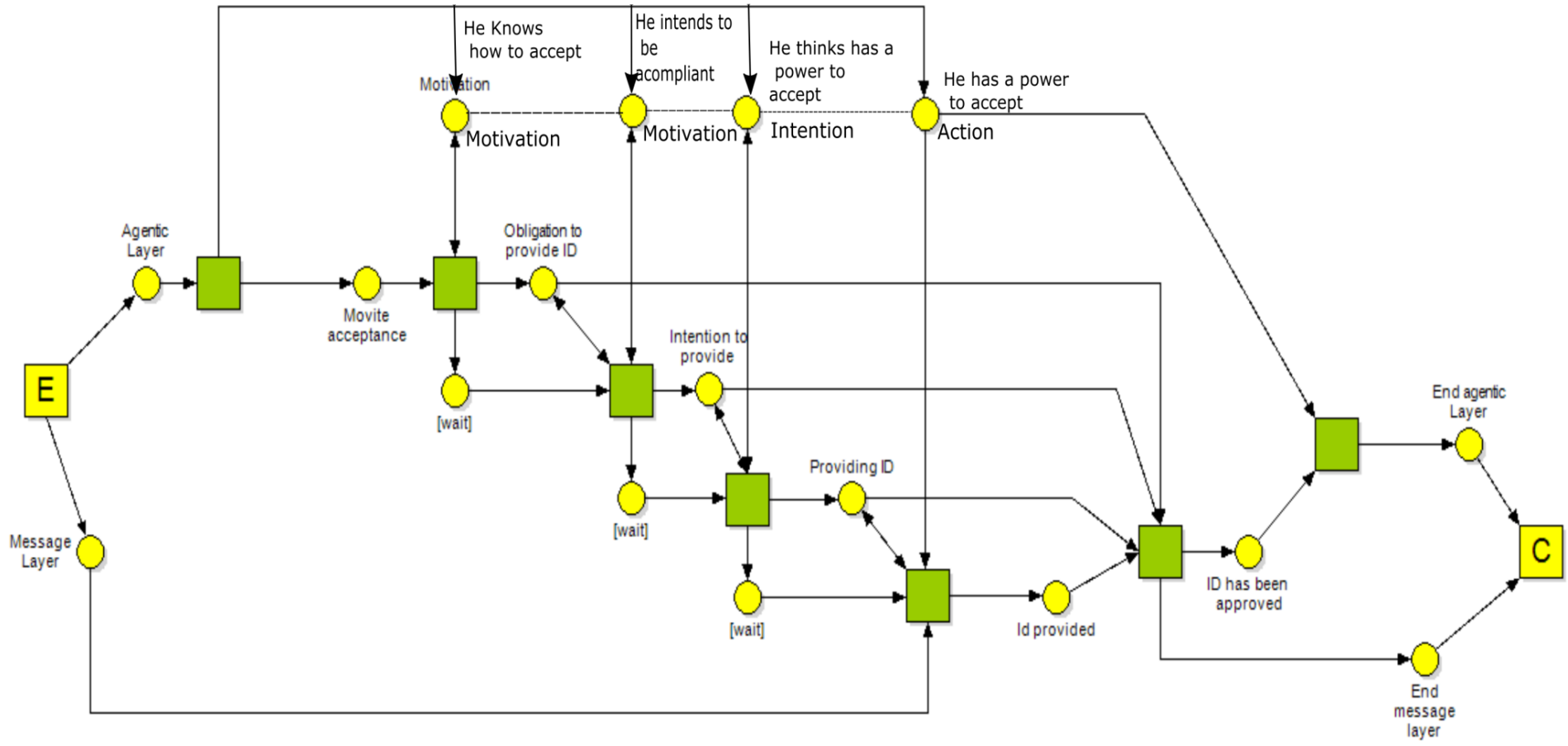
- the signal layer— describes acts, side-effects and failures showing outcomes of actions in a topology.
- the action layer—actions: performances that bring a certain result,
- the intentional layer—intentions: commitments to actions, or to build up intentions,
- the motivational layer—motives: events triggering the creation of intentions.

Simplified Eduroam case at signalling layer



Petri net of EduRoam Case
(first step)

Describing Intentions, Motivations and Actions

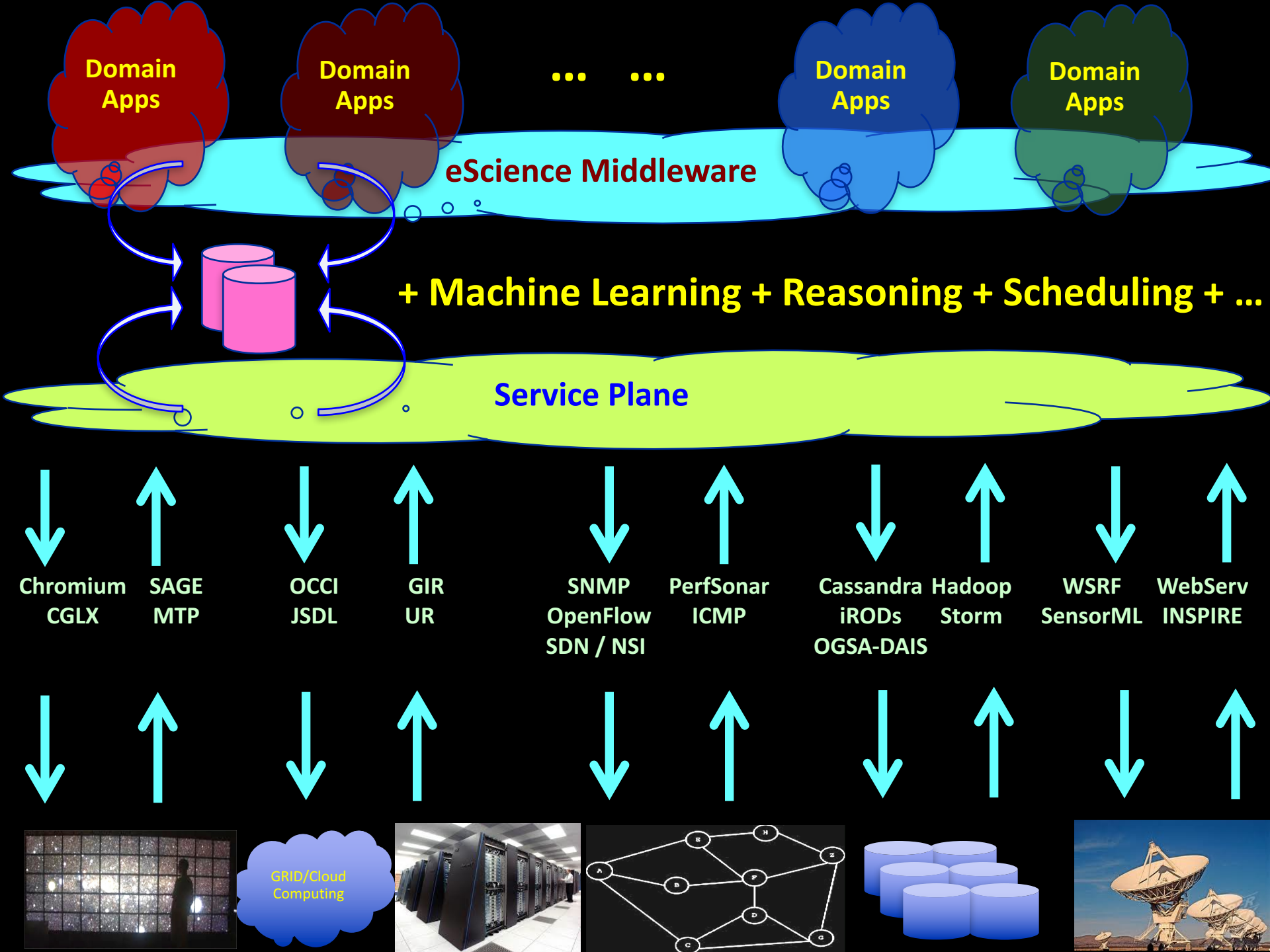


Petri net of EduRoam Case

SNE - Mission

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*
- *Capability*
  - *Programmability, virtualization, complexity, semantics, workflows*
- *Security*
  - *Policy, Trust, Anonymity, Privacy, Integrity*
- *Sustainability*
  - *Greening infrastructure, Awareness*
- *Resilience*
  - *Failures, Disasters, Systems under attack*


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

The Big Data Challenge

Doing Science

Wis dom

Knowledge to act

Information

Data

a.o. from ESFRI's

ICT to enable Science

e-IRG

Workflows Schedulers to act

OWL

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

The Big Data Challenge

Doing Science

ICT to enable Science

Scientists live here!

Science App Store?

Wis dom

Knowledge

e-IRG

Workflows Schedulers

MAGIC DATA CARPET

curation - description - trust - security - policy – integrity

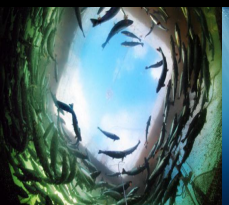
Information

OWL

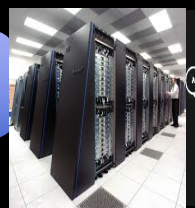
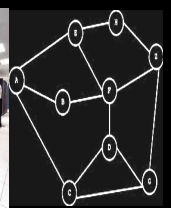
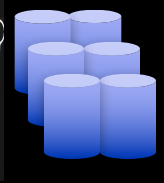
Data

a.o. from ESFRI's

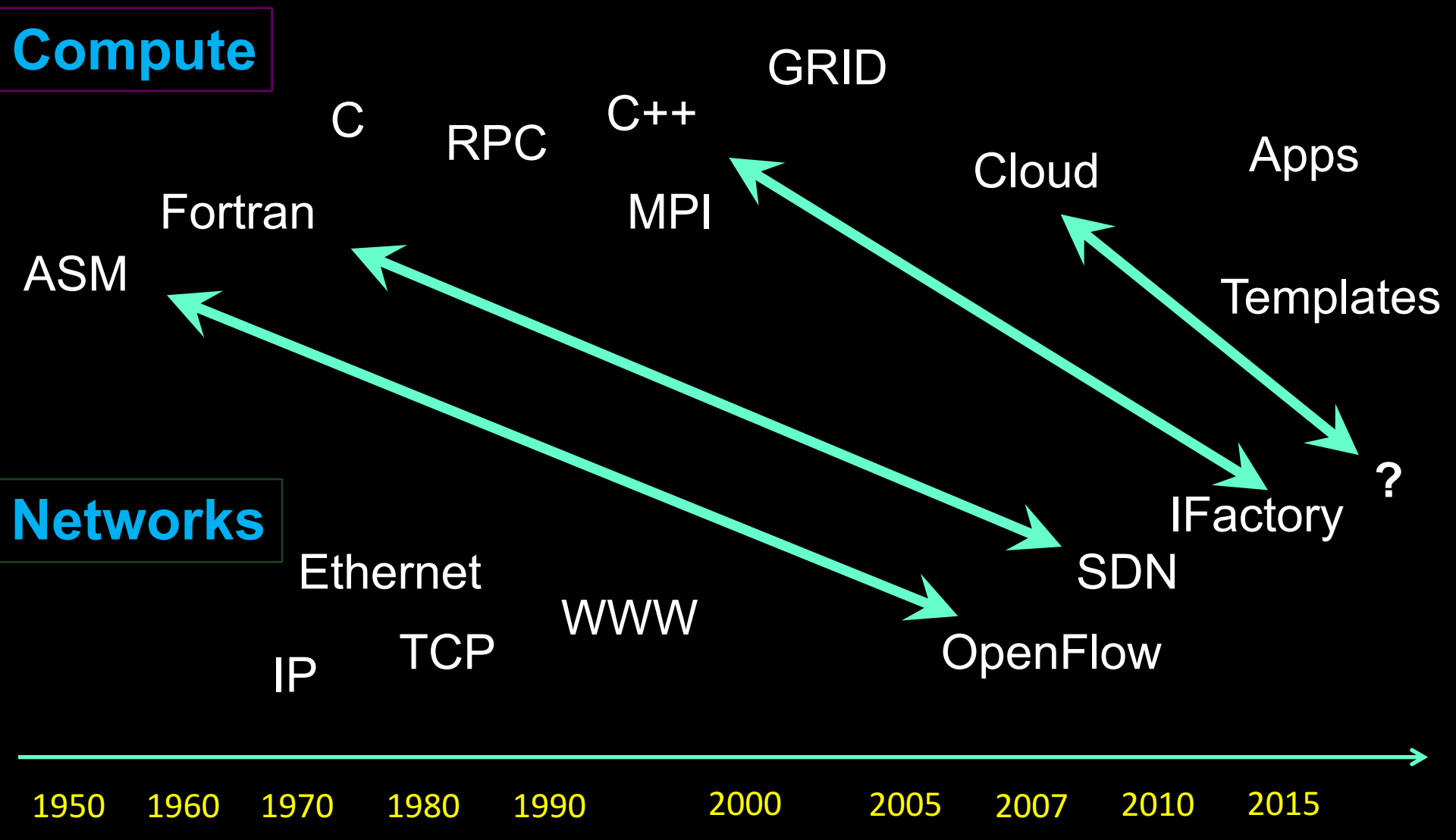
XML, RDF, rSpec, SNMP, Java based, etc.





TimeLine


Compute
GRID
C
C++
RPC
Cloud
Apps
Fortran
MPI
ASM
Templates
?
IFactory
Networks
SDN
Ethernet
WWW
TCP
IP
OpenFlow
1950
1960
1970
1980
1990
2000
2005
2007
2010
2015

Questions?

http://delaat.net

http://delaat.net/sarnet

Leon Gommans, "Multi-Domain Authorization for e-Infrastructures", UvA, Dec 2014.

http://delaat.net/pubs/2014-t-3.pdf

Rudolf Strijkers, "Internet Factories", UvA, Nov 2014.

http://delaat.net/pubs/2014-t-2.pdf

Contact us:

delaat@uva.nl

a.l.varbanescu@uva.nl

R.vanNieuwpoort@esciencecenter.nl