Virtualisation & Cyber Infrastructure.

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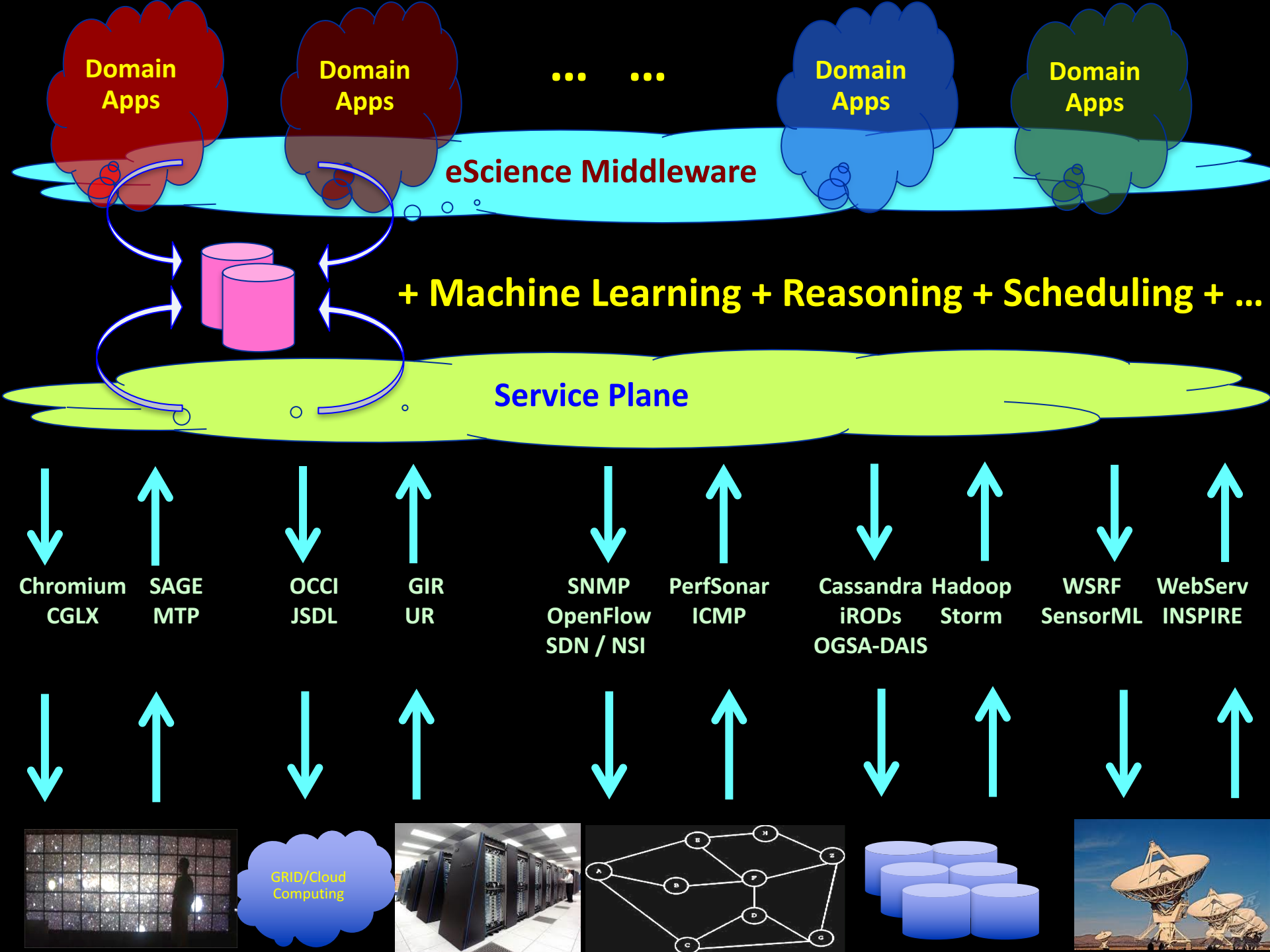
University of Amsterdam


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

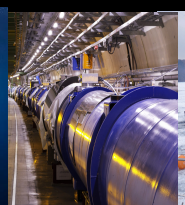
OWL

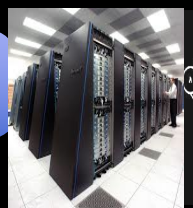
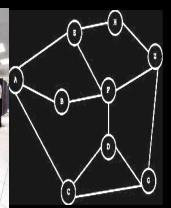
Data

a.o. from ESFRI's

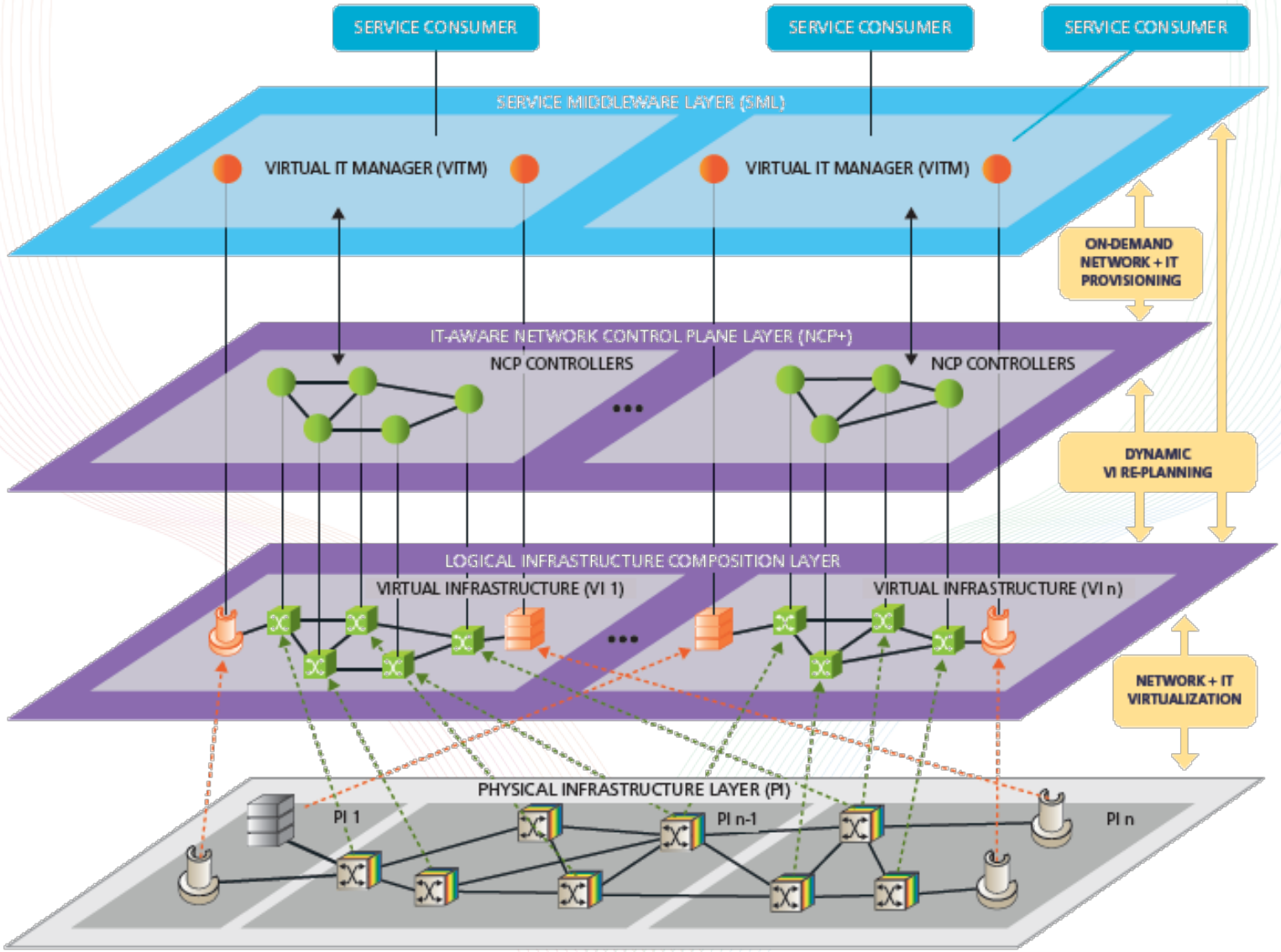
XML, RDF, rSpec, SNMP, Java based, etc.



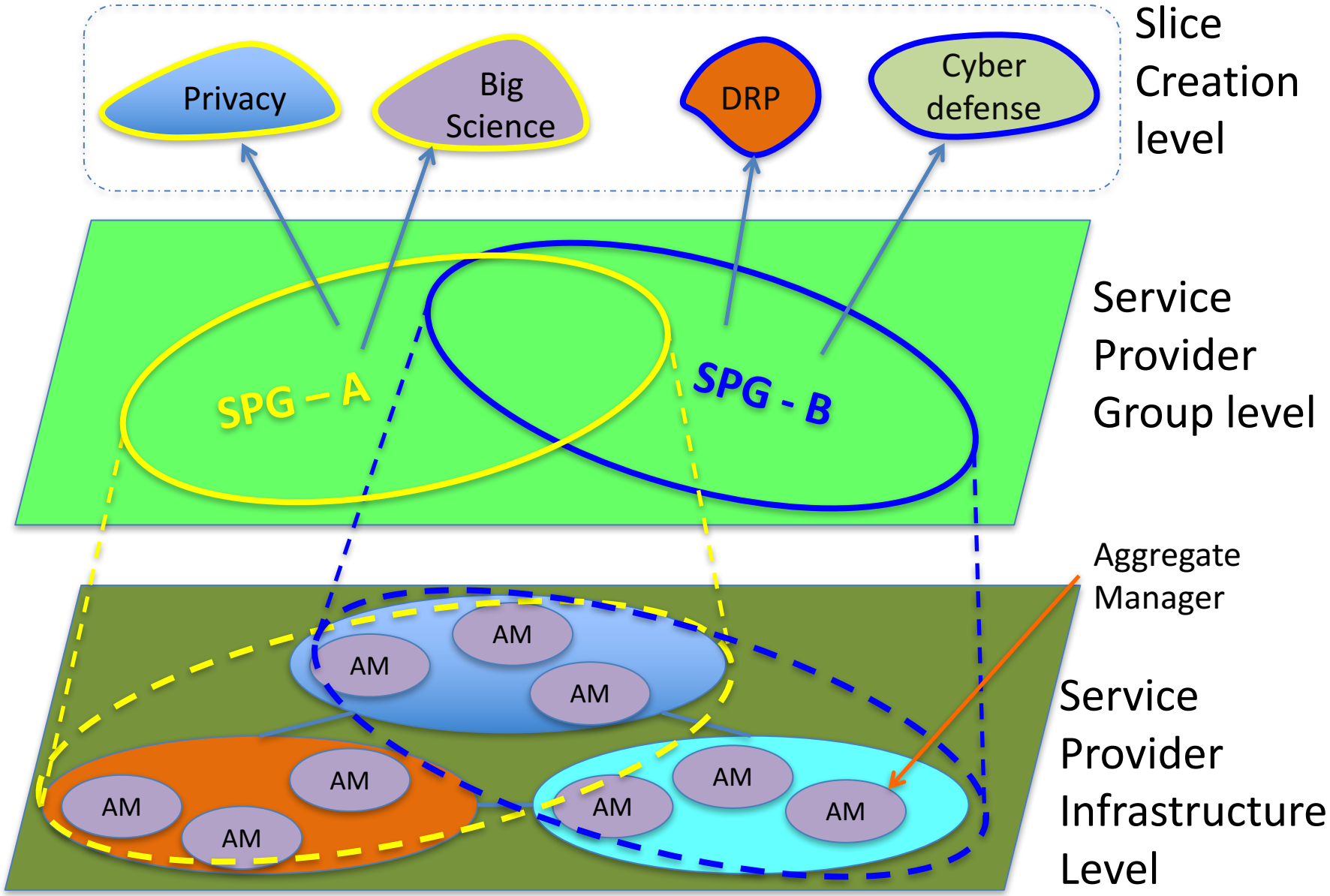



Reference model



Envisioned role of the SPG: define slice archetypes?



ExoGeni

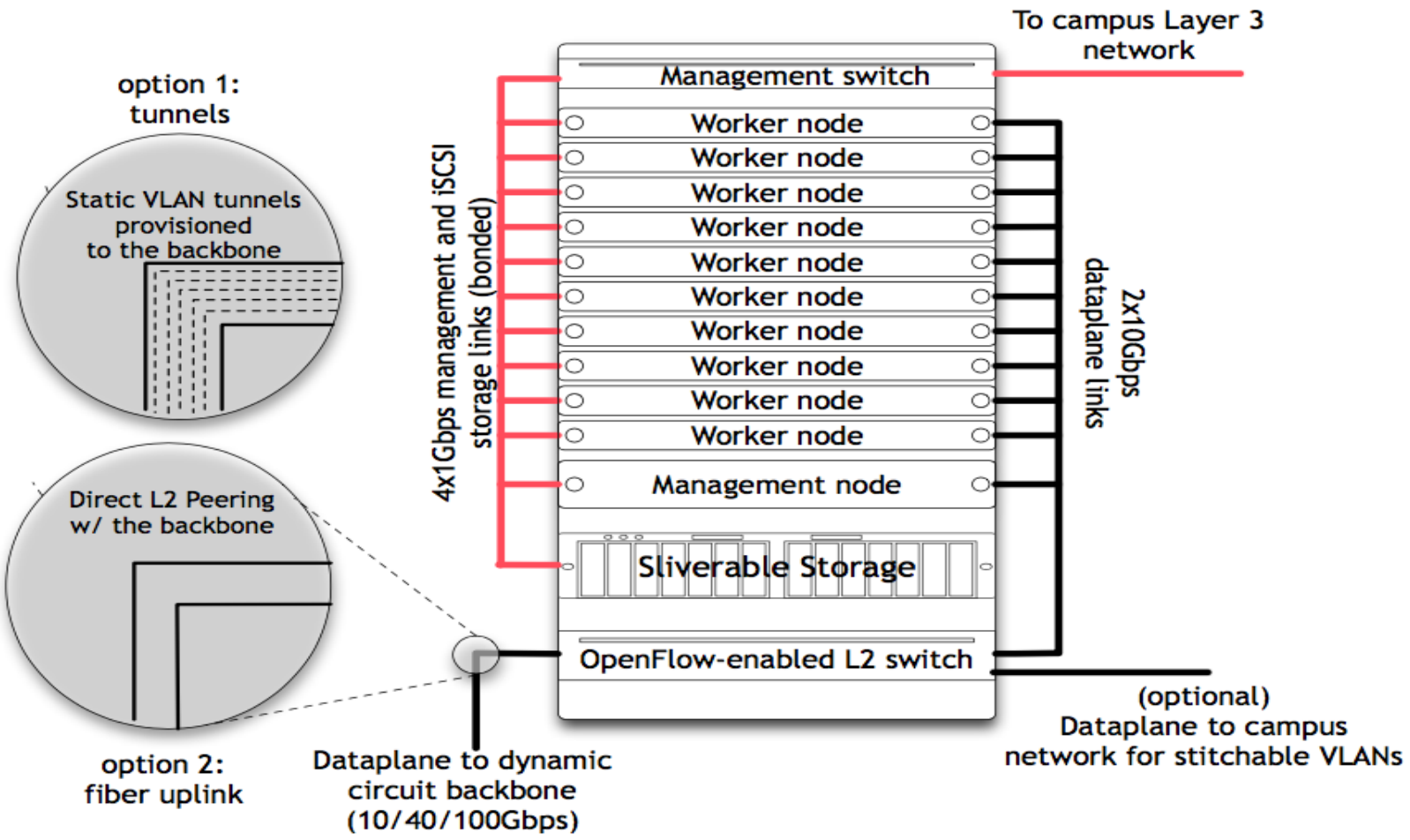
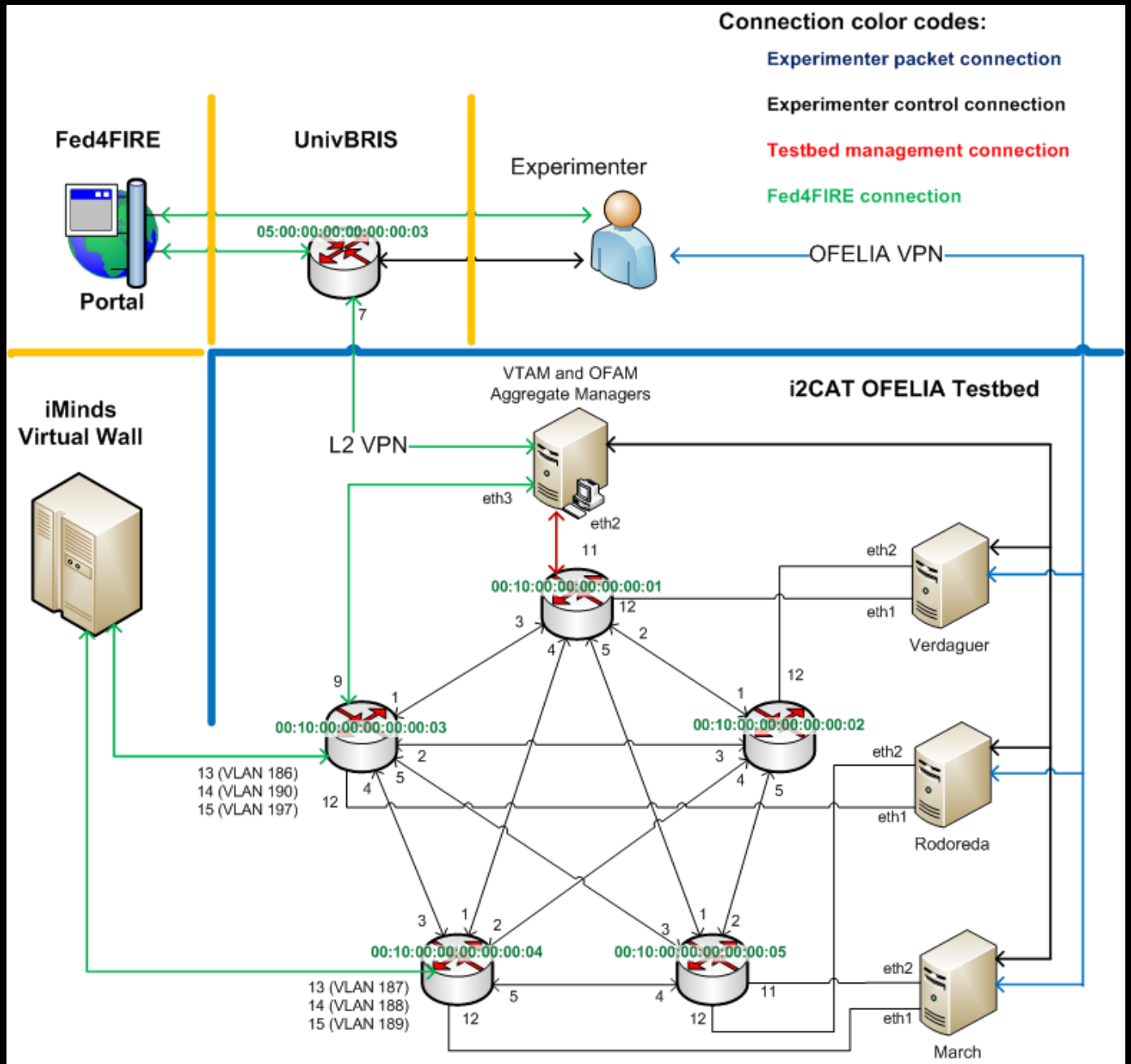
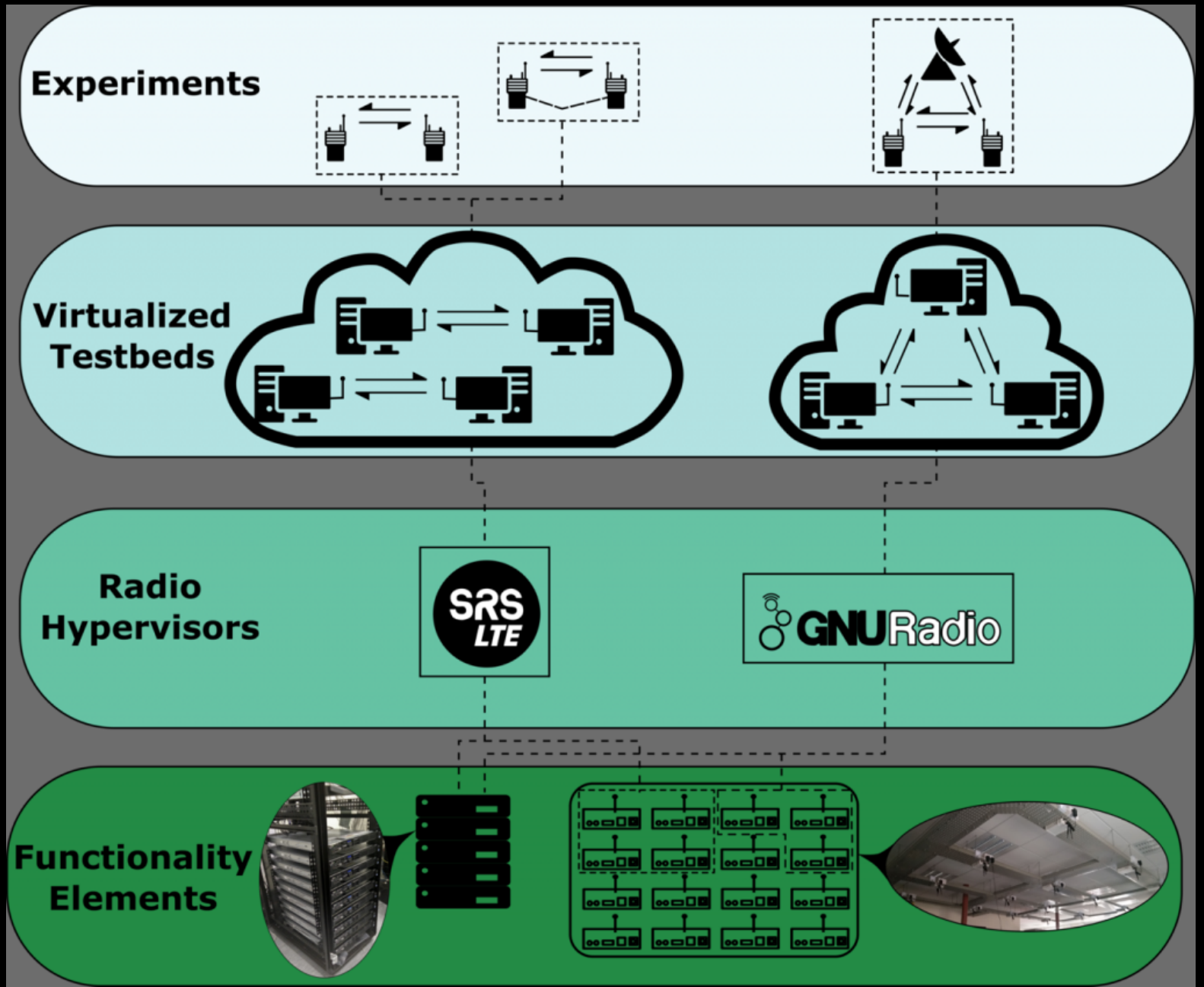


Fig. 1.2. Structure of an ExoGENI site rack for the initial deployment. Each rack has low-bandwidth IP connectivity for management and a high-bandwidth hybrid OpenFlow switch for the slice dataplanes. The site ORCA server controls L2 dataplane connections among local nodes and external circuits.

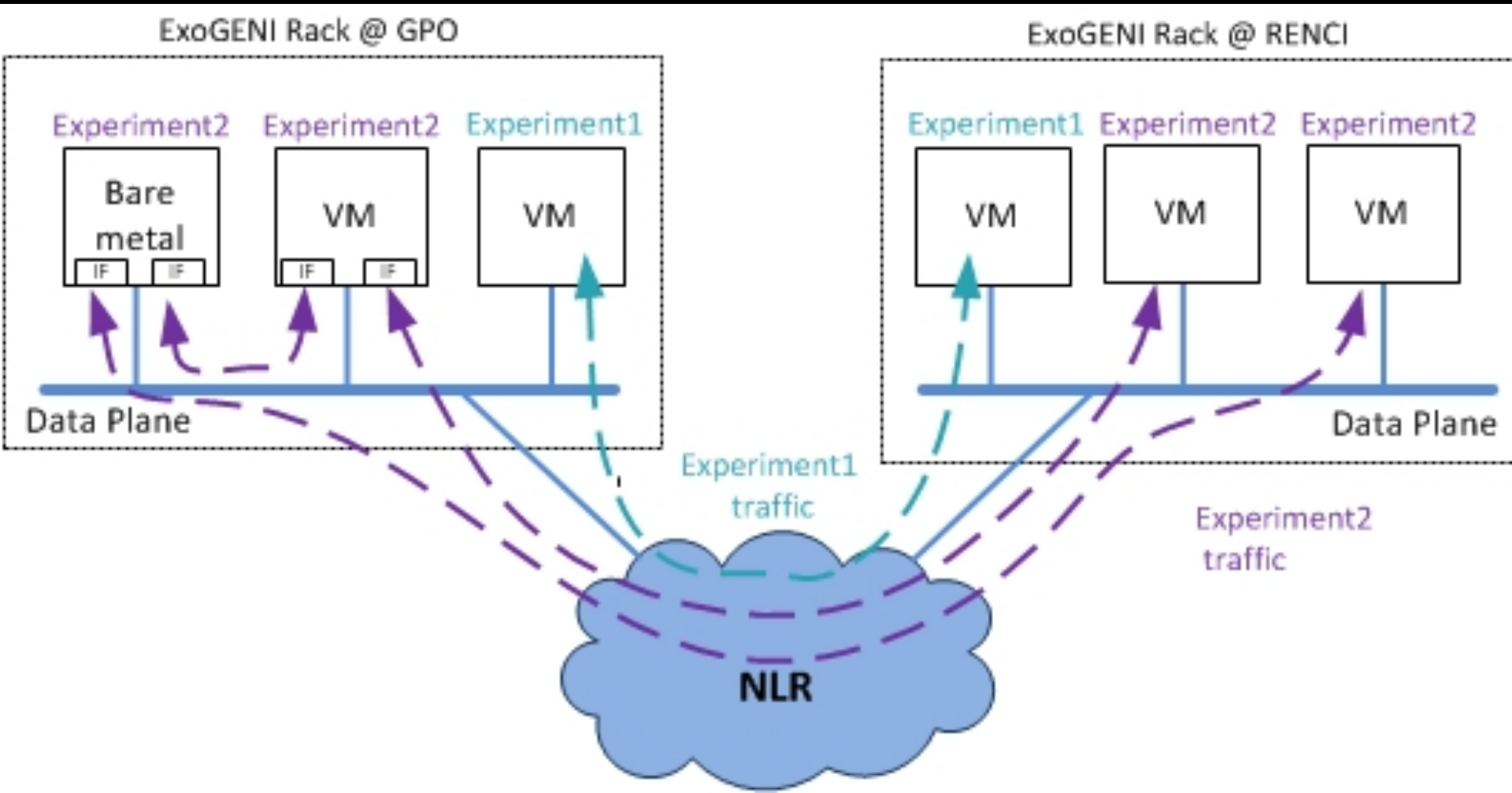
Fed4Fire


Connection color codes:
Experimenter packet connection
Experimenter control connection
Testbed management connection
Fed4FIRE connection
Fed4FIRE
UnivBRIS
Experimenter
Portal
05:00:00:00:00:00:00:03
7
OFELIA VPN
VTAM and OFAM
Aggregate Managers
i2CAT OFELIA Testbed
iMinds
Virtual Wall
L2 VPN
eth3
eth2
11
00:10:00:00:00:00:00:01
12
3
4
5
2
eth2
eth1
Verdaguer
9
1
00:10:00:00:00:00:00:03
2
5
4
12
13 (VLAN 186)
14 (VLAN 190)
15 (VLAN 197)
1
00:10:00:00:00:00:00:02
3
4
5
12
eth2
eth1
Rodoreda
3
1
2
00:10:00:00:00:00:00:04
5
12
13 (VLAN 187)
14 (VLAN 188)
15 (VLAN 189)
3
1
2
00:10:00:00:00:00:00:05
4
11
12
eth2
eth1
March

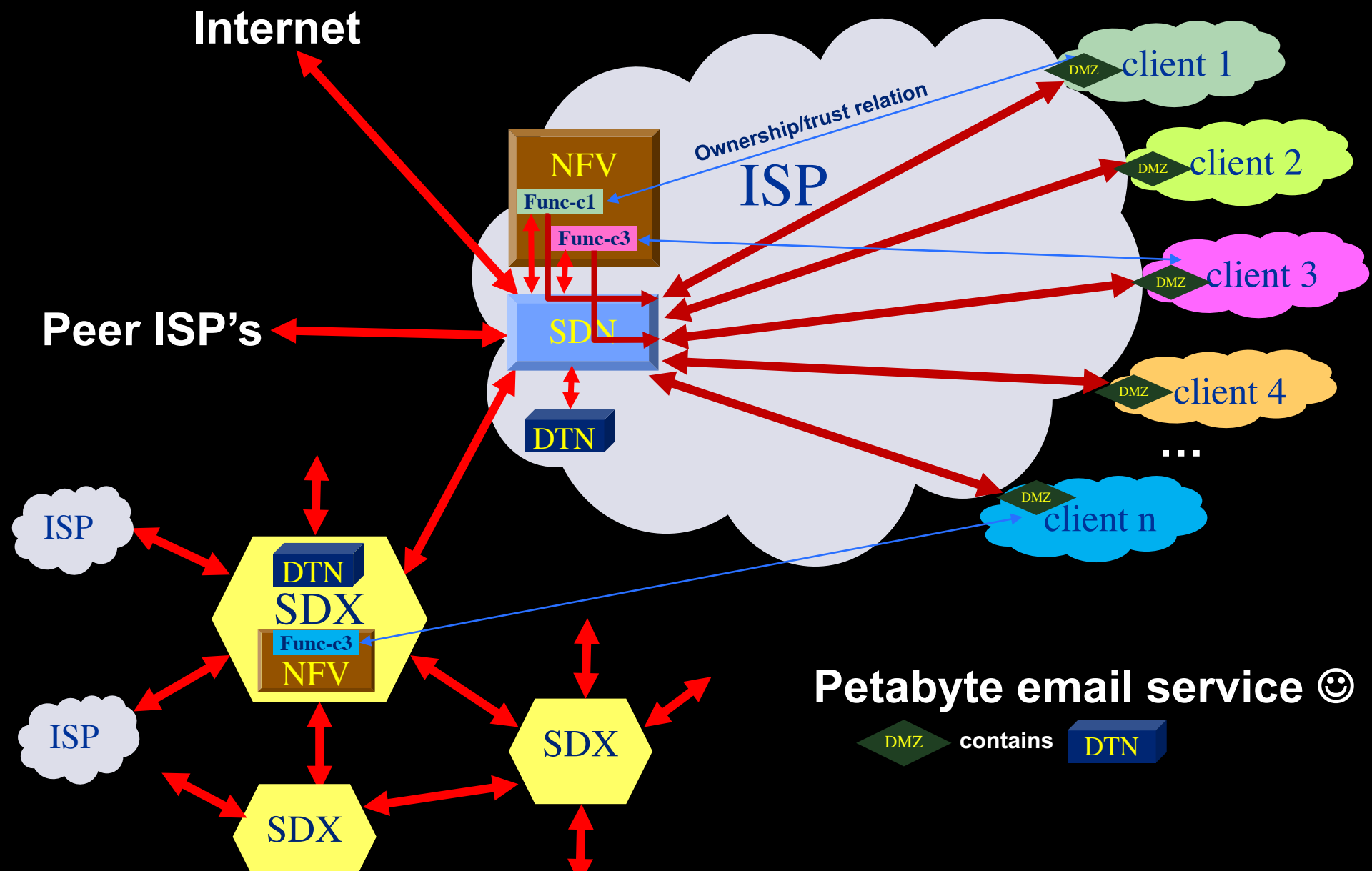
Fed4Fire


Experiments
Virtualized Testbeds
Radio Hypervisors
SRS LTE
GNURadio
Functionality Elements

Fed4Fire


ExoGENI Rack @ GPO
Experiment2
Experiment2
Experiment1
Bare metal
VM
VM
IF
IF
IF
IF
Data Plane
ExoGENI Rack @ RENCI
Experiment1
Experiment2
Experiment2
VM
VM
VM
Data Plane
Experiment1 traffic
Experiment2 traffic
NLR

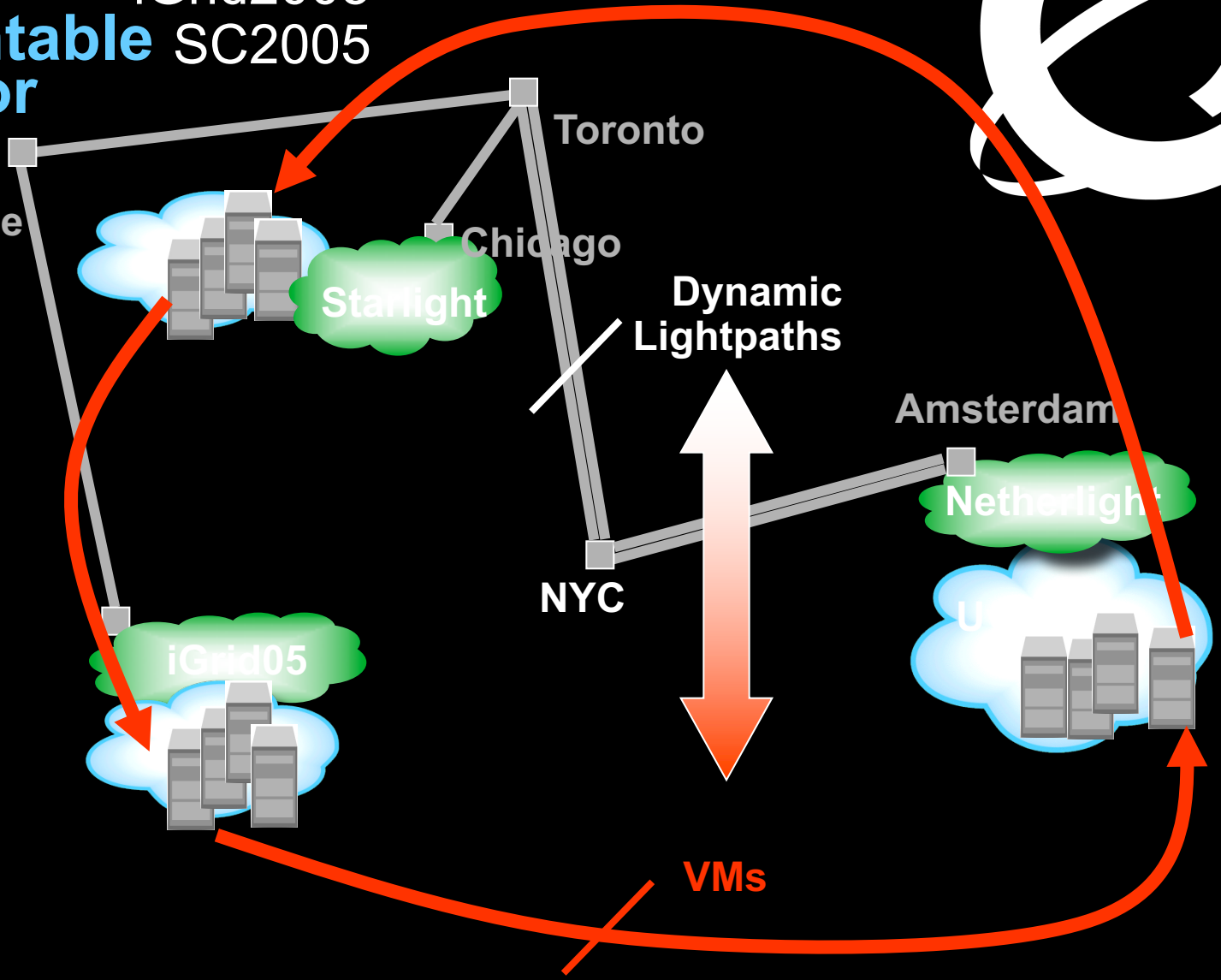
Networks of ScienceDMZ's & SDX's



The VM Turntable Demonstrator

iGrid2005
SC2005

hitless remote rendering



The VMs that are live-migrated run an iterative search-refine-search workflow against data stored in different databases at the various locations. A user in San Diego gets hitless rendering of search progress as VMs spin around

Experiment outcomes
Note, this was in 2005!

We have demonstrated seamless, live migration of VMs over WAN

For this, we have realized a network service that

- Exhibits predictable behavior; tracks endpoints
- Flex bandwidth upon request by credited applications
- Doesn't require peak provisioning of network resources

Pipelining bounds the downtime in spite of high RTTs

- San Diego – Amsterdam, 1GE, RTT = 200 msec, downtime <= 1 sec
- Back to back, 1GE, RTT = 0.2-0.5 msec, downtime = ~0.2 sec*
- **Clark et al. NSDI 05 paper. Different workloads*

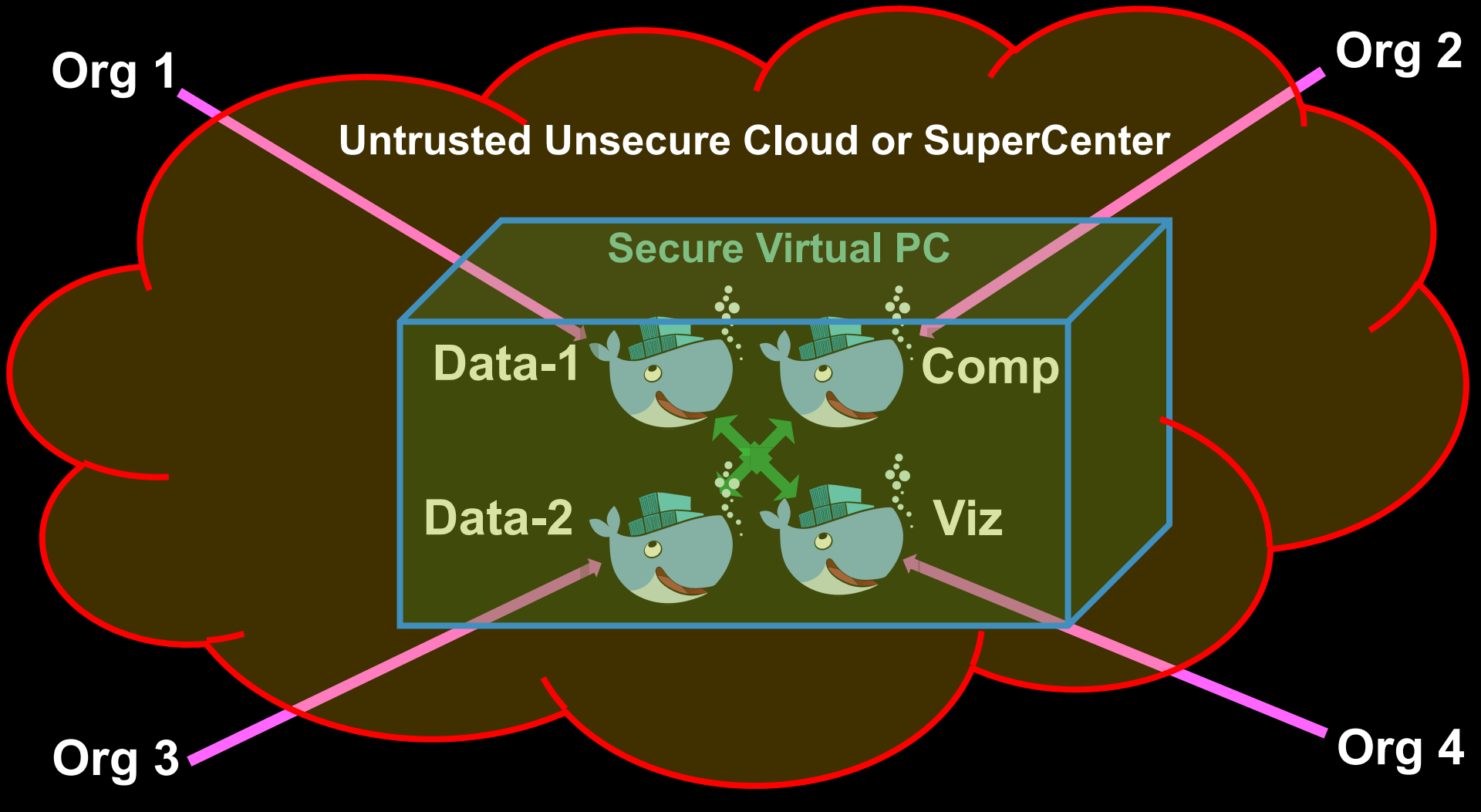
VM + Lightpaths across MAN/WAN are deemed a powerful and general alternative to RPC, GRAM approaches

We believe it's a representative instance of active cpu+data+net orchestration

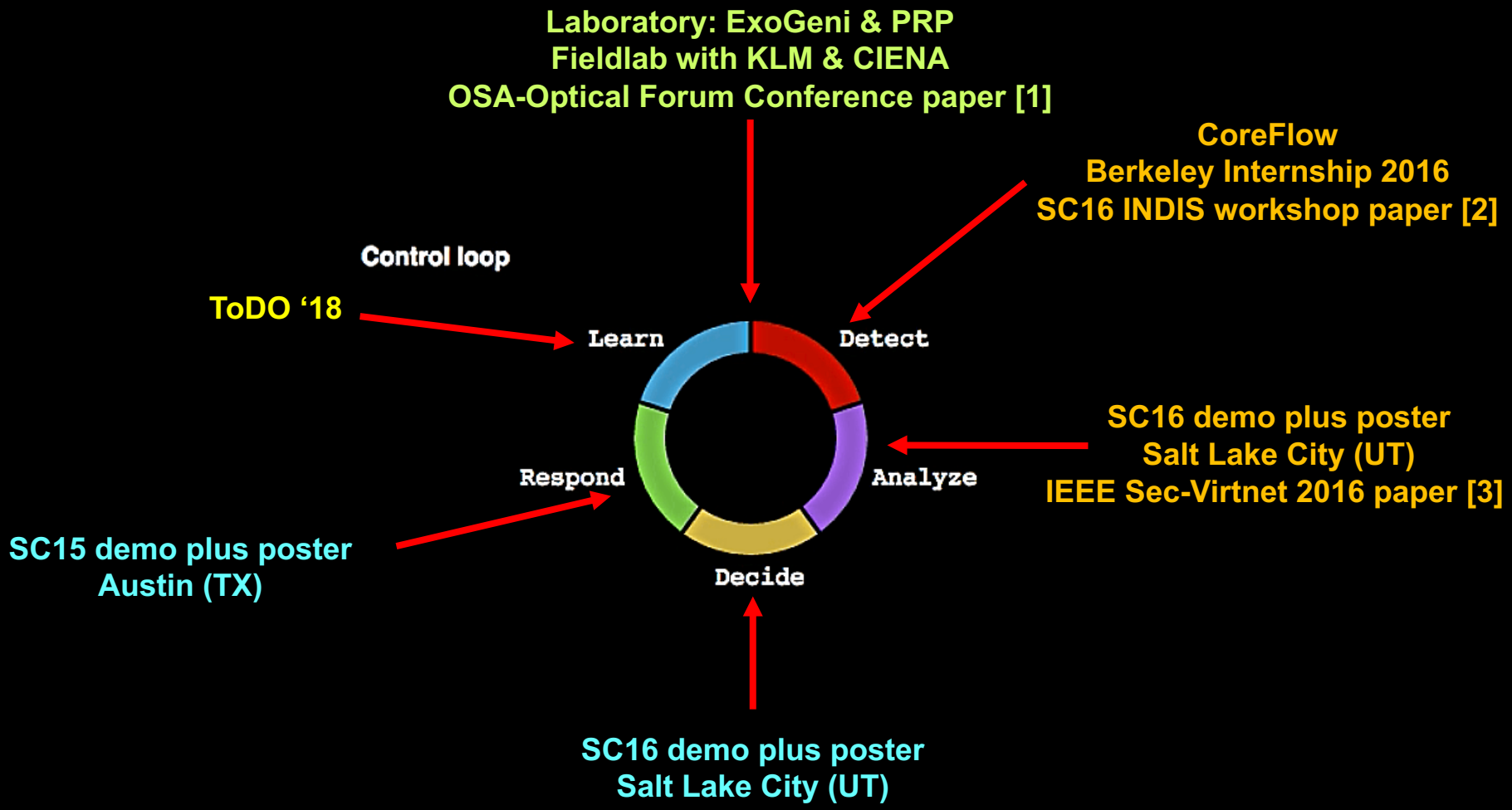
F. Travostino, P. Daspit, L. Gommans, C. Jog, C.T.A.M. de Laat, J. Mambretti, I. Monga, B. van Oudenaarde, S. Raghunath and P.Y. Wang, "Seamless Live Migration of Virtual Machines over the MAN/WAN", Future Generation Computer Systems, Volume 22, Issue 8, October 2006, Pages 901-907.

Secure Policy Enforced Data Processing

- Bringing data and processing software from competing organisations together for common goal
- Docker with encryption, policy engine, certs/keys, blockchain and secure networking
- Data Docker (virtual encryped hard drive)
- Compute Docker (protected application, signed algorithms)
- Visualization Docker (to visualize output)

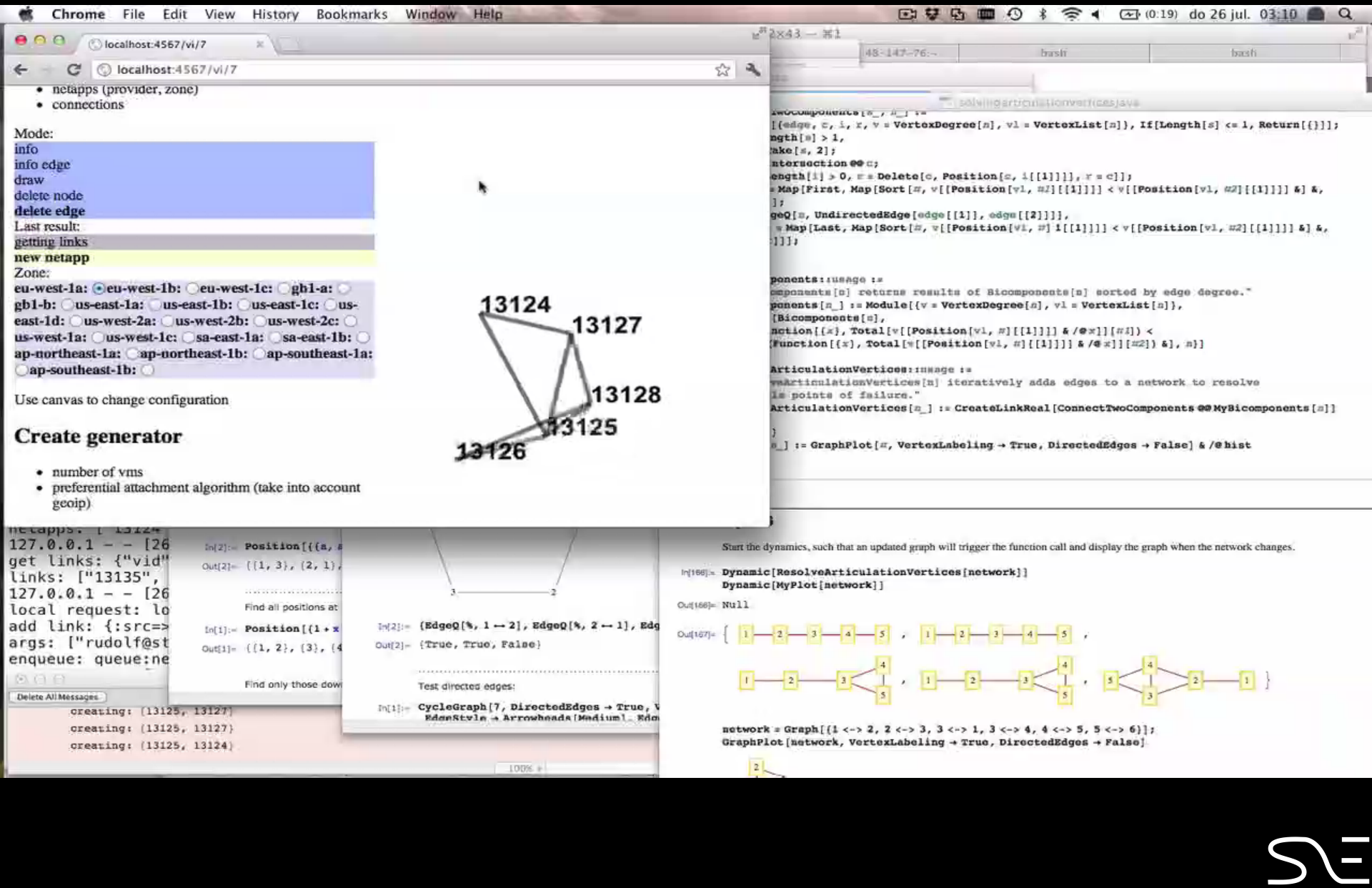


Status SARNET Operational Level



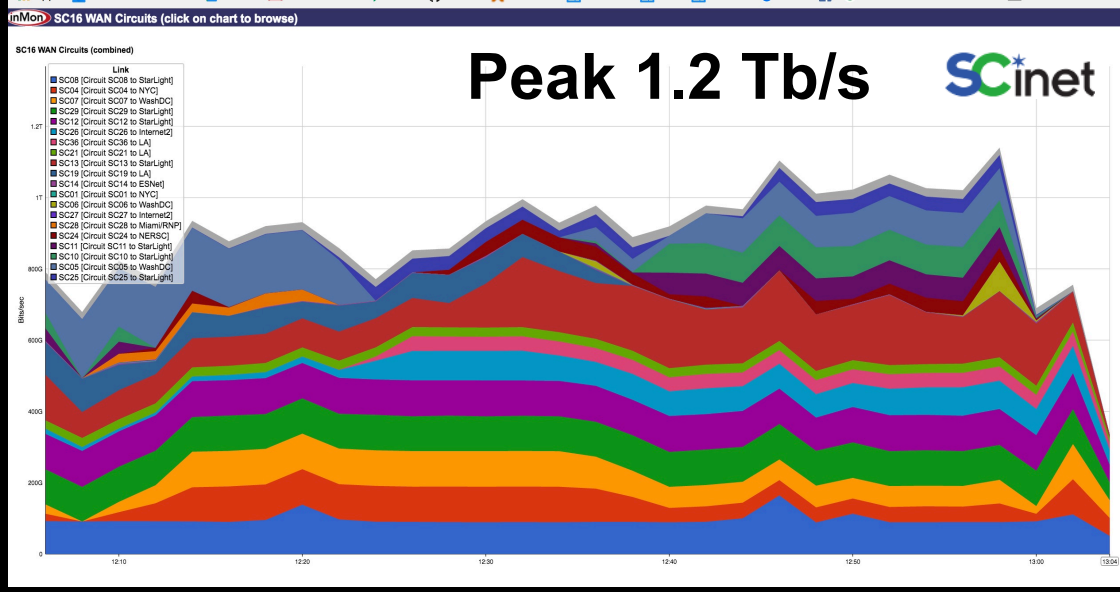
1. Paper: R. Koning, A. Deljoo, S. Trajanovski, B. de Graaff, P. Grosso, L. Gommans, T. van Engers, F. Fransen, R. Meijer, R. Wilson, and C. de Laat, "Enabling E-Science Applications with Dynamic Optical Networks: Secure Autonomous Response Networks ", OSA Optical Fiber Communication Conference and Exposition, 19-23 March 2017, Los Angeles, California.
2. Paper: Ralph Koning, Nick Buraglio, Cees de Laat, Paola Grosso, "CoreFlow: Enriching Bro security events using network traffic monitoring data", SC16 Salt Lake City, INDIS workshop, Nov 13, 2016.
3. Paper: Ralph Koning, Ben de Graaff, Cees de Laat, Robert Meijer, Paola Grosso, "Analysis of Software Defined Networking defences against Distributed Denial of Service attacks", The IEEE International Workshop on Security in Virtualized Networks (Sec-VirtNet 2016) at the 2nd IEEE International Conference on Network Softwarization (NetSoft 2016), Seoul Korea, June 10, 2016.

Basic operating system loop

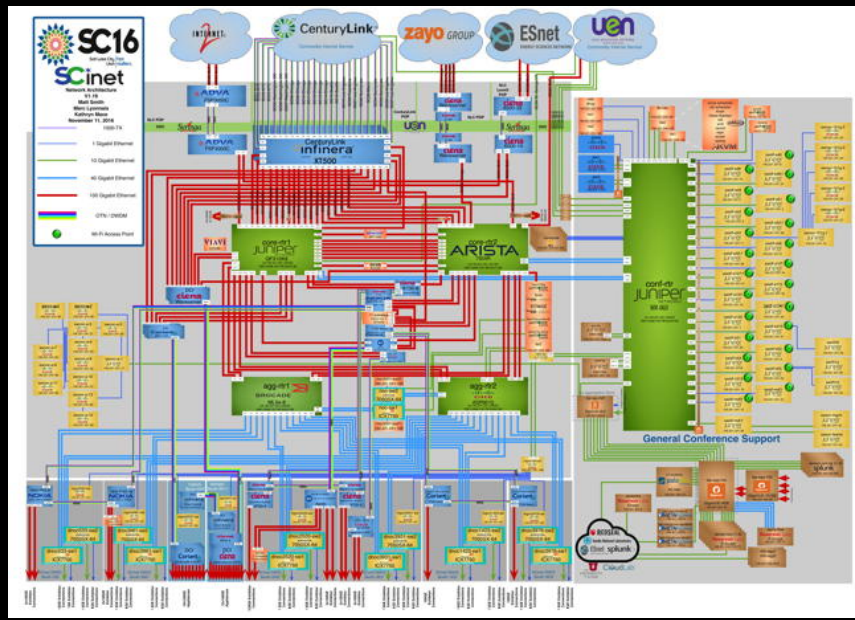


SC16 DEMO STARNET Operational Level

Learned from Scinet & INDIS



- 2013 - 2016
  - SDN
  - Security
  - Traffic management, policing, control
  - Hybrid – optical ring - approach to reach Tb/s
- 2017 - 2020
  - NFV
  - SDX
  - DTN @ core ➔ petabyte email network
  - Data abstractions (e.g. NDN)



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Q & A