



External Research Automotive Program

The Vision and accomplishments

Winter 2018

For the next 5-10 years to come

To allow all devices to interconnect in a smart, protected and efficient manner

Smart Edge

- The smart edge model was first introduce by the GENI initiative
 - We have 2 100G Exo GENI racks
 - They have allowed us to understand the next generation of smart devices interconnection and simulation of networks intelligence
 - The GENI infrastructure did not allow to drive bandwidth growth but allow smart networking to evolve

Smart Data

- Smart data "knows" when it is shared and the content to be shared
- Smart data acknowledges the owners and the read/write permissions (like Unix)
- Smart data recognizes when it is compromised or when the network is compromised

Smart Devices

- We are planning to have smart programmable NIC cards to achieve P4 service layer definition and network programmability

Smart Core

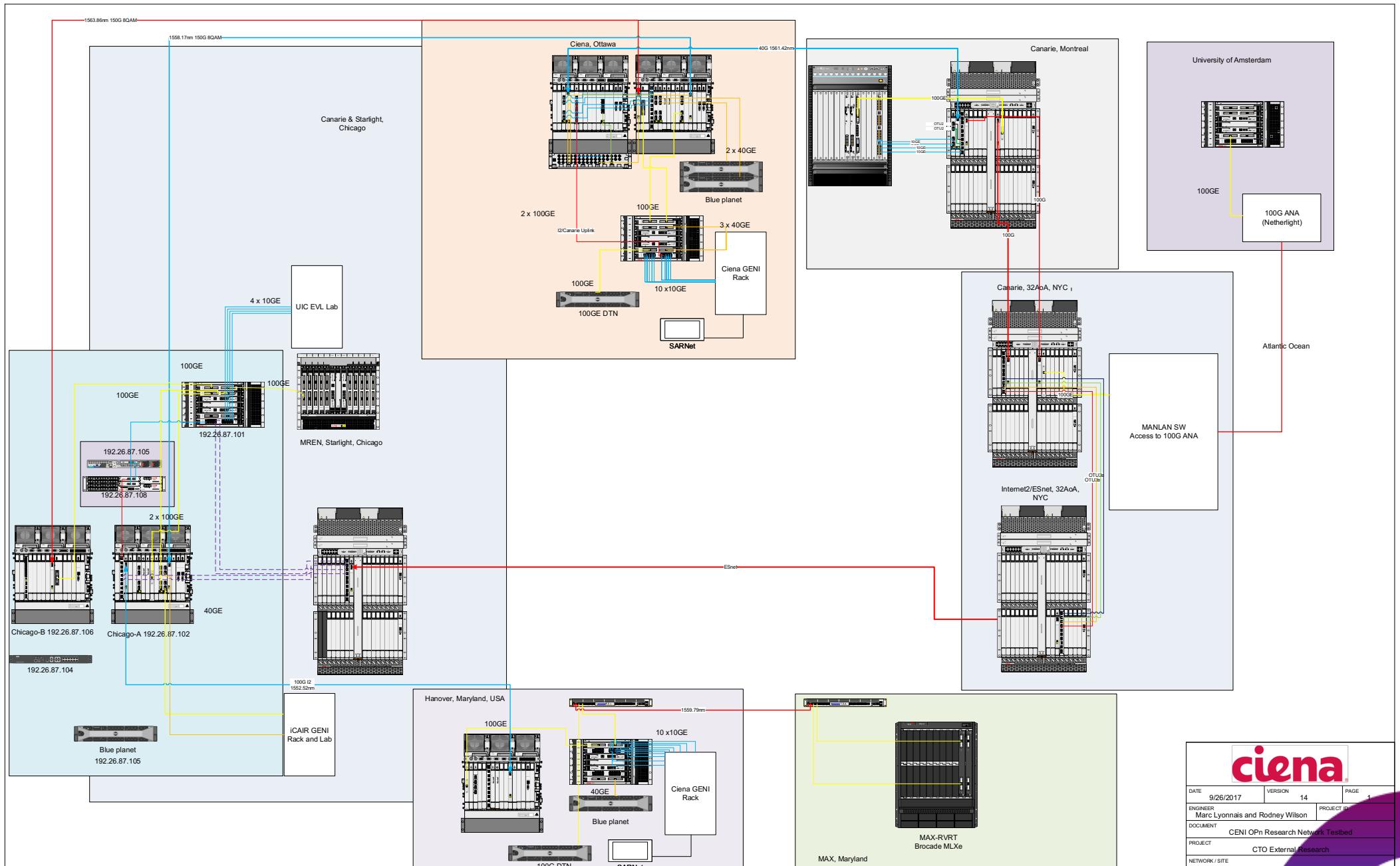
Smart Network

The CENI Testbed



Interconnecting REN and Open Exchanges

- **Starlight**
- **NetherLight**
- **SurfNET**
- **Internet2**
- **ESnet**
- **Canarie**
- **MAX**
- **MAnLAN**
- **KLM Data center**
- **WIX**



Subhead Information

Things to explore in 2018

2018 Interests

- **AI Garcia Smart city**
- **Harvey Newman Smart networking**
- **Tom Lehman SDX investigation**
- **uVA dl4Id**
- **UEN Cloud interconnection between private and public Cloud providers**
- **Internet2 WIX and ManLAN Next Gen Open Exchange modelisation and experimentation**
- **100G DTNs**
- **To partner with a non research and education entity and to explore a more commercial endeavour**
- **To lead SCinet Innovations by accepting the Experimental Network and INDIS workshop co-chair nomination**
- **To explore the industrialisation of SARNET**
- **To explore Open Line System on CENI with the addition of devices like Voyager and Cassini and Ciena White boxes offer (5162)**
- **To explore new network models for data exchanges**
- **SAGE2 @ 8k/16k**
- **To Explore P4 Programmability at the edge and at the service layer**

External Research Group Track Record



Press Releases

CANARIE, StarLight and Ciena Complete 300G Trial

Shows the ability to provide 50 percent more capacity at longer distance to meet growing demand from scientific research, OTT, disaster recovery and DCI applications

HANOVER, Md. – June 15, 2016 – Ciena (NYSE: CIEN), [CANARIE](#), a vital component of Canada's digital infrastructure supporting research, education and innovation, and the [StarLight International/National Communications Exchange Facility Consortium](#) showed the ability to greatly improve network efficiencies using the open interfaces and programmable modulation of Ciena's [Waveserver™](#) stackable interconnect system. Announced at this week's TNC16 Networking [Conference](#), the trial transmitted 300 Gb/s capacity using the latest coherent optical modulation available via Ciena's [WaveLogic 3 Extreme](#) chipset.

MAX and Ciena Join Forces to Expand Opportunities for Collaborative Research in the Science and Higher Education Communities

New MAX-Ciena 200 Gbps Connection will Facilitate Multi-Domain SDN Technology Development and Testing

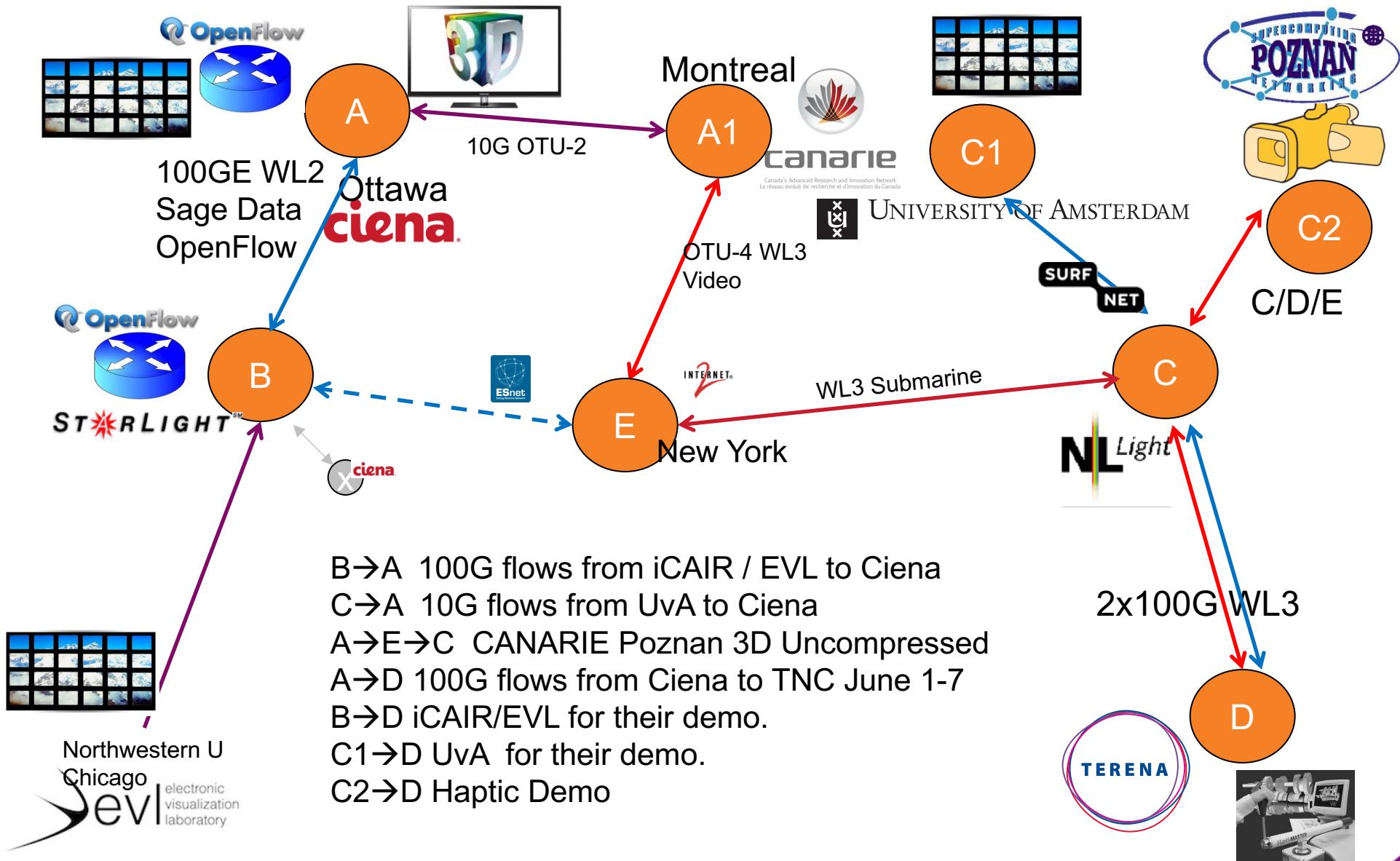
COLLEGE PARK, MD (November 14, 2017) – Mid-Atlantic Crossroads (MAX), a center at the University of Maryland (UMD) that operates a regional advanced cyberinfrastructure platform, and [Ciena](#), a network strategy and technology company, today announced a strategic partnership that will leverage the resources of both organizations to enable and expand sophisticated research activities in the science and higher education communities.

A newly-created 200 Gbps network connection will join together MAX and Ciena's robust research infrastructures to facilitate technology development and testing in the areas of multi-domain, multi-layer software-defined networking (SDN), along with distributed systems integration. As a result, this interconnection will allow both organizations to expand the reach of their testbed facilities as well as their research activities, thus opening up new opportunities for scientific collaboration and innovation.



2014

Ciena Vectors 2013 Conceptual Network topology



B→A 100G flows from iCAIR / EVL to Ciena
C→A 10G flows from UvA to Ciena
A→E→C CANARIE Poznan 3D Uncompressed
A→D 100G flows from Ciena to TNC June 1-7
B→D iCAIR/EVL for their demo.
C1→D UvA for their demo.
C2→D Haptic Demo

Ciena's research-on-demand network topology (2014)



Final mile dark fiber between Ciena HQ and Internet2 (2014)



Ciena Environment for Network Innovation (aka Ciena GENI 2014)



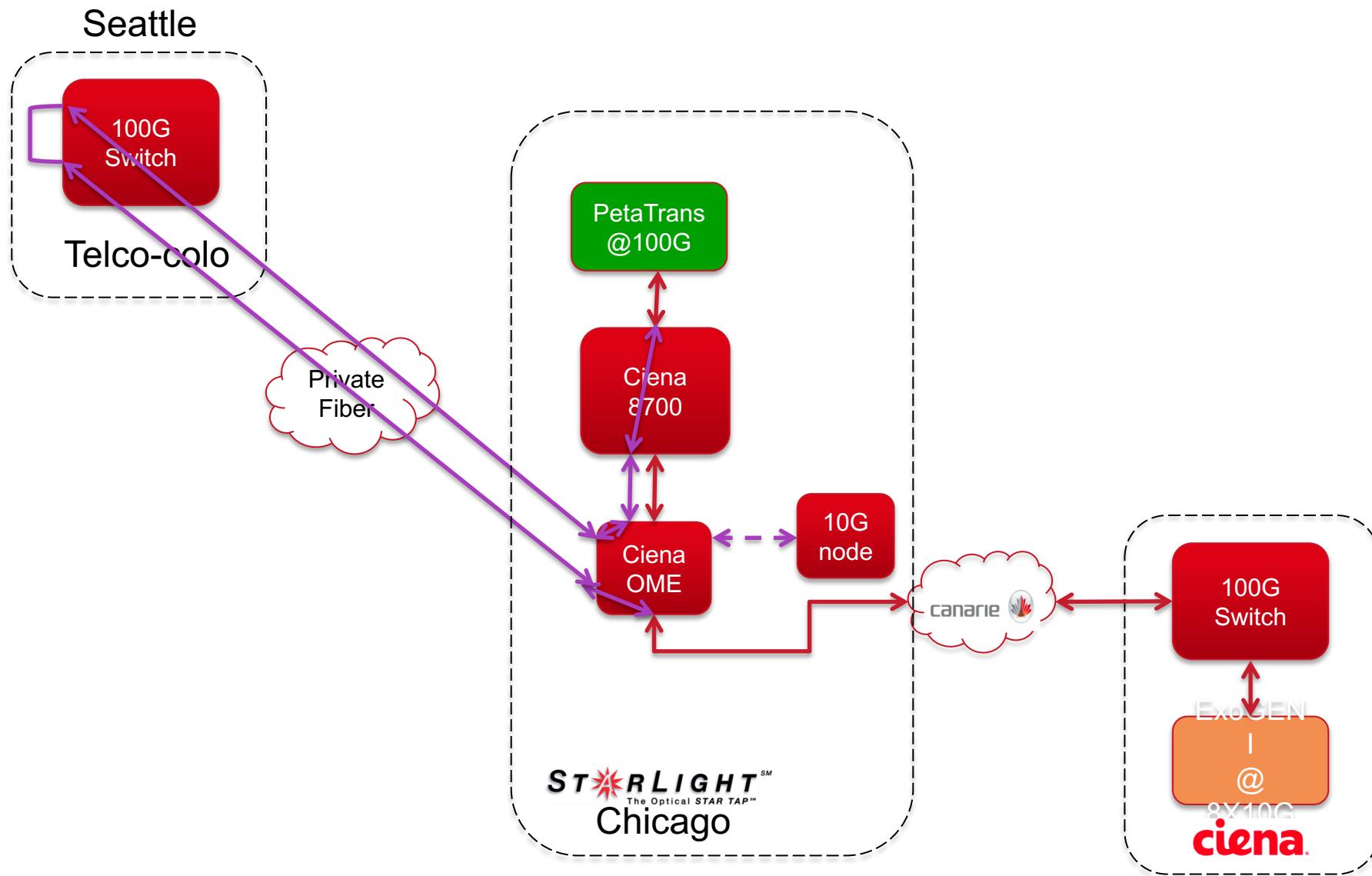
CENI Ottawa System Specifications

- ❑ 8700 4 Slot with 560G of L2 Capacity
 - ❑ 4x40G (2 PSLM-200-2)
 - ❑ 2x100G (1 PSLM-200-2)
 - ❑ 20x10GE (1 PSLM-200-20)
- ❑ 10 Dell Servers
 - ❑ 180 Physical Cores Machines Running Linux RedHAT 6.0
 - ❑ Up to ~ 80 VMs (using 4 Cores each.)
 - ❑ 608 GB of Physical RAM -> approx. 1.2TB VRAM
 - ❑ 6 TB of HD-> more than 12TB Virtual Disk Capacity
- ❑ 100GE Upload Capacity, first of its kind for GENI
- ❑ 20GE in Management Ethernets ports (approx 48 ports) via 5142 and 5150)
- ❑ All DC powered (approx. 100A)
- ❑ 175 Public IP addresses on CANARIE Network

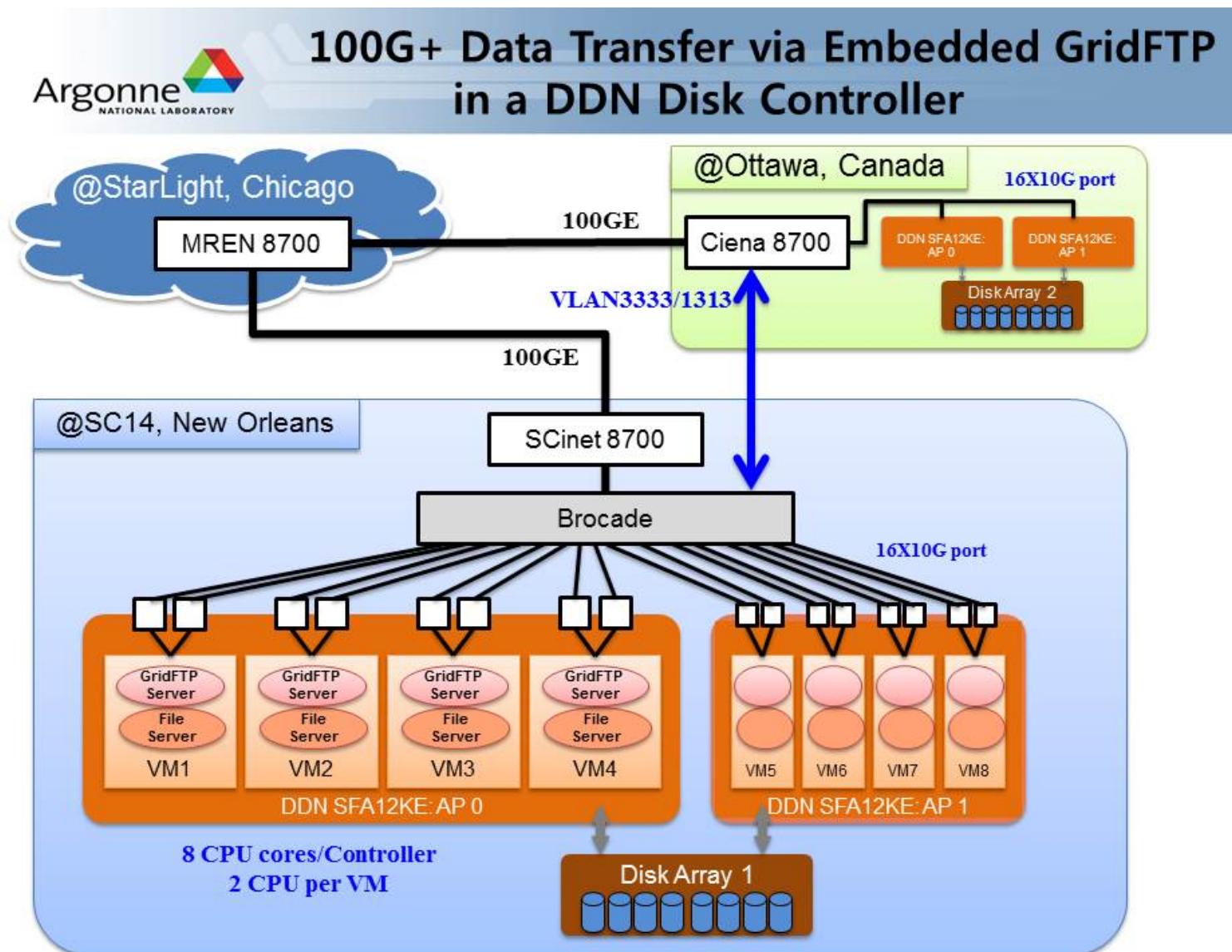
Encrypted uncompressed 4k video transport over 30,000 kms (2014)



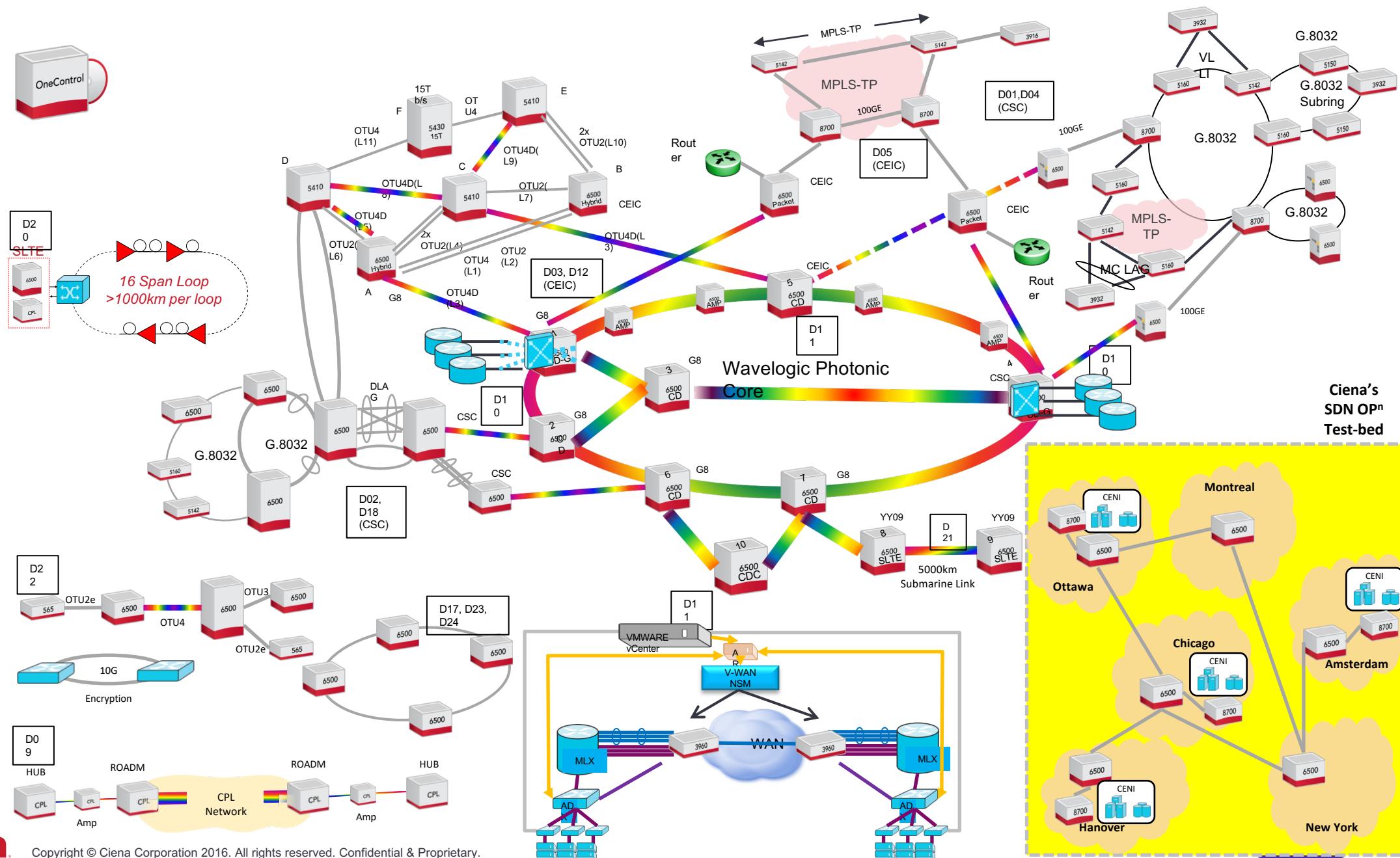
SC14 100G Iperf Performance Characterization over long distance



SC14 Hosted Experiment on the Research On Demand Network



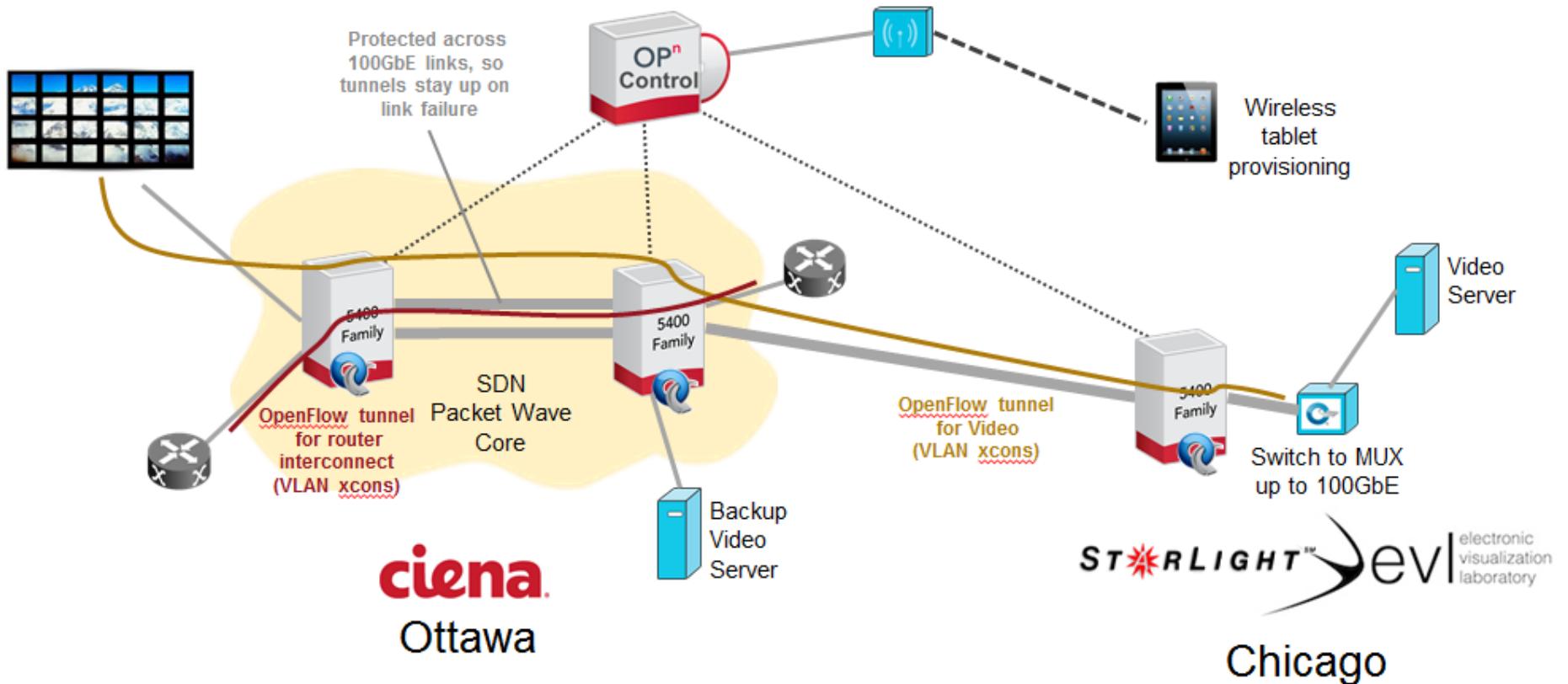
2014 Vectors Network Diagram



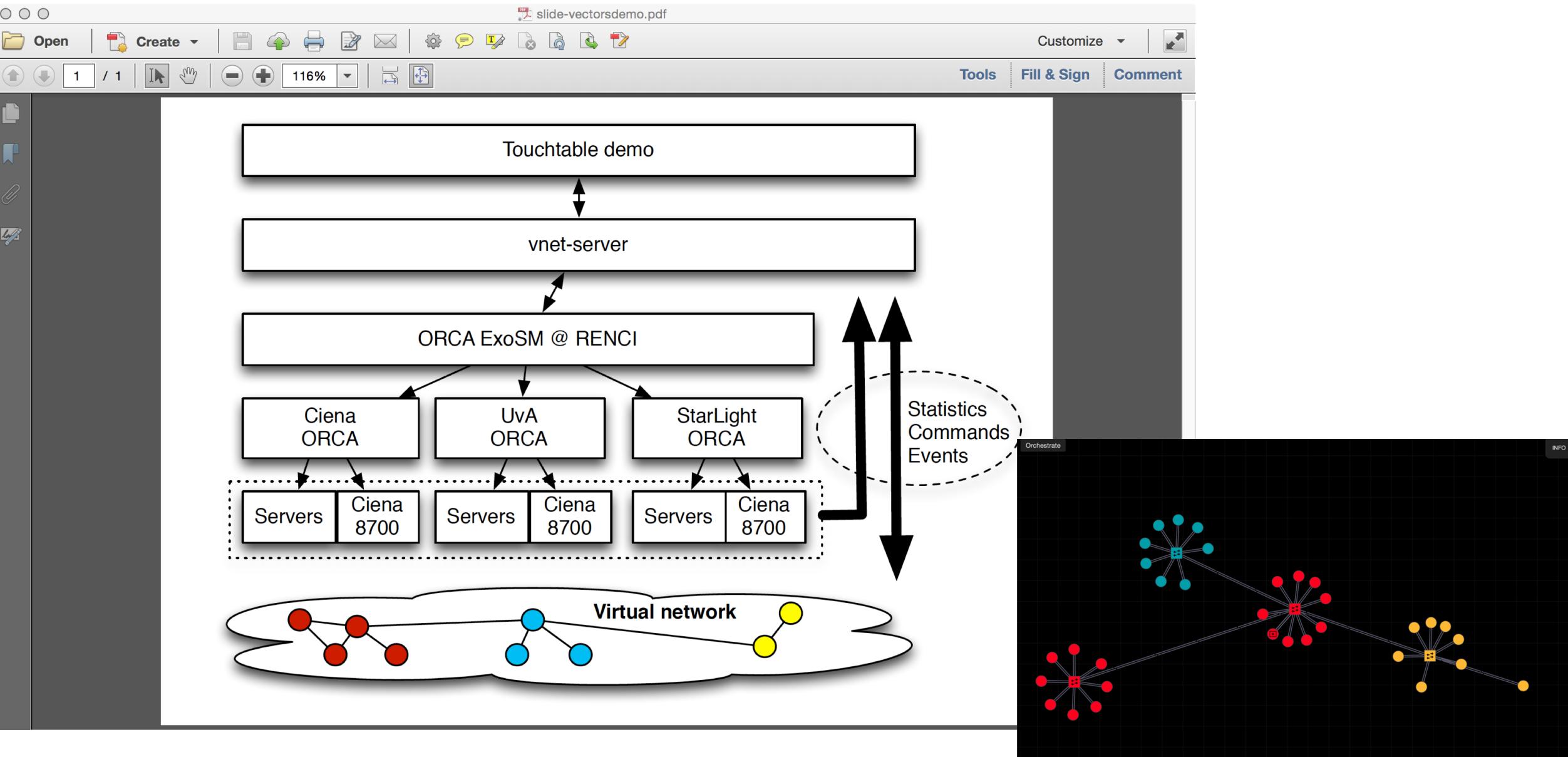


2015

2015 Ciena Vectors SDN demonstration support for OTN control plane

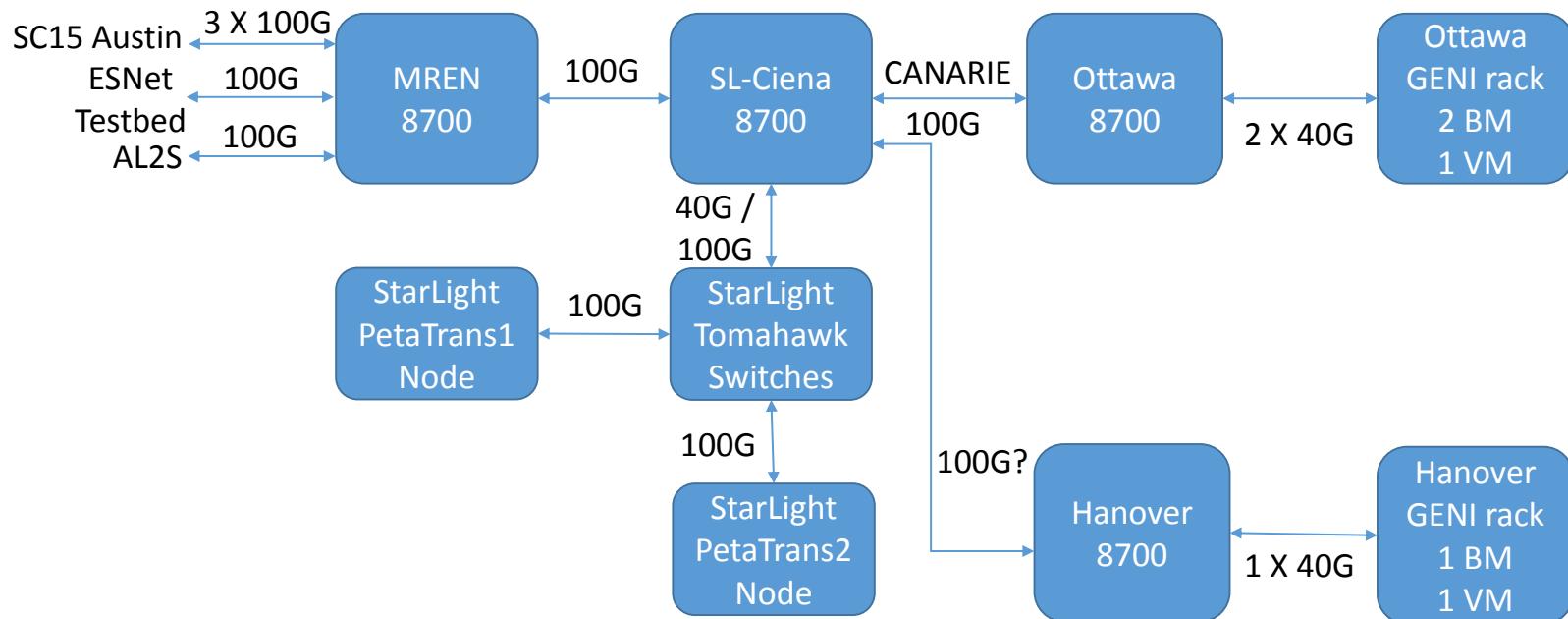


2015 SARNET First Phase

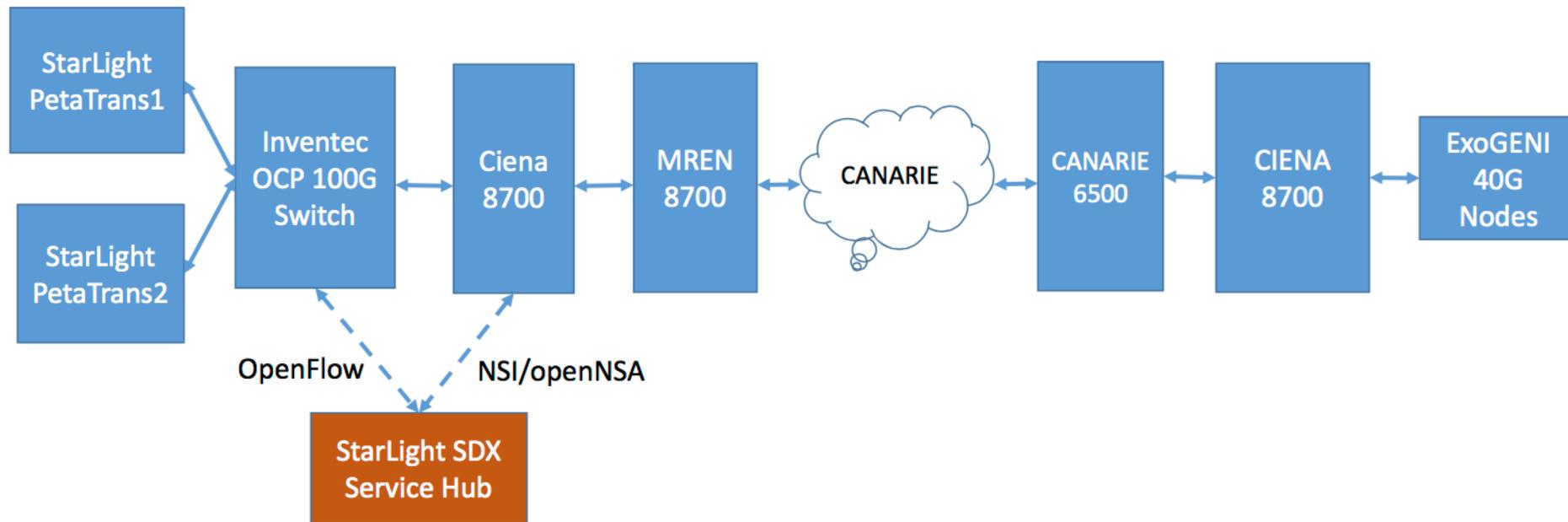


Multi-Tenant 100GE Science Network Exchange

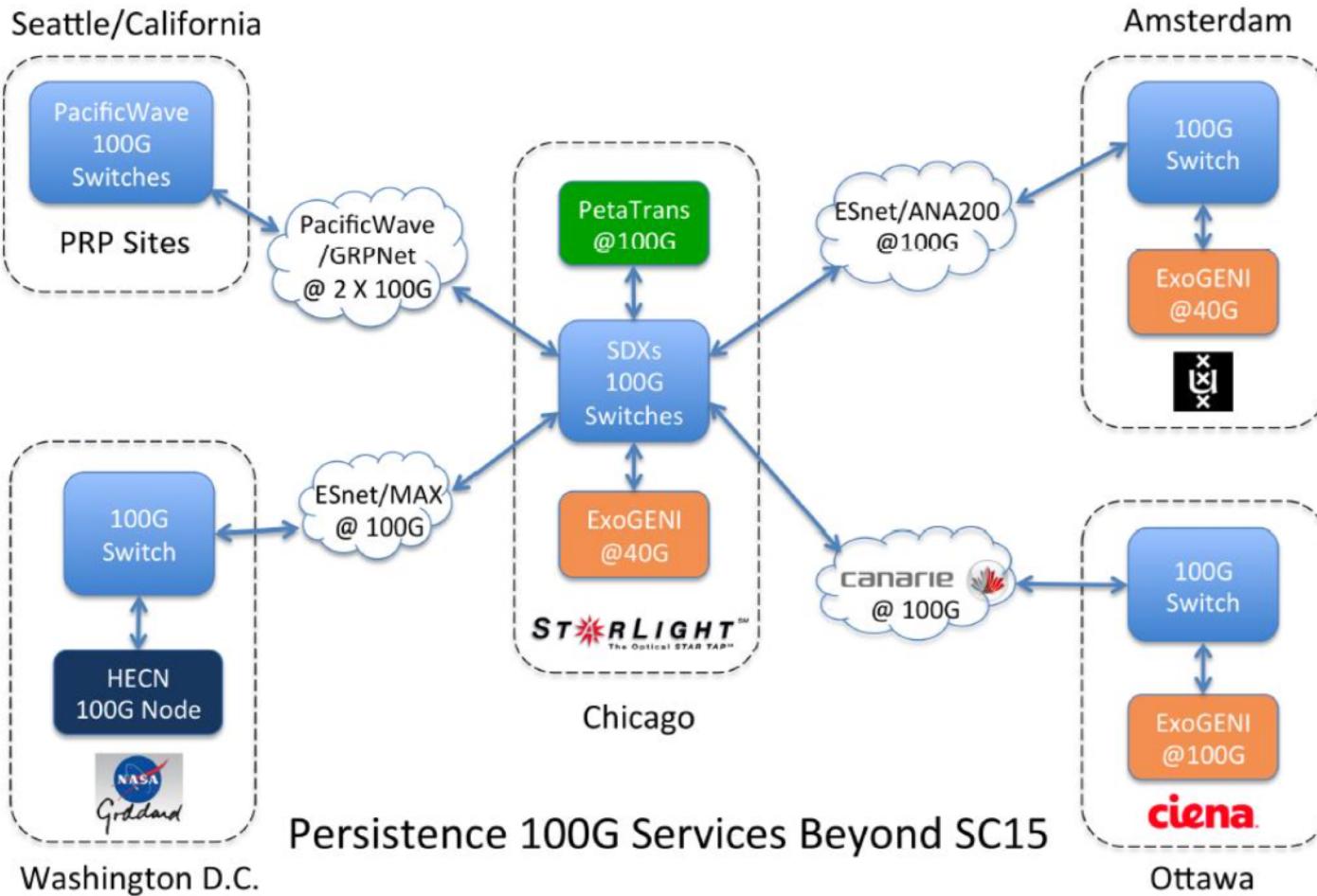
SC15 NRE Testing Phase(Sep/20 – Oct/20 2015)

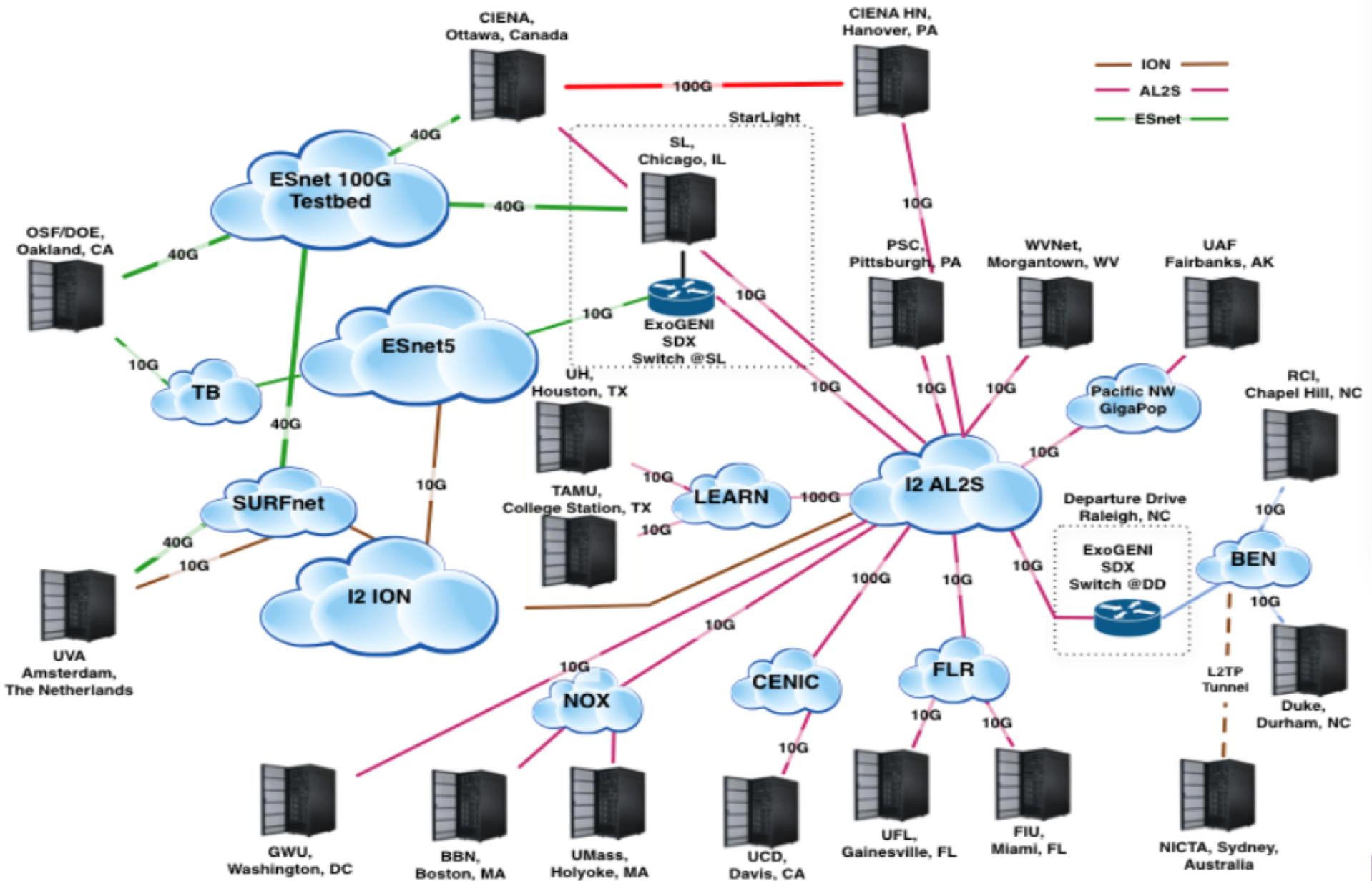


100GE End to End Services based on Open Architecture (E2SOA) for Peta Scale Sciences: Prototype Set Up



PetaTrans: Petascale Sciences Data Transfer

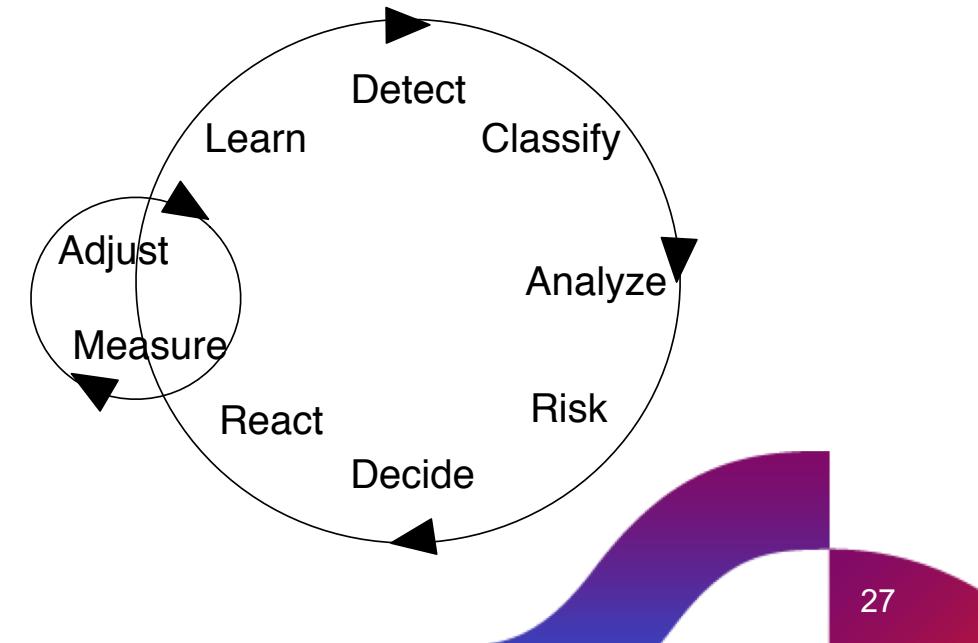
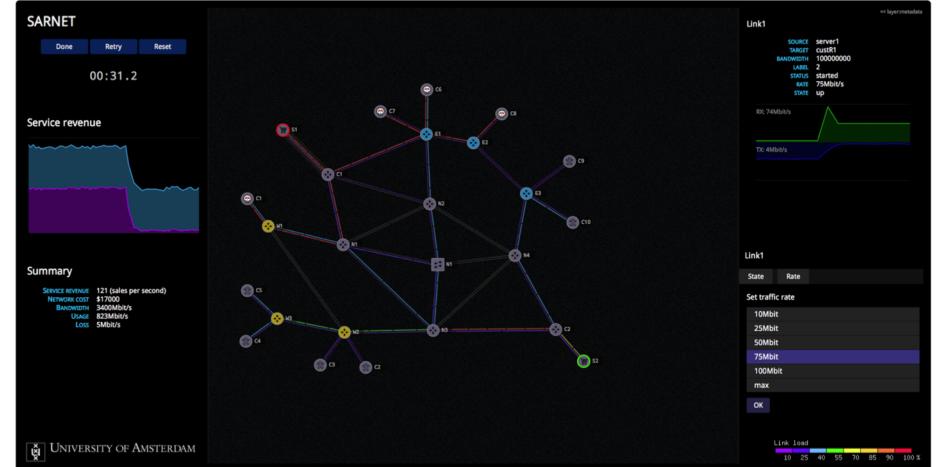




2015 uVA

Vectors 2015 Demo
SC15 Demo
2 posters
2 presentations at KLM
2nd Draft of SARNET paper

KLM security brainstorm session
Finish paper
Talk at OnVector*
Write short paper about SC15 demo
Scoping and defining research question
Demo next steps, Ciena vectors?



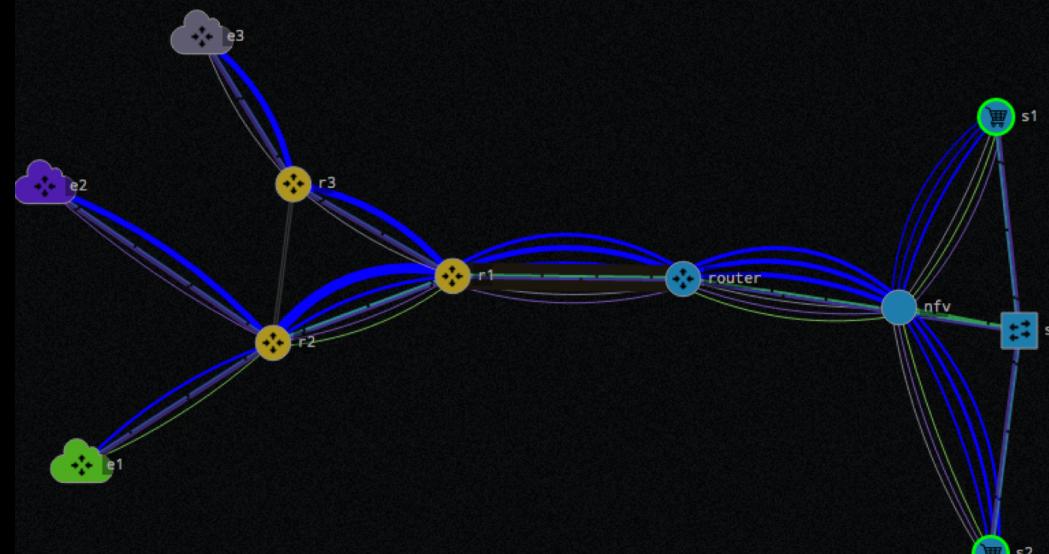


2016

Information

This area will contain textual information that helps the user with the demo.

View

[Show physical links](#)[Show traffic flows](#)

Node and Link information

Choose your attack

Start a Distributed Denial of Service attack from the upstream ISP networks:

[UDP DDoS](#)

Start a specific attack originating from one of the upstream ISP networks:

Origin: UNSELECTED

[CPU utilization](#)[Password attack](#)[Normal operation](#)**link.r1.core.as200.router.services.as100**

SOURCE	r1.core.as200
TARGET	router.services.as100
BANDWIDTH	100000000
IPV4	169.254.0.17/30,169.254.0.18/30
LABEL	8
STATUS	started
RATE	100Mbit/s
STATE	up

link.r1.core.as200.router.services.as100

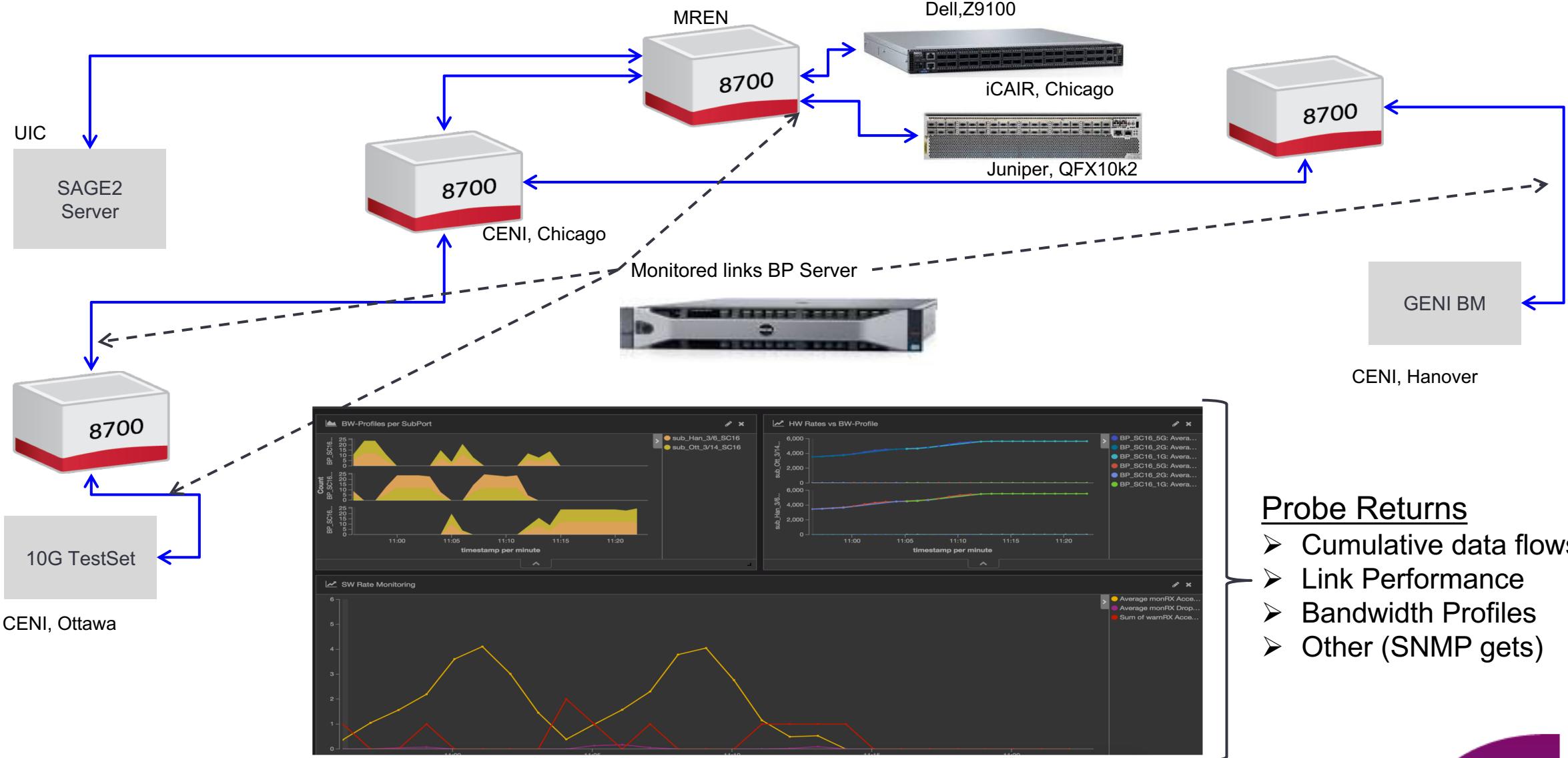
State	Rate	Filter
RX: 43Mbit/s		

RX: 43Mbit/s

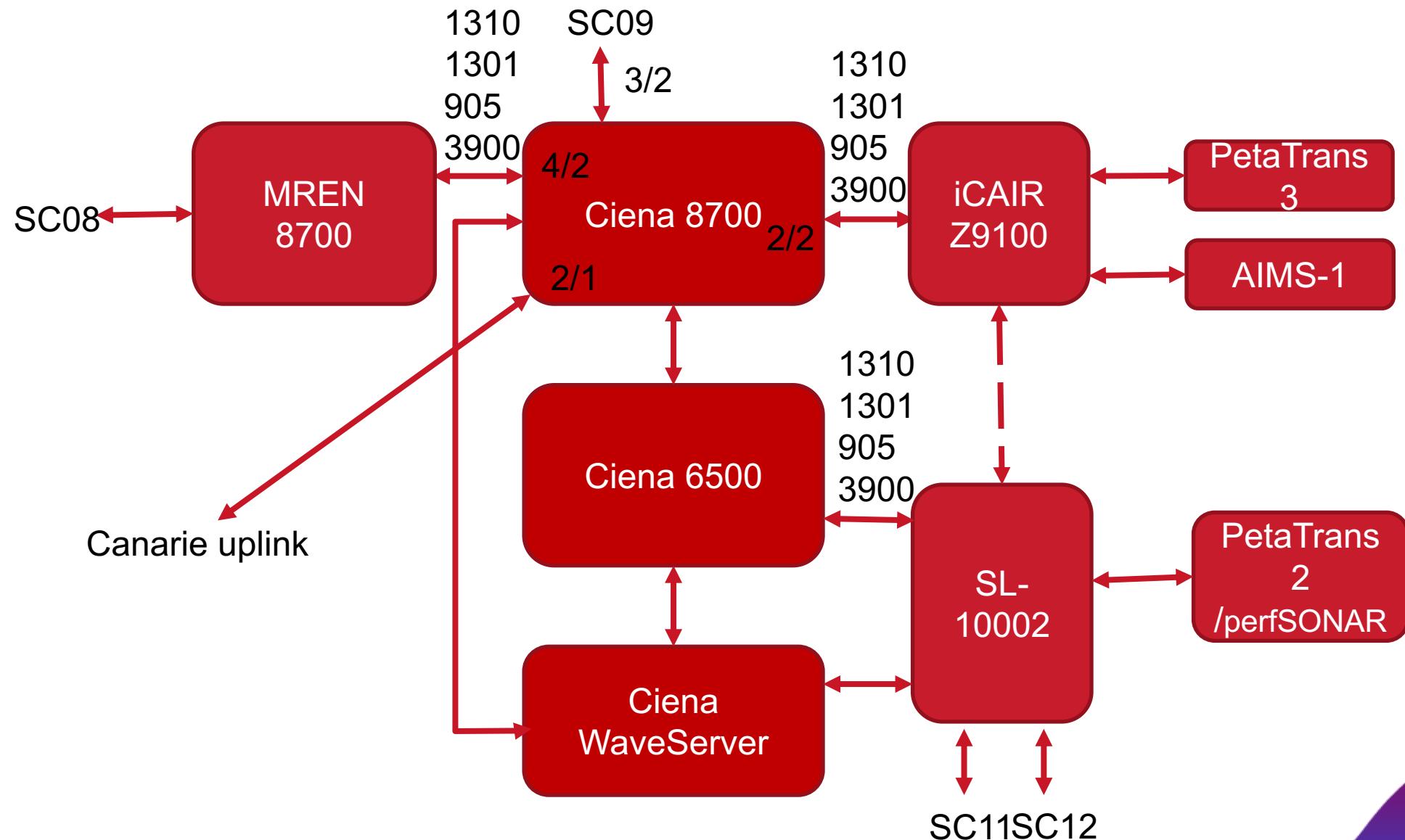
TX: 6Mbit/s

attack controls

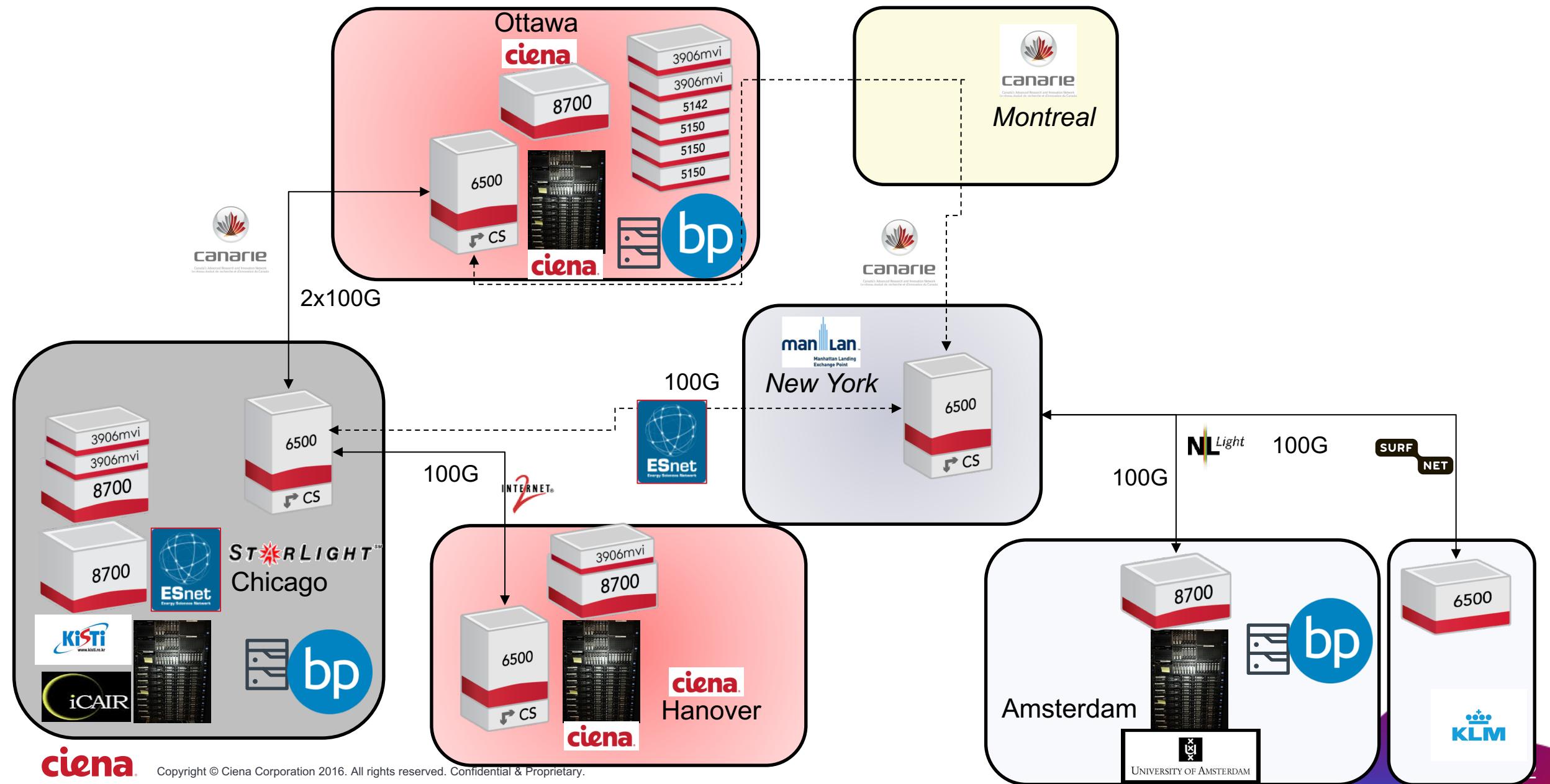
SC16 Network Diagram for Analytics Demonstration

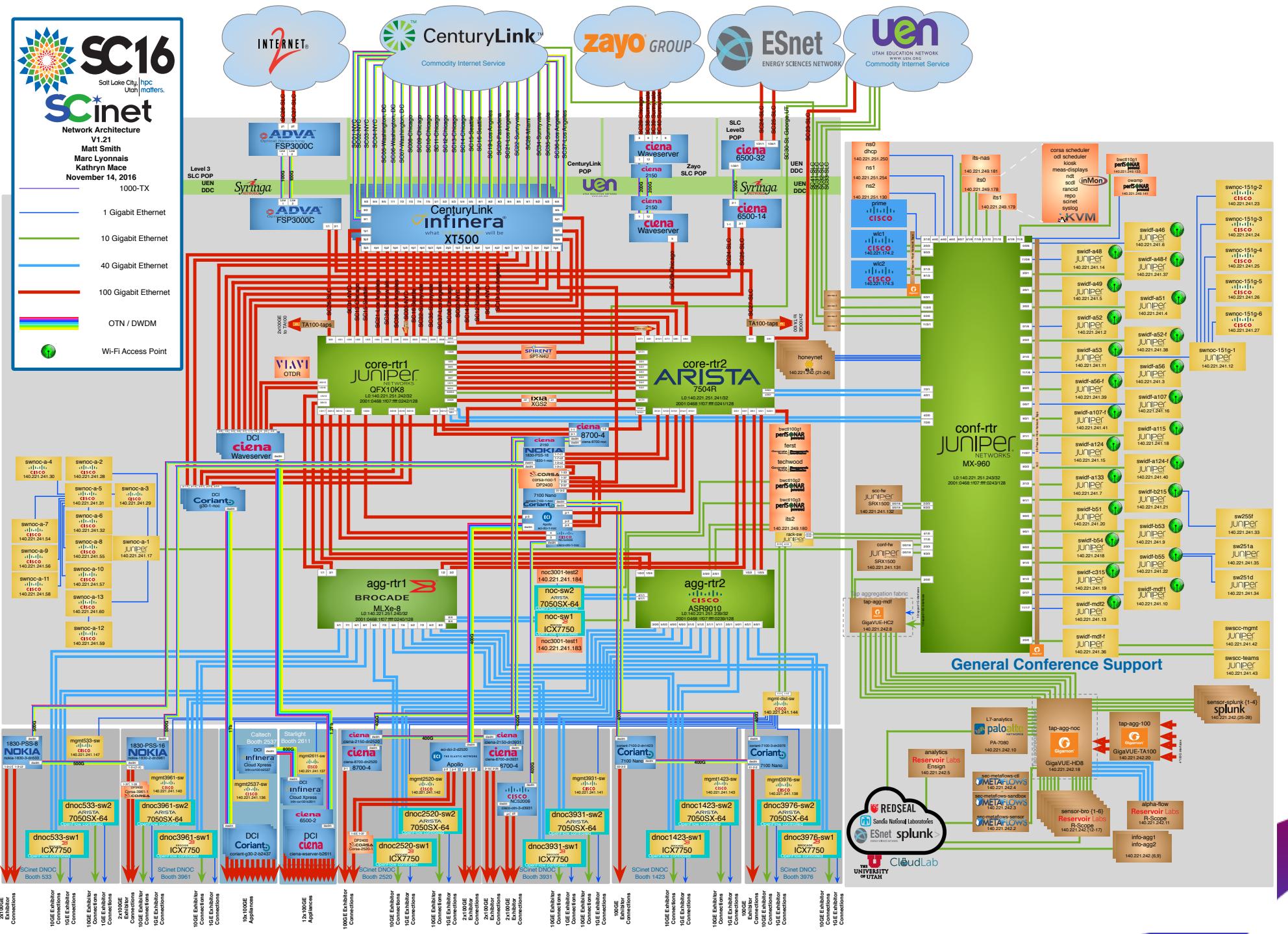
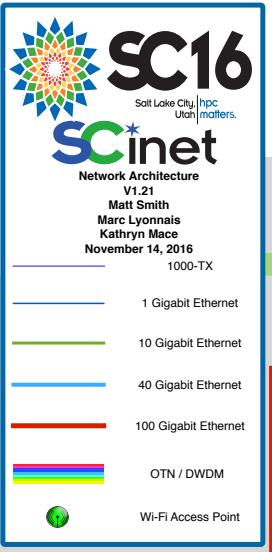


SC16 StarLight testbed local configuration



Next Gen Network Overlay with SDE Capability





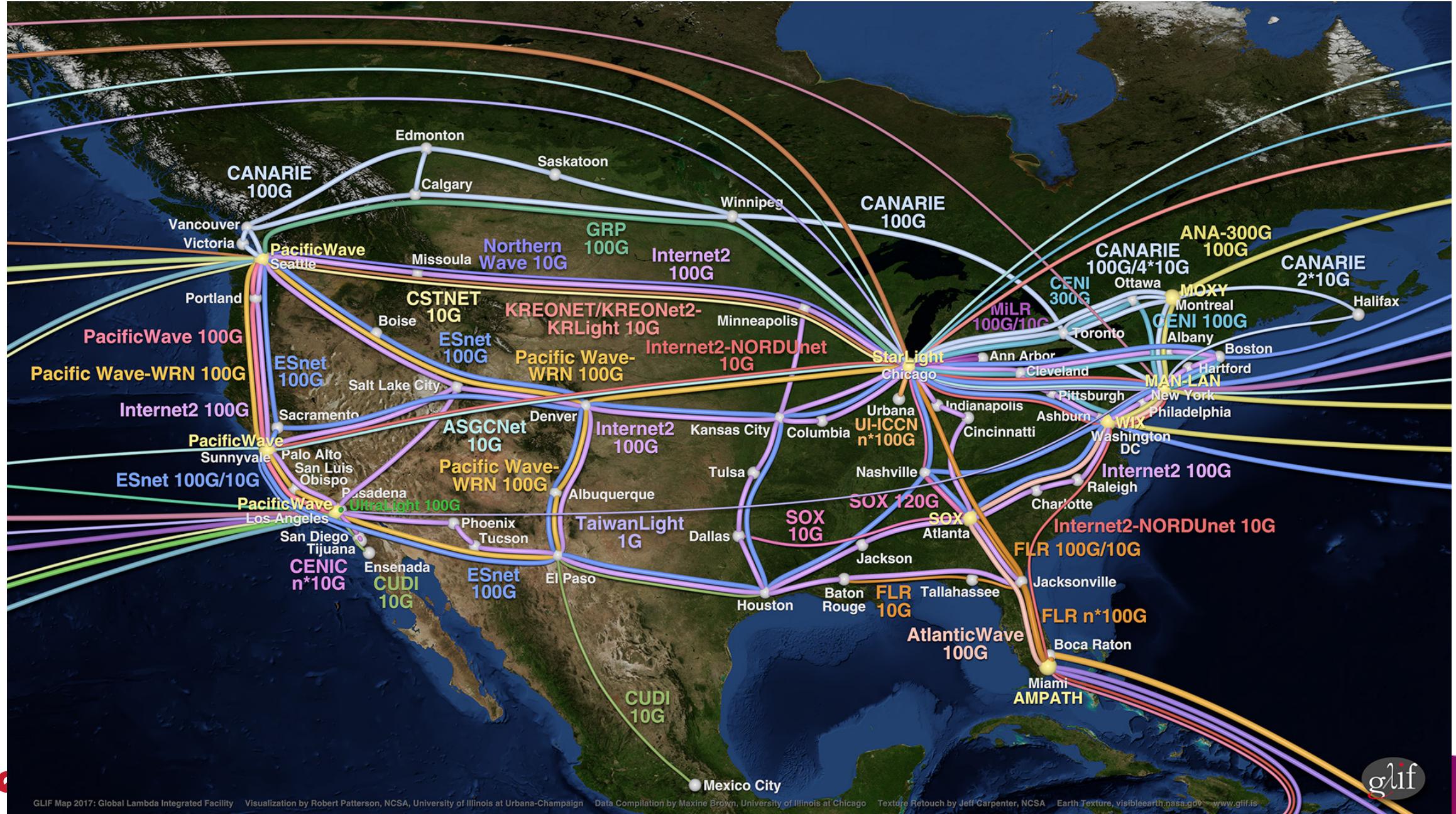


2017

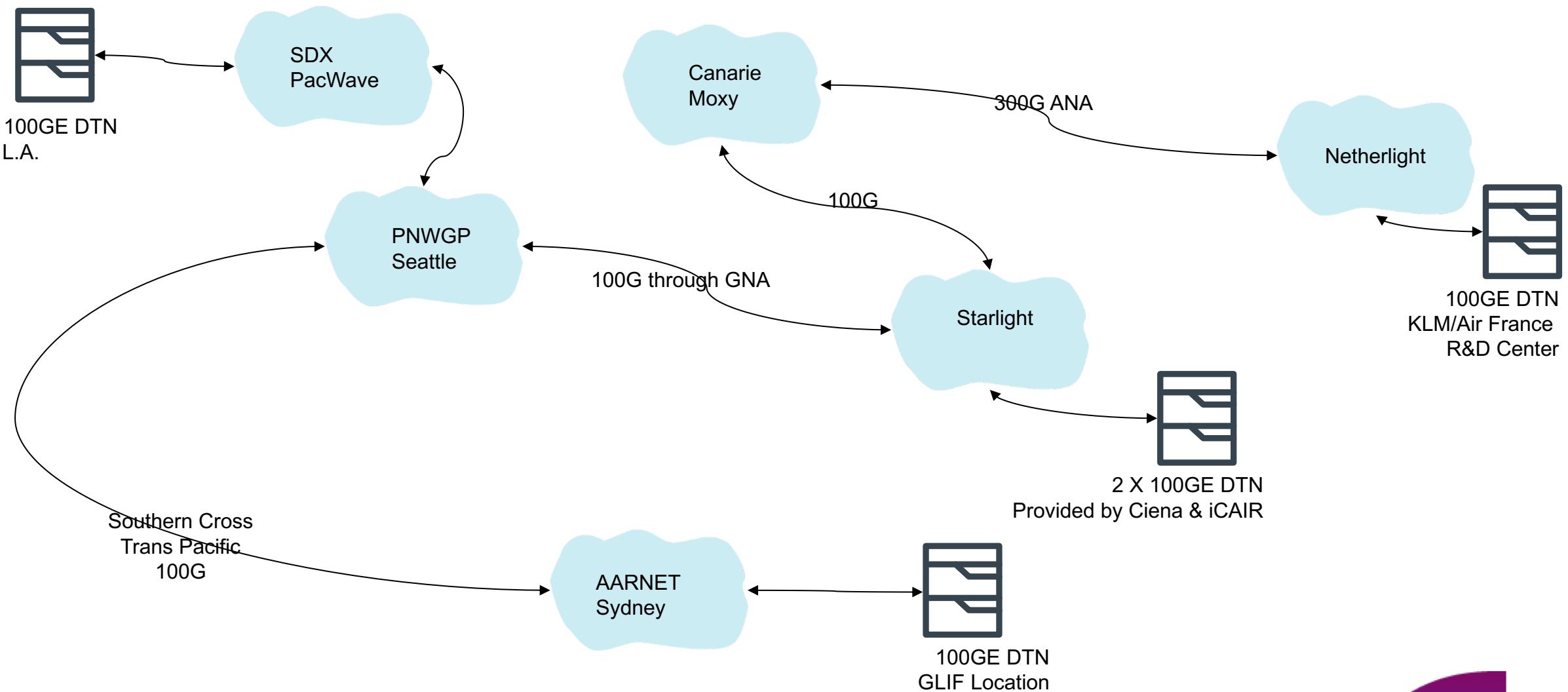
GLIF 2017 Demonstrations: International Multi-Domain SD-WAN Services

Will Black, Pieter de Boer, Jim Chen, Wei-Yu Chen, Buseung Cho, Leon Gommans, John Hess, Joseph Hill, Marc Lyonnais, Gerben van Malenstein, John Macauley, Joe Mambretti, Warrick Mitchell, Chris Myers, Dave Reese, Thomas Tam, J.P.Velders, Migiel de Vos, Kevin Wang, David Whittaker, David Wilde, Rod Wilson, Fei Yeh, Se-Young Yu

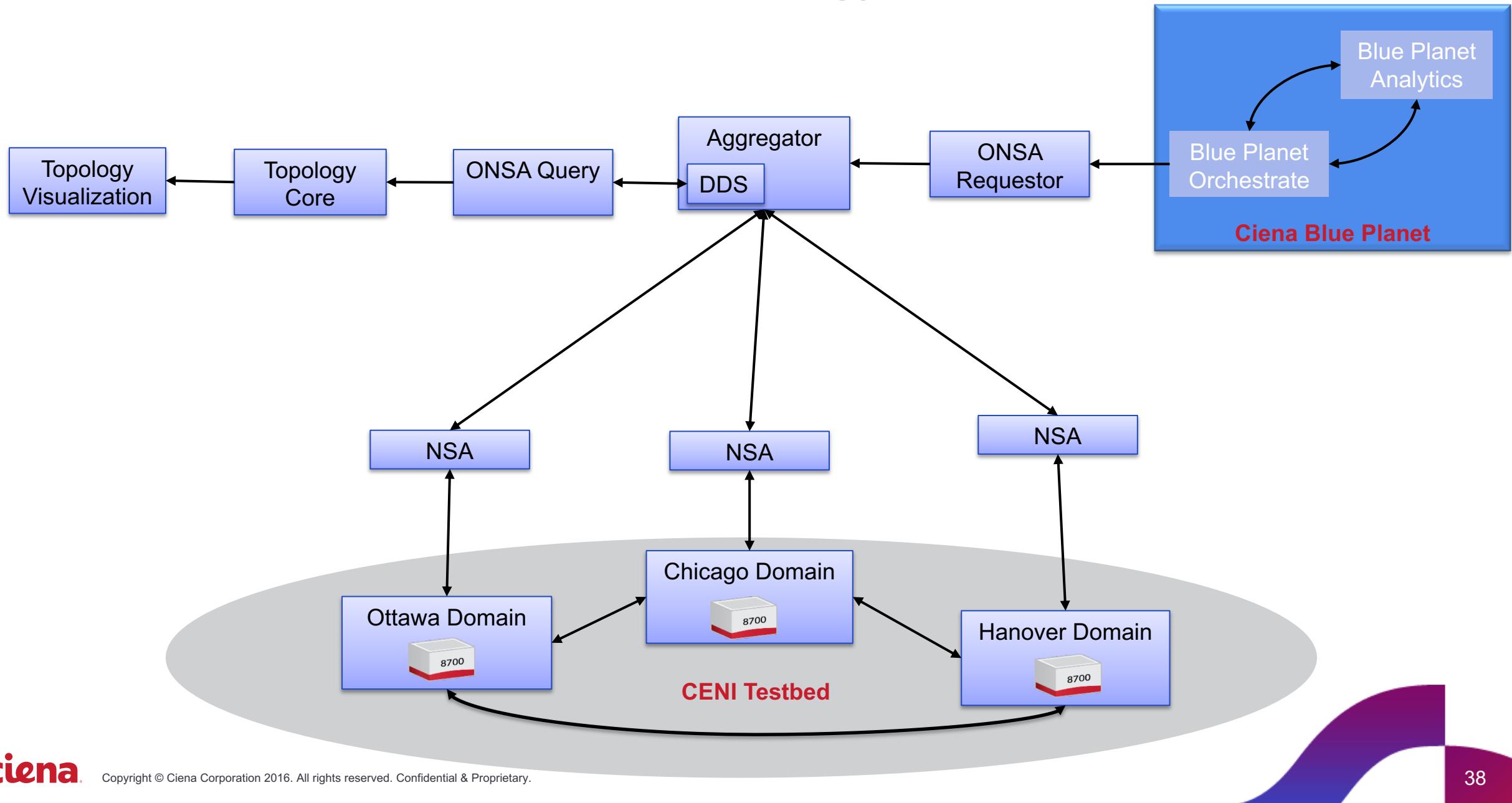
CENI in GLIF2017 map



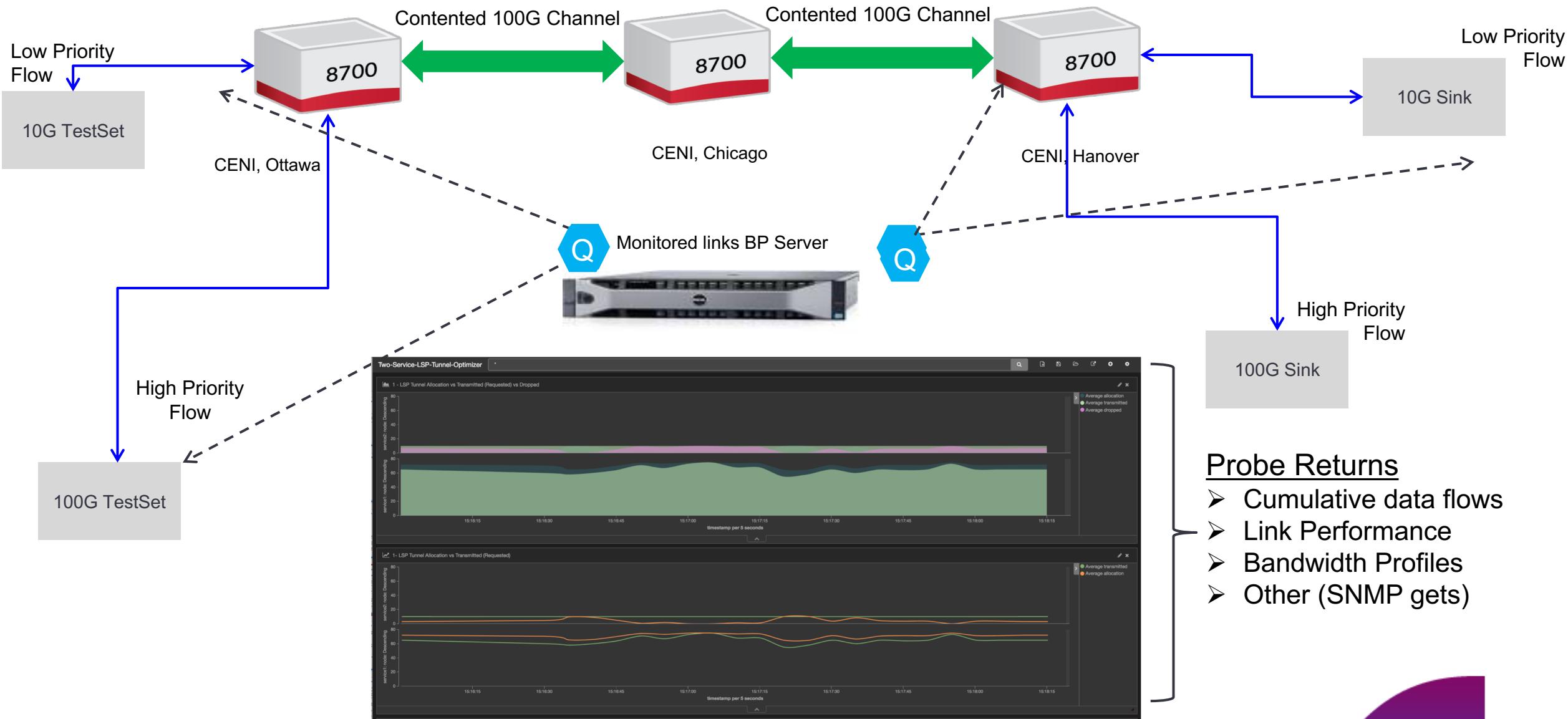
2017 GLIF DTN Experiment



2017 CENI - NSI Topology Architecture



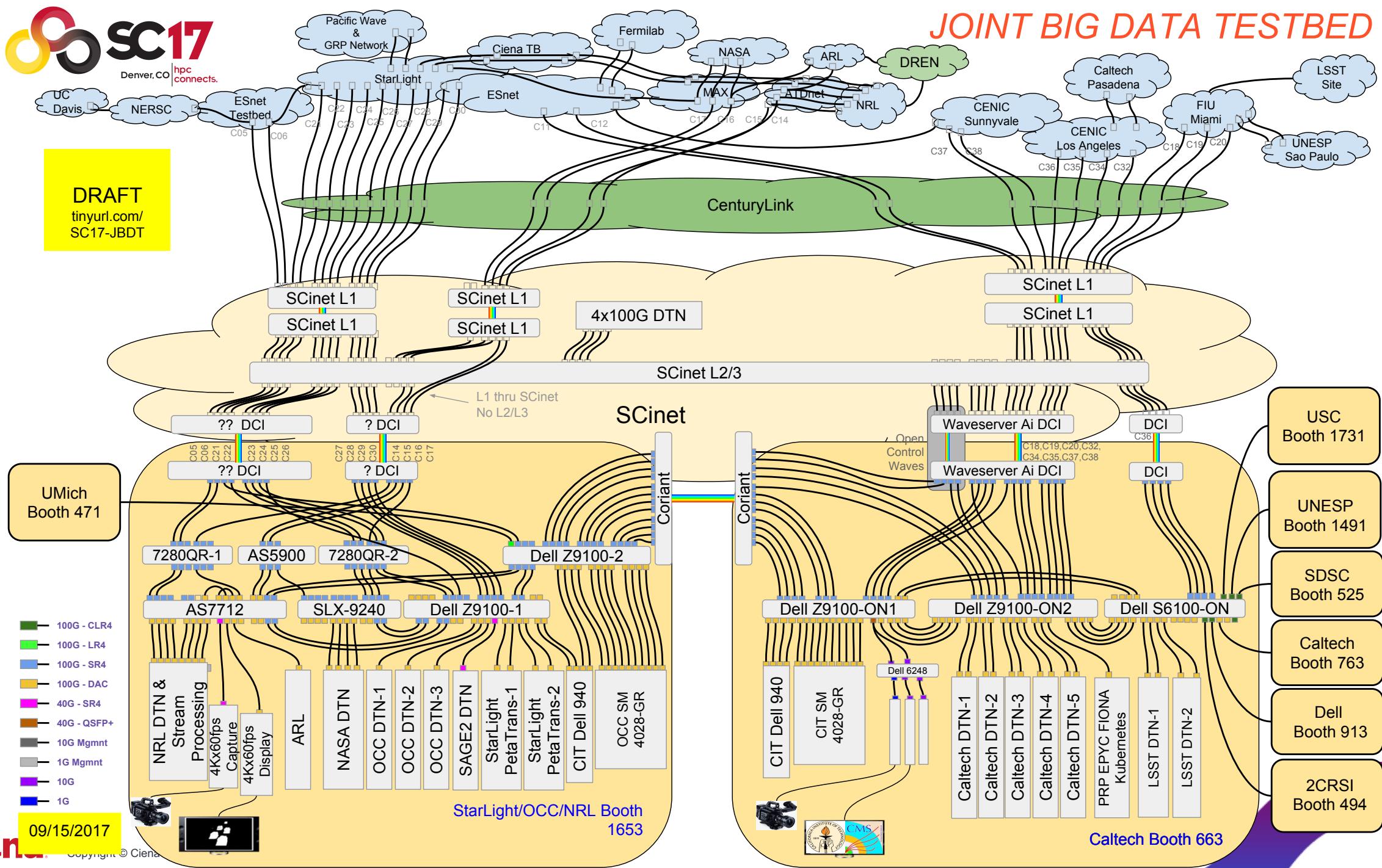
2017 Network Diagram for Analytics with Machine Learning Demonstration

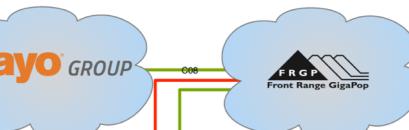
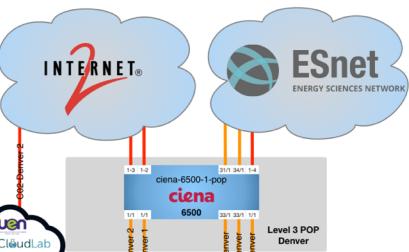
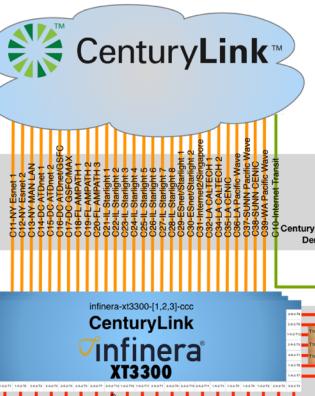
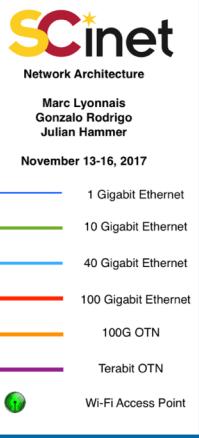




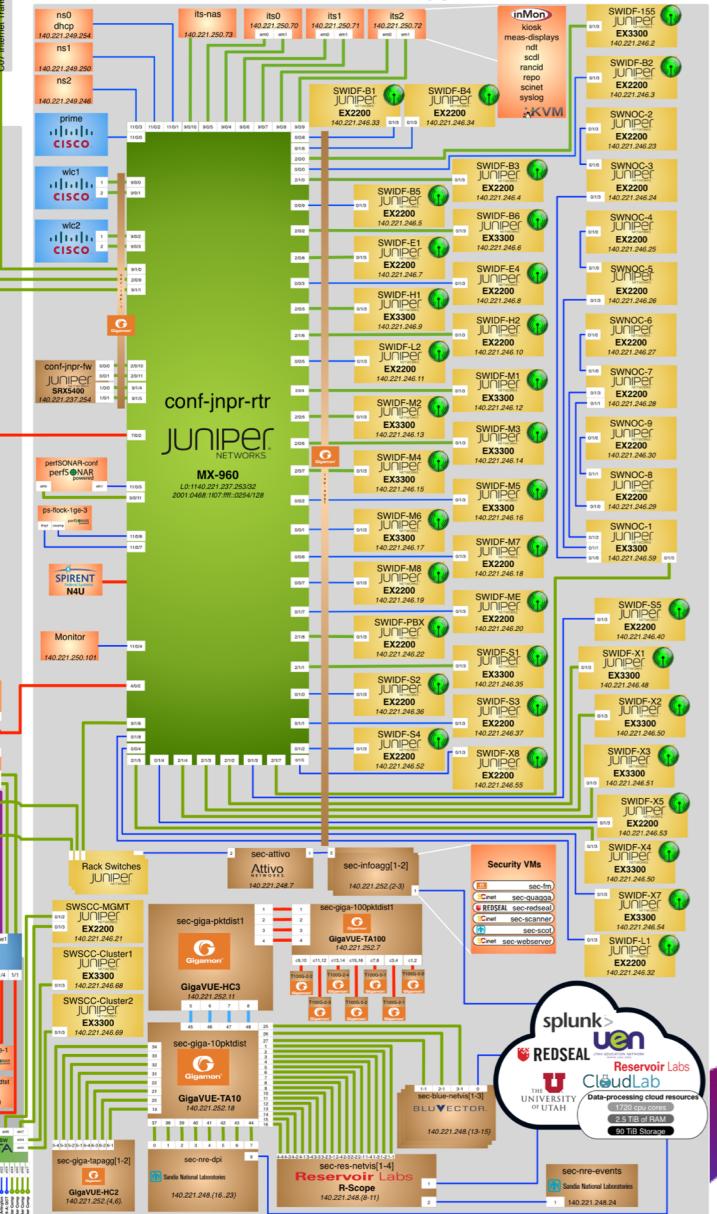
JOINT BIG DATA TESTBED

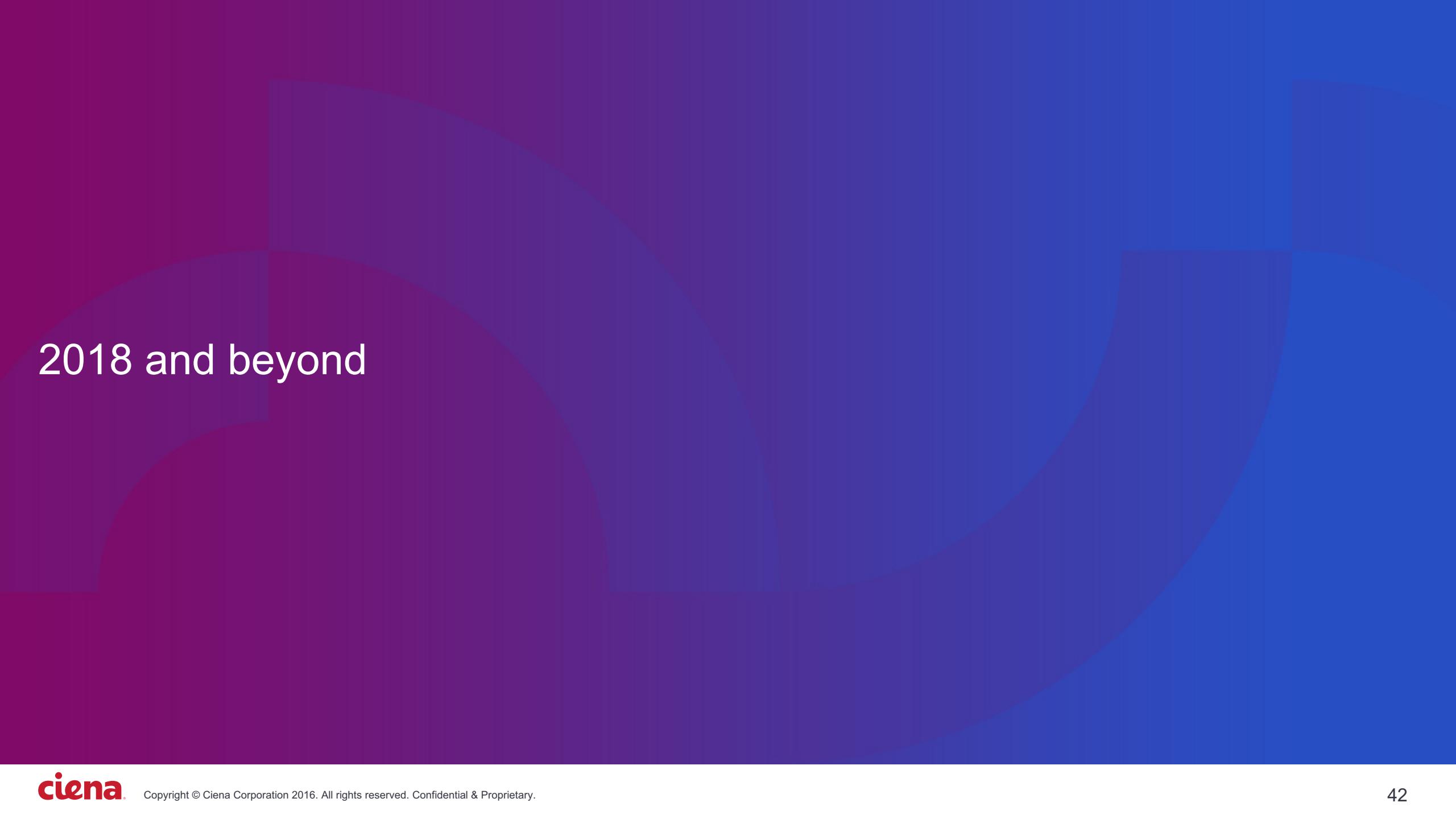
DRAFT
[tinyurl.com/
SC17-JBDT](http://tinyurl.com/SC17-JBDT)





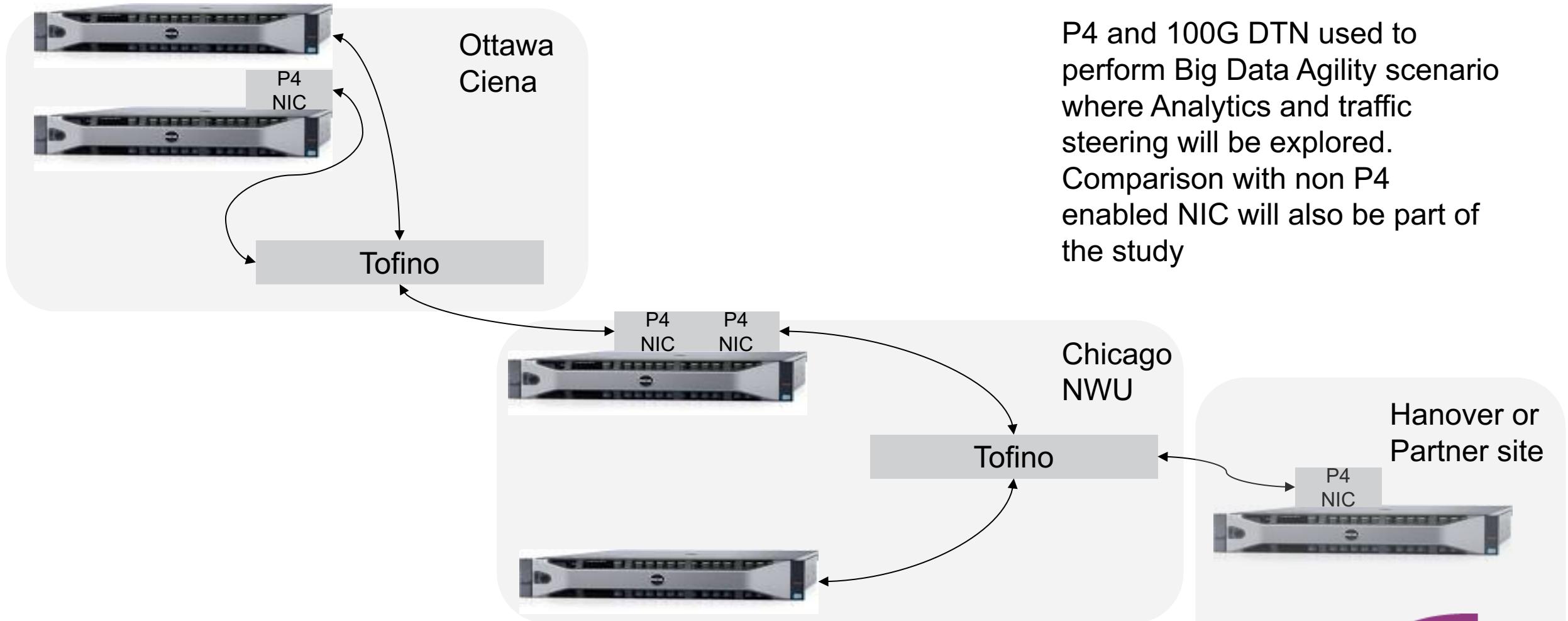
General Conference Support





2018 and beyond

100G+ Data Transfer Nodes Network Adaptability using P4 Language



External Research RoadMap

- **SARNET** 2014-2018
- **SDI** 2015-2019
- **DL4LD** 2017-2020
- **DTN w P4** 2018-2021
- **Agile Networking with ML Analytics** 2016-2019
- **Edge Networking with Max** 2017-2020
- **SMART CITY IoT** 2019-2022

Key Takeaway

Key Takeaways

- 1 We have started CENI in 2014
- 2 We have staged permanent experiments, test and proof of concept with Leading reaserchers
- 3 Ciena is learning by doing and collaborating with the best
- 4 We have a unique position in R&E
- 5 What we learn benefits Ciena in Business, R&D and expand our knowledge horizon of interest

Thank You

