

StarLight GOLE Update: Transitioning To Software Defined Services (SDS)/Software Defined Infrastructure (SDI)

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Global LambdaGrid Workshop

University of Sydney

Sydney, Australia

March 25-27, 2017



SD Network Research Topics

- **Transition From Legacy Networks To Networks That Take Full Advantage of IT Architecture and Technology**
- **Migration From “One-Size-Fits-All” Networks To Multi-Scale Individualized Networks**
- **Extremely Large Capacity (Multi-Tbps Streams)**
- **High Degrees of Communication Services Customization**
- **Highly Programmable Networks**
- **Network Facilities As Enabling Platforms for Any Type of Service**
- **Tenet Networks**
- **Network Virtualization**
- **Network Programming Languages (e.g., P4) API (e.g., Jupyter)**
- **Disaggregation**
- **Orchestrators**
- **Highly Distributed Processes**
- **Network Operations Automation**

IRNC: RXP: StarLight SDX A Software Defined Networking Exchange for Global Science Research and Education

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Co-Director, StarLight

**Jim Chen, Associate Director, International Center for Advanced Internet
Research, Northwestern University**

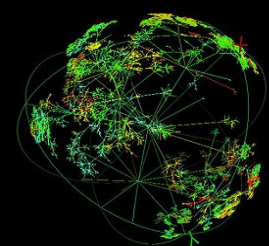
National Science Foundation

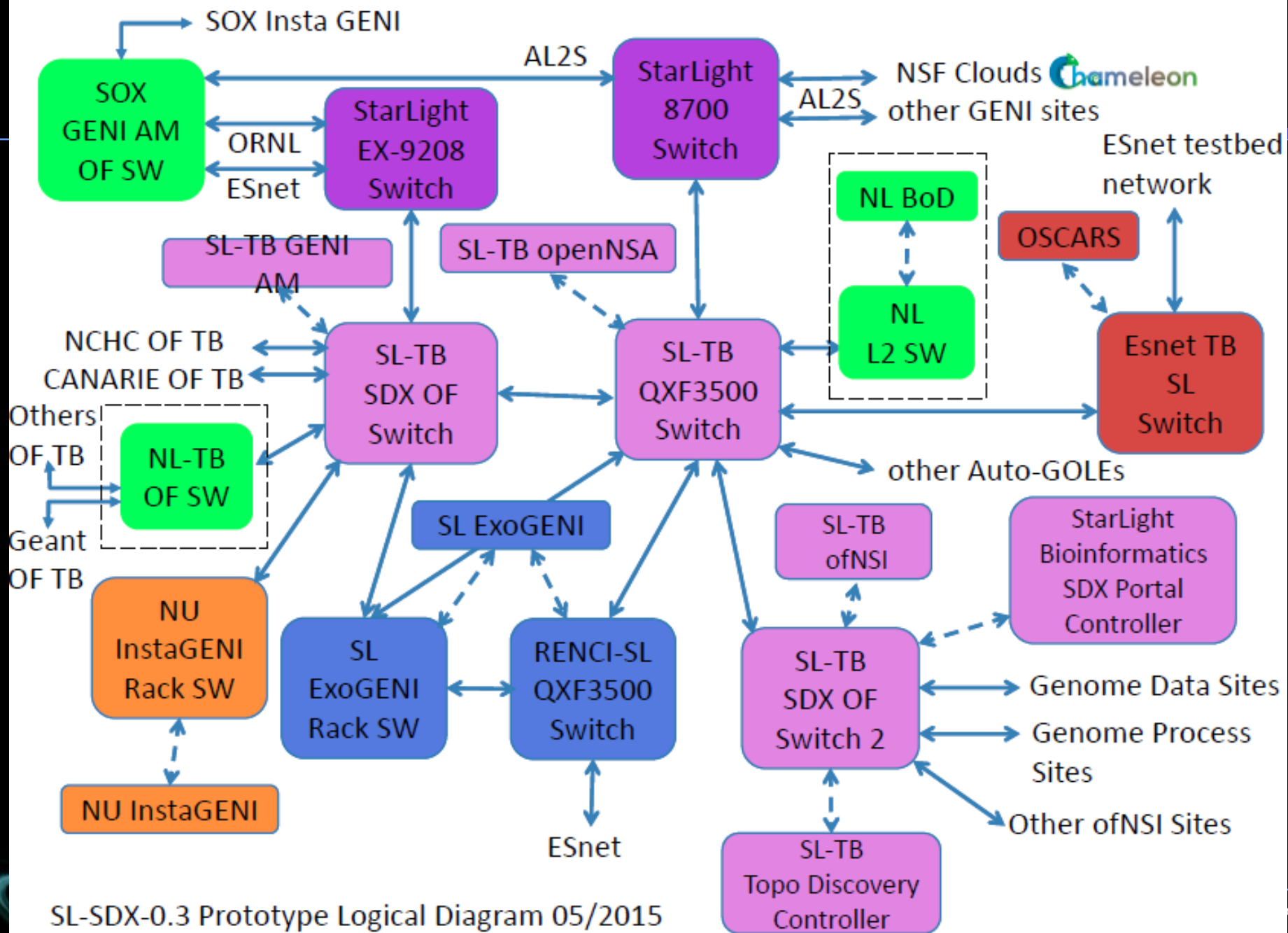
International Research Network Connections Program

Workshop

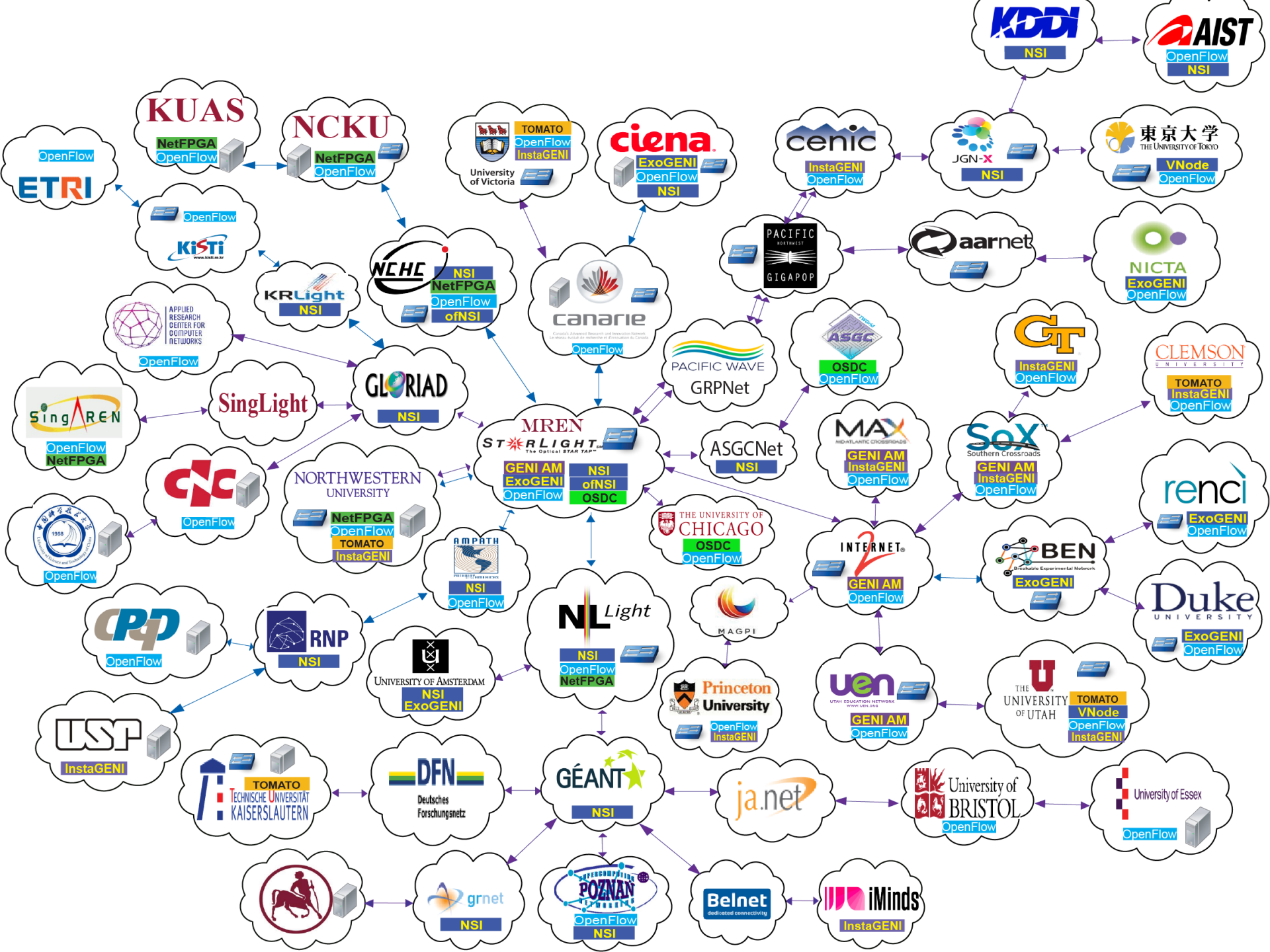
Chicago, Illinois

May 15, 2015





SL-SDX-0.3 Prototype Logical Diagram 05/2015



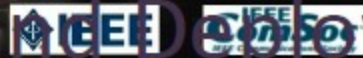
20th Innovations in Clouds, Internet and Networks

PARIS

March 7 - 9, 2017



Designing and Deploying A



Bioinformatics Software-Defined Network Exchange (SDX): Architecture, Services, Capabilities, and Foundation Technologies

Joe Mambretti, Jim Chen, Fei Yeh

International Center for Advanced Internet Research
Northwestern University

Robert Grossman, Piers Nash, Alison Heath, Renuka Arya, Stuti Agrawal,
Zhenyu Zhang

Center for Data Intensive Science
University of Chicago
Chicago, Illinois, USA

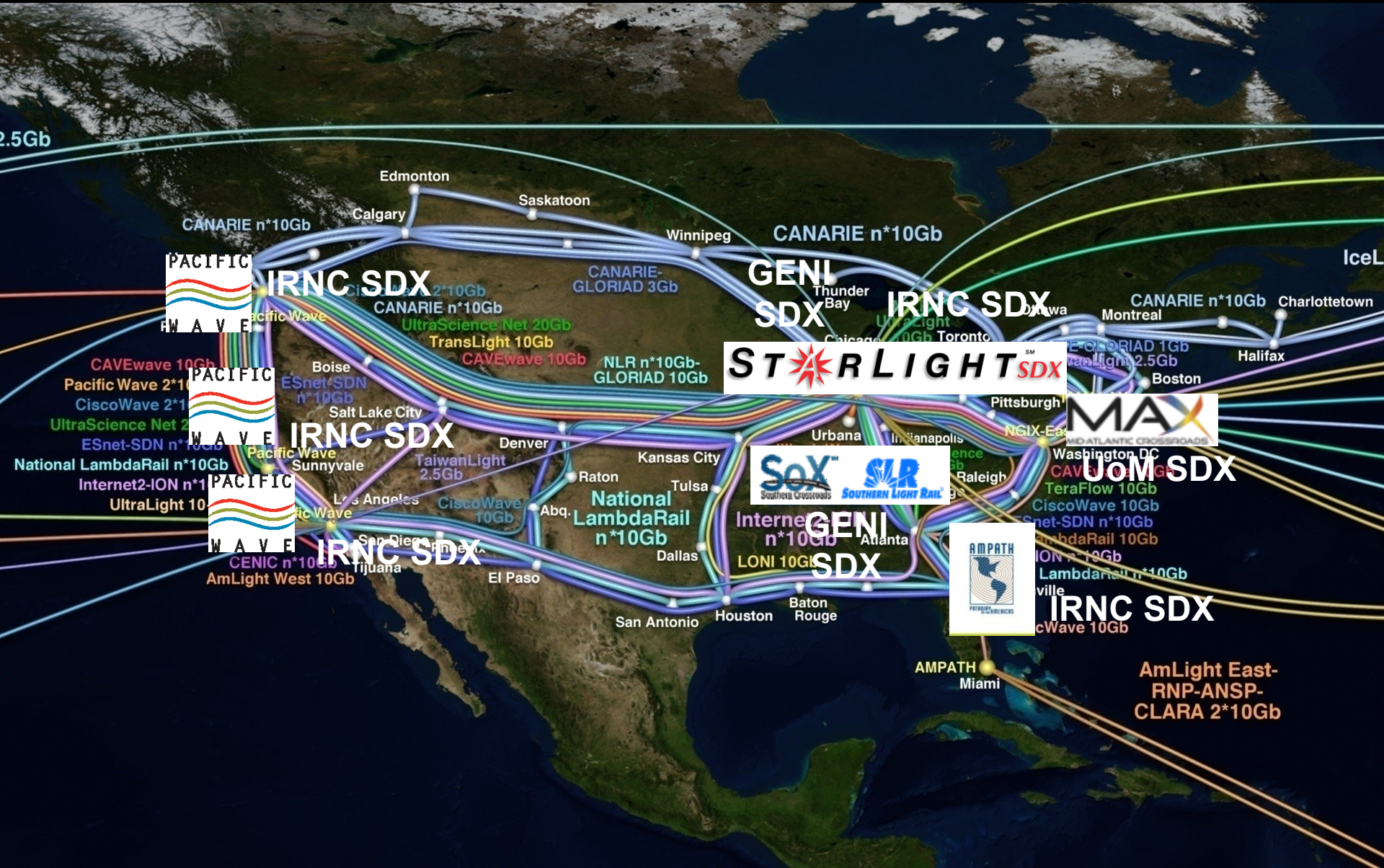


March 7-9, 2017

Network and Service IT-zation

STARLIGHTSM

Emerging US SDX Interoperable Fabric



Pacific Research Platform

Pacific Wave CalREN HPR
CENIC

**Will Be Contiguous To
the StarLight SDX**



- PRP Partners include:
- Univ. of Hawaii System
 - Montana State Univ.
 - Northwestern Univ.
 - NCAR
 - MREN
 - StarLight
 - UIC
 - Chameleon
 - UvA

Note: this diagram represents a subset of sites and connections. v1.12 – 20150521

Global Research Platform: Building On CENIC/Pacific Wave, GLIF and StarLight



Current International GRP Partners

Global Research Platform (GRP)

- **A Emerging International Fabric**
- **A Specialized Globally Distributed Environment/Platform For Science Discovery and Innovation**
- **Based On State-Of-the-Art-Clouds, Networks, Storage Systems, Data Repositories, etc**
- **Interconnected With Computational Grids, Supercomputing Centers, Specialized Instruments, et al**
- **Also, Based On World-Wide 100 Gbps (Soon 100 G+) Networks**
- **Leveraging Advanced Architectural Concepts, e.g., SDN/SDX/SDI – Science DMZs**
- **Ref: 1st Demonstrations @ SC15, Austin Texas November 2015**
- **Subsequent Demonstrations @ SC16 Salt Lake City Utah, November 2016, Global LambdaGrid Workshop 2016 and 2017,**
- **Planning for Major Demonstrations at SC17 in Denver, Colorado**



SC16 SDN-WAN Demonstration End-Points

Caltech, UM, Vanderbilt, UCSD, Dell, 2CRSI, KISTI, StarLight, PRP, FIU, RNP, UNESP, CERN



GENI Dynamic SD-WAN Provisioning, Including International Multi-Domain L2 Provisioning

**Ilya Baldin, Jeronimo Bezerra, Mert Cevik, Jim Chen,
Leandro Cuiffo, Russ Clark, Cas D'Angelo, Sean Donovan,
Heidi Picher Dempsey, John Hess, Tom Lehman, Lance Long,
John MacAuley, Joe Mambretti, Luisa Nevers, Jose Rezene,
Ali Sydney, Xi Yang, Fei Yeh, Matt Zekauskas**

GENI Engineering Conference 25 (GEC 25)

March 14, 2017

Miami, Florida

www.geni.net

Global LambdaGrid Workshop 2017 Demonstrations, Sydney Australia:

International Multi-Domain Provisioning Using AutoGOLE Based
Network Service Interface (NSI 2.0)

Using RNP MEICAN Tools for NSI Provisioning

Large Scale Airline Data Transport Over SD-WANs

Using NSI and DTNs

Large Scale Airline Data Transport Over SD-WANs

Using NSI and DTNs

SDX Interdomain Interoperability At L3

Transferring Large Files E2E Across WANs Enabled By SD-WANs
and SDXs

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**

Dashboard

Reservations

Create
Status
History
Authorization
Configuration

Workflows

Create
Status

Topologies

Domains
Providers
Networks
Devices
Ports
Viewer
Synchronizer
Changes

Automated Tests

Create
Status

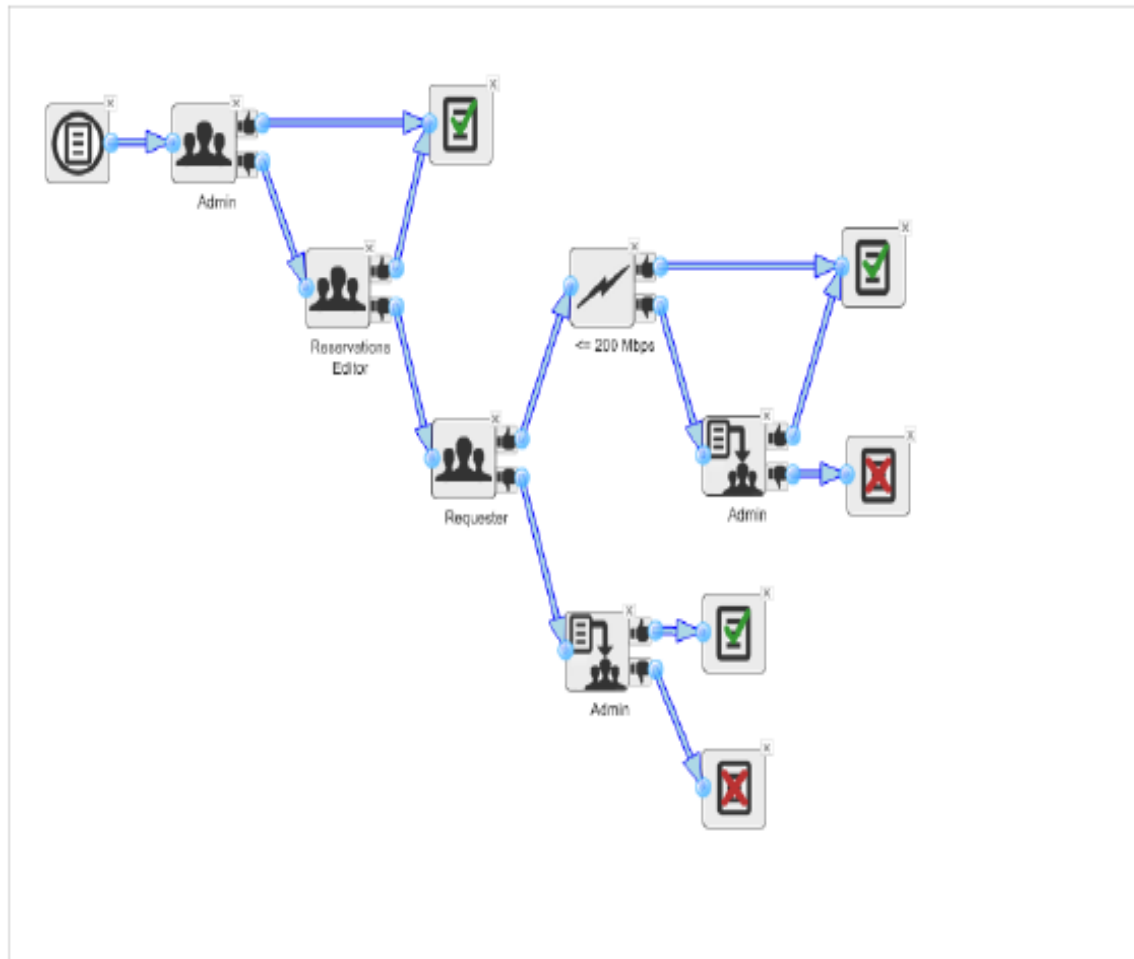
Users

Users
Groups
Configuration

External Access

Console Central
Monitoring
Weathermap

Owner Domain: cipo.rnp.br

Workflow Name: 

Drag and drop these elements

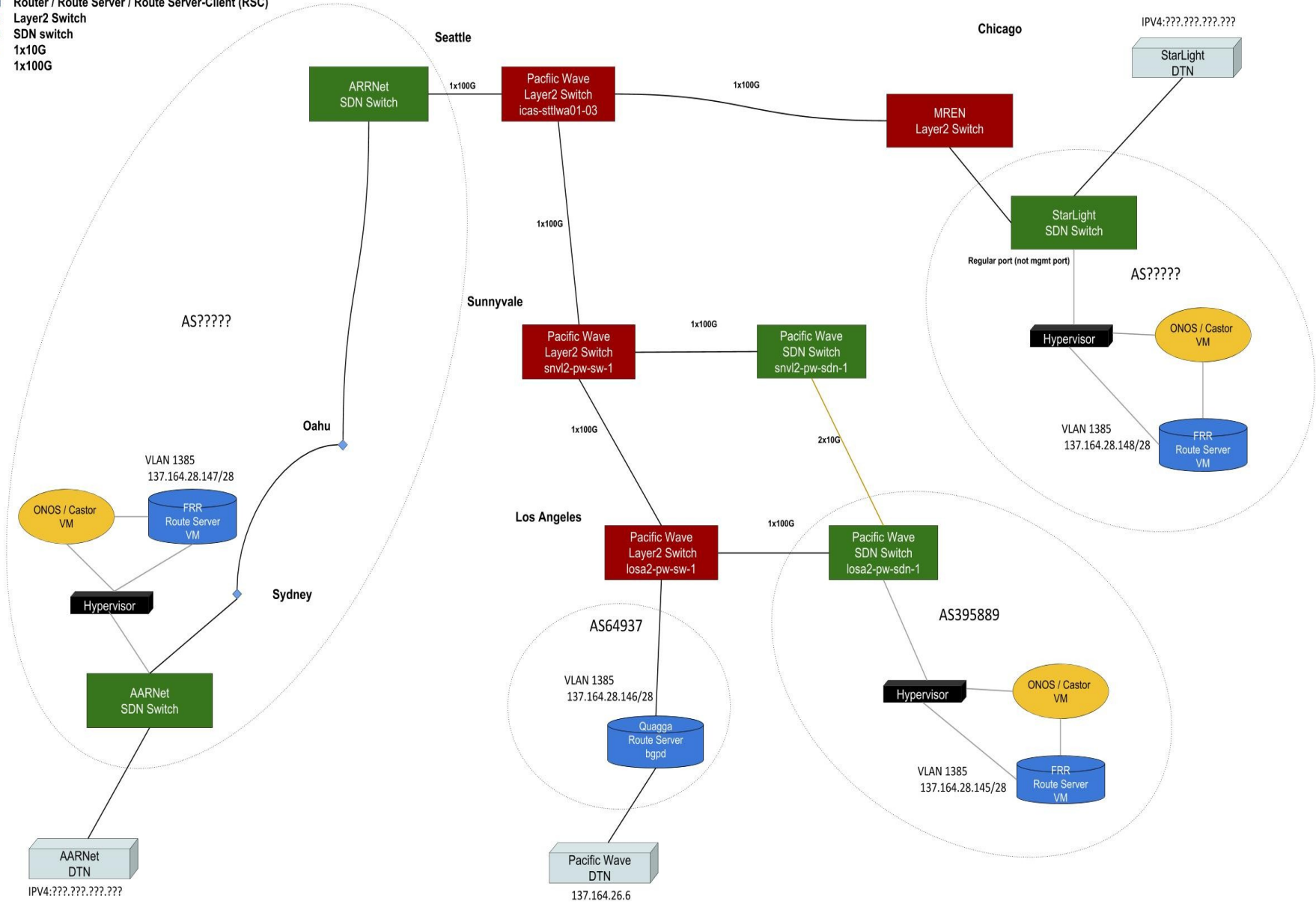
- Arriving a New Request
- Filter by Domain
- Filter by Requesting User
- Filter by Group
- Filter by Device
- Filter by Requested Bandwidth
- Filter by Duration
- Request Authorization to User
- Request Authorization to Group
- Authorization Accepted
- Authorization Denied

Save

Cancel

AARNet - Pacific Wave - Starlight Inter-domain SDX Topology v0.4

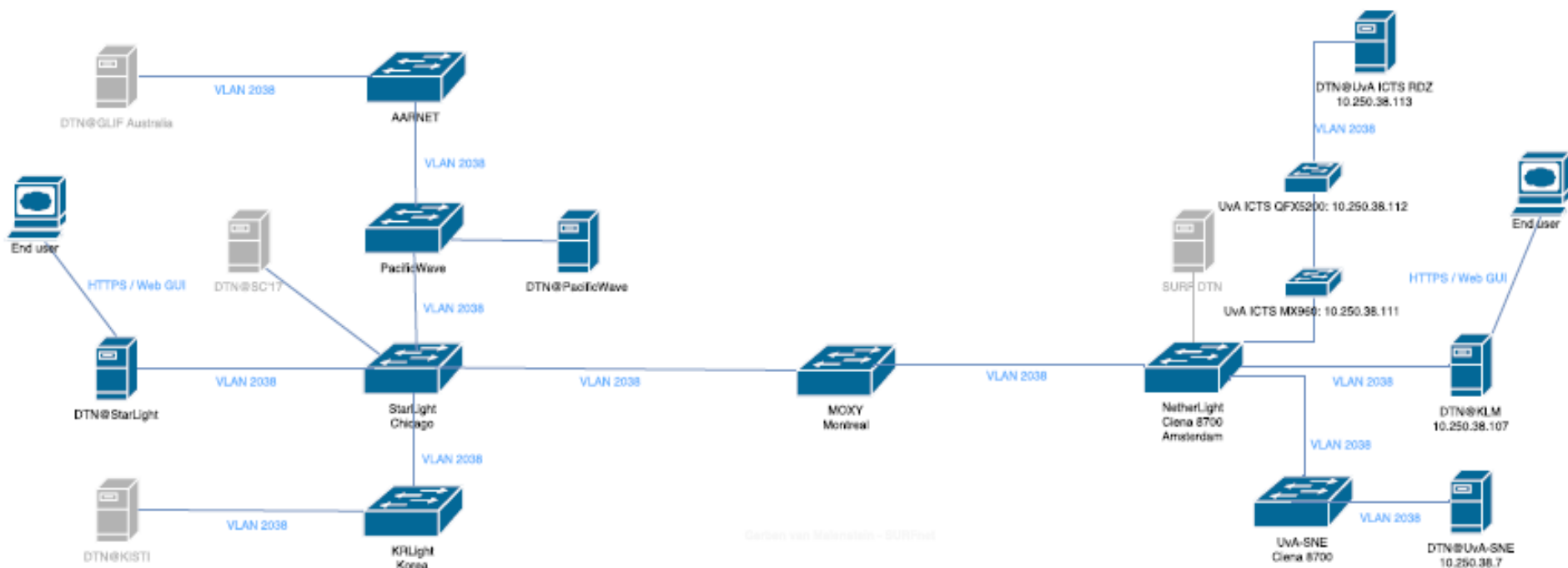
- Router / Route Server / Route Server-Client (RSC)
- Layer2 Switch
- SDN switch
- 1x10G
- 1x100G



NOTE: this diagram represents a subset of sites, devices, and connections

Transferring LargeScale Airline Data E2E Across WANs Using DTNs

v5, 21 SEP 2017



Carsten von Malenstein - SURFPost

Ingredients

- Using Globus Toolkit (NOT Globus Online)
- Has GridFTP under the hood
- Under Globus license (must be evaluated)
- 40Gbit/s data transfer expected
- VLAN 2038, multipoint/extending
- Including authentication/authorization framework, e.g. SURFconext

Minimal setup

- Data transfer between DTN@Uva to DTN@StarLight at 40G
- Compare this to IPv4 performance Chicago-Amsterdam

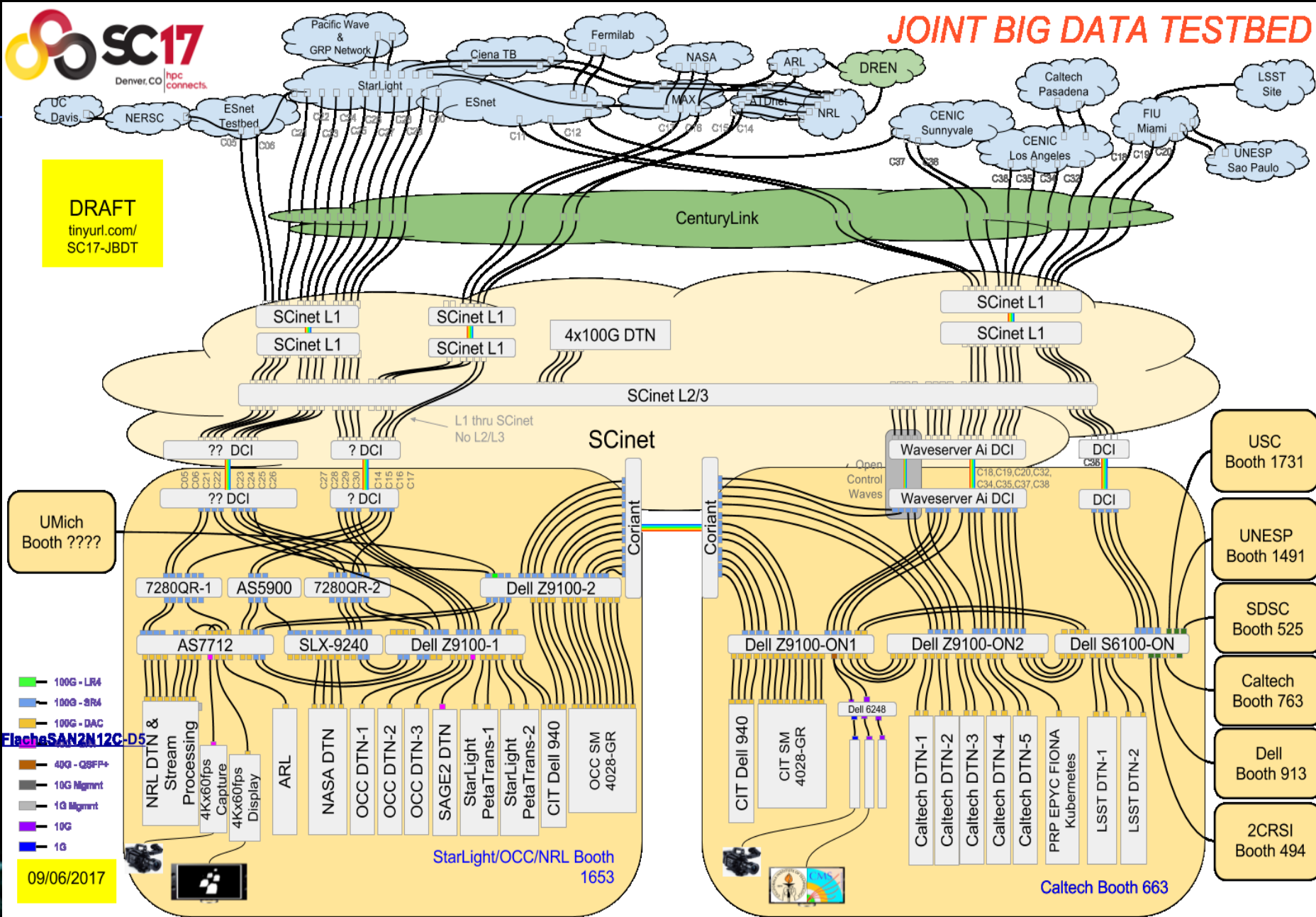
Additional features

- Single Sign-On
- Comparison to IPv6
- Auto-deletion of file when transfer completed
- >40Gbps data transfer
- Expanding sites for GLIF and/or SC

Ideas

- Dutch Research LAN Project

DRAFT
tinyurl.com/
SC17-JBdT

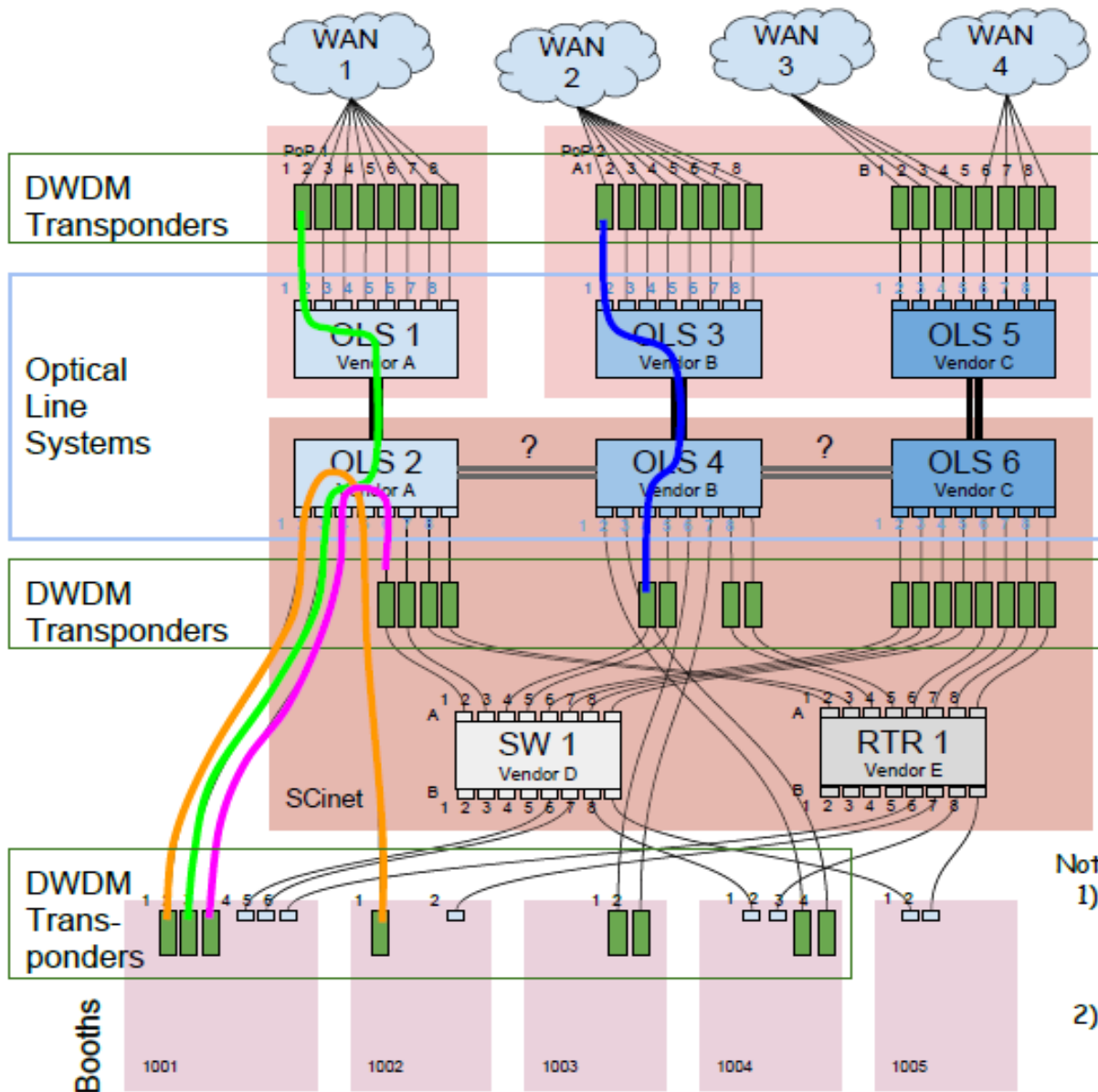


UMich Booth ????

FlachSAN2N12C-D5

- USC Booth 1731
- UNESP Booth 1491
- SDSC Booth 525
- Caltech Booth 763
- Dell Booth 913
- 2CRSI Booth 494

A Disaggregated SCinet Optical Layer



Reconfiguration options

- A. Booth to booth connections
- B. Booth to WAN connections
- C. Booth to switch or router connections
- D. WAN to switch or router connections

Examples

- A. B-B
 - a. Booth 1001-1 to 1002-1 via optical layer █
 - b. Booth 1001-1 to 1004-3 via optical layer (assumes OLS2 to OLS4 path)
- B. Booth to WAN
 - a. Booth 1001-2 to PoP1-1 via OLS2-2 and OLS1-1 █
 - b. Booth 1001-2 to PoP2-B1 via OLS2-2, OLS4, OLS6 and OLS5-1
- C. Booth to switch/router
 - a. Booth 1001-3 to SW1-A1 █
 - b. Booth 1003-1 to RTR1-A5 (assumes OLS4 to OLS6 path)
- D. WAN to switch/router
 - a. PoP2-A1 (WAN2) to SW1-3 via OLS3-1 and OLS4-3 █
 - b. PoP2-A2 (WAN2) to RTR1-3 via OLS3-2 and OLS4-7

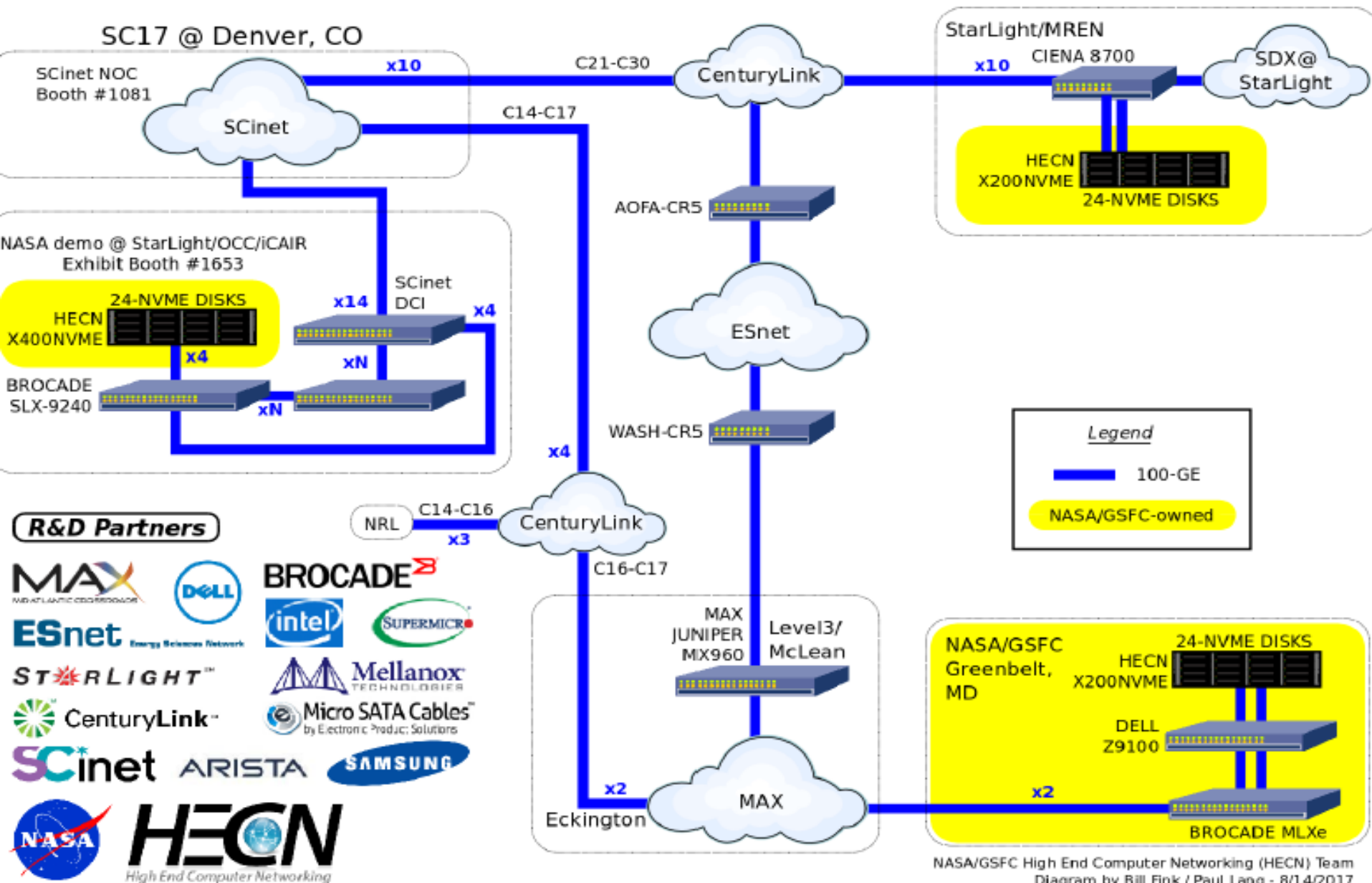
Notes

- 1) Transponders could be from multiple vendors but for near term the links would need to be built with matching transponders.
- 2) **Controllers and orchestration systems are not shown** but all Tpnldr/OLS systems must be connected

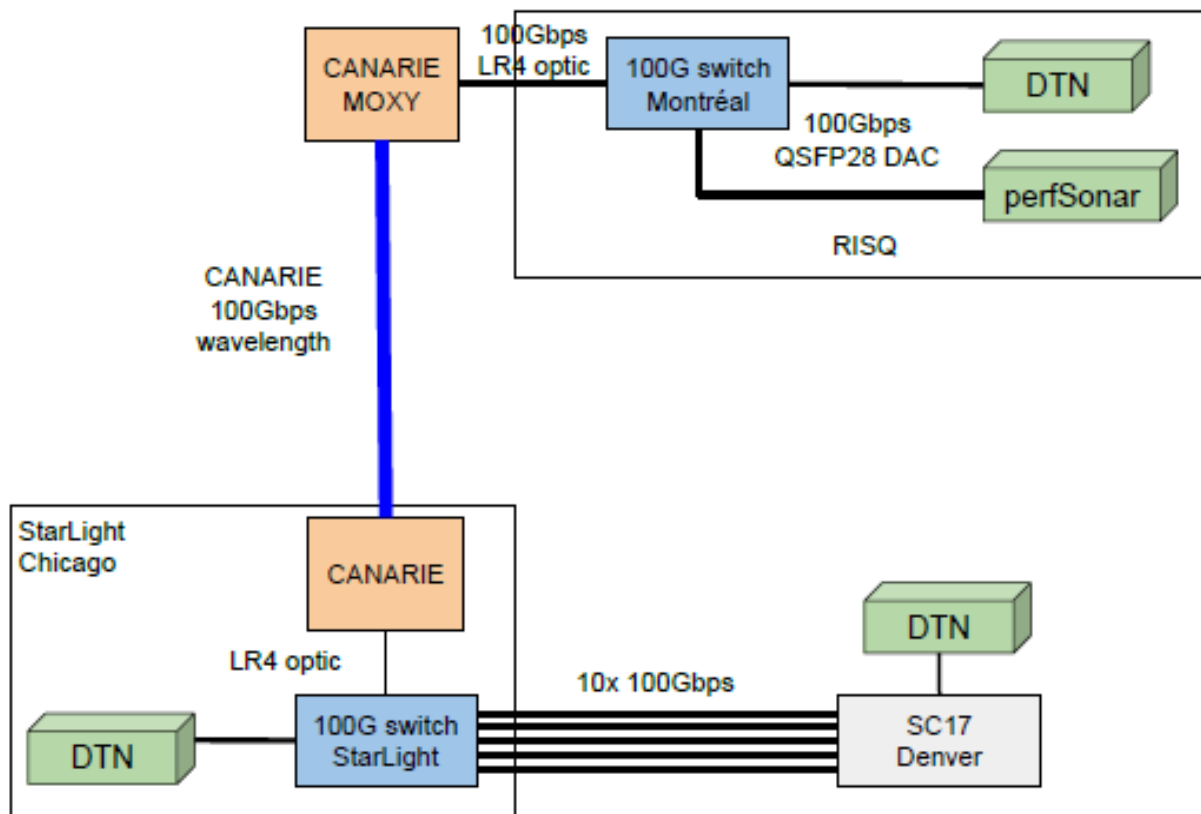
SC17

Demonstrations of 400 Gbps Disk-to-Disk WAN File Transfers using iWARP and NVMe Drives

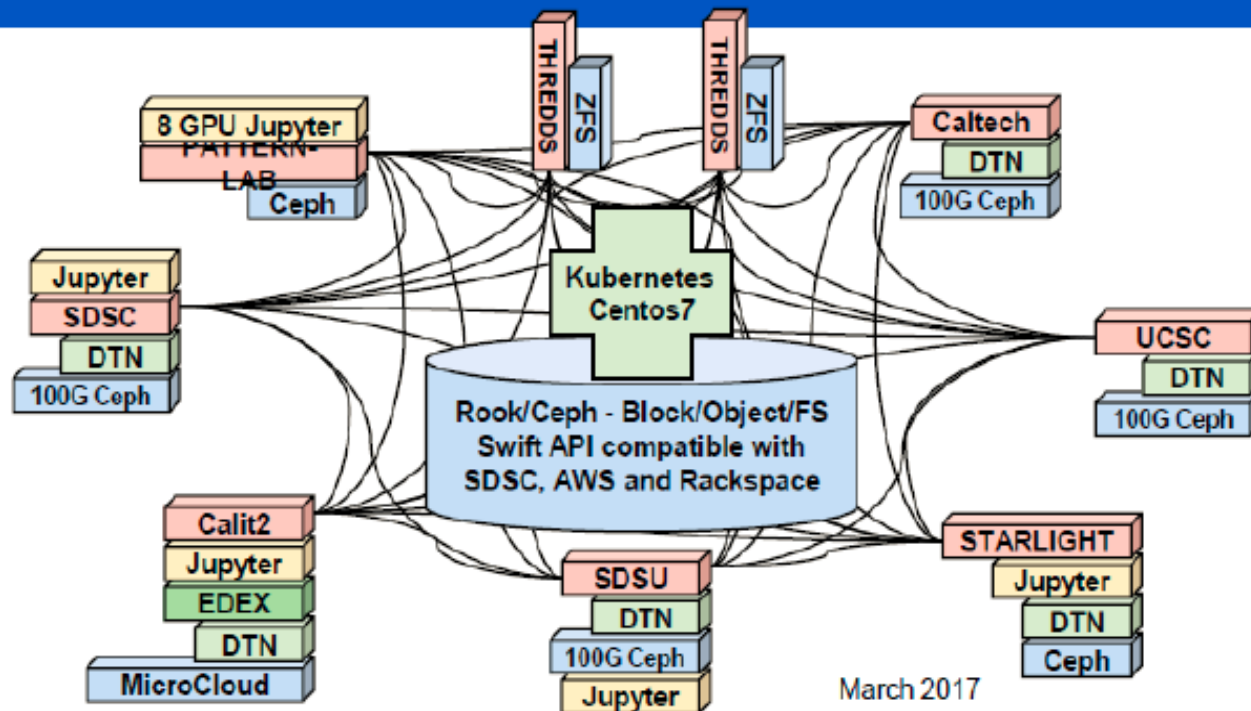
An SC17 Collaborative Initiative Among NASA and Several Partners



Compute Canada/CANARIE/StarLight SC17 Demonstrations



Multi-Institution, Hyper-Converged ScienceDMZ



II. Source; John Graham UCSD



STARLIGHTSM



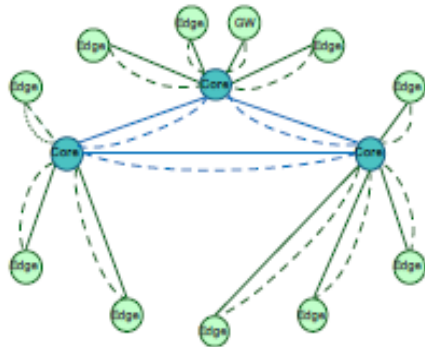
Nationwide 100 Gbps and Minimized Latency

- ◆ SINET5 will be a nationwide 100-Gbps backbone network using 100-Gigabit Ethernet technology and connect each pair of nodes with a minimized latency.

SINET4

- Star-like topology
- Resource-consuming secondary circuits

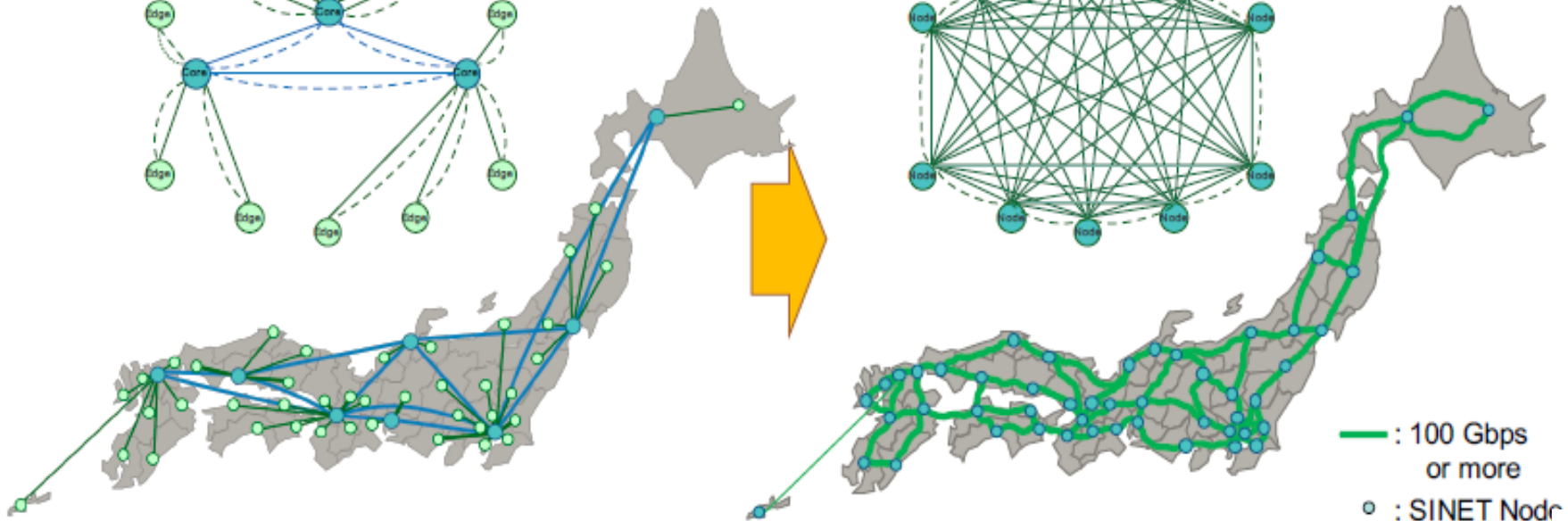
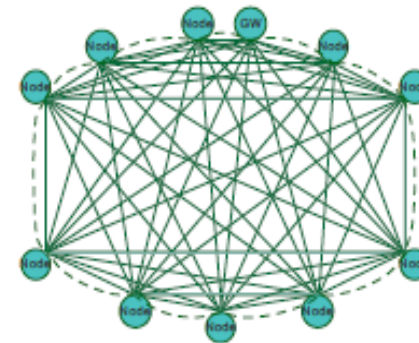
==== : Leased Line (Primary Circuit)
- - - - : Leased Line (Secondary Circuit)



SINET5

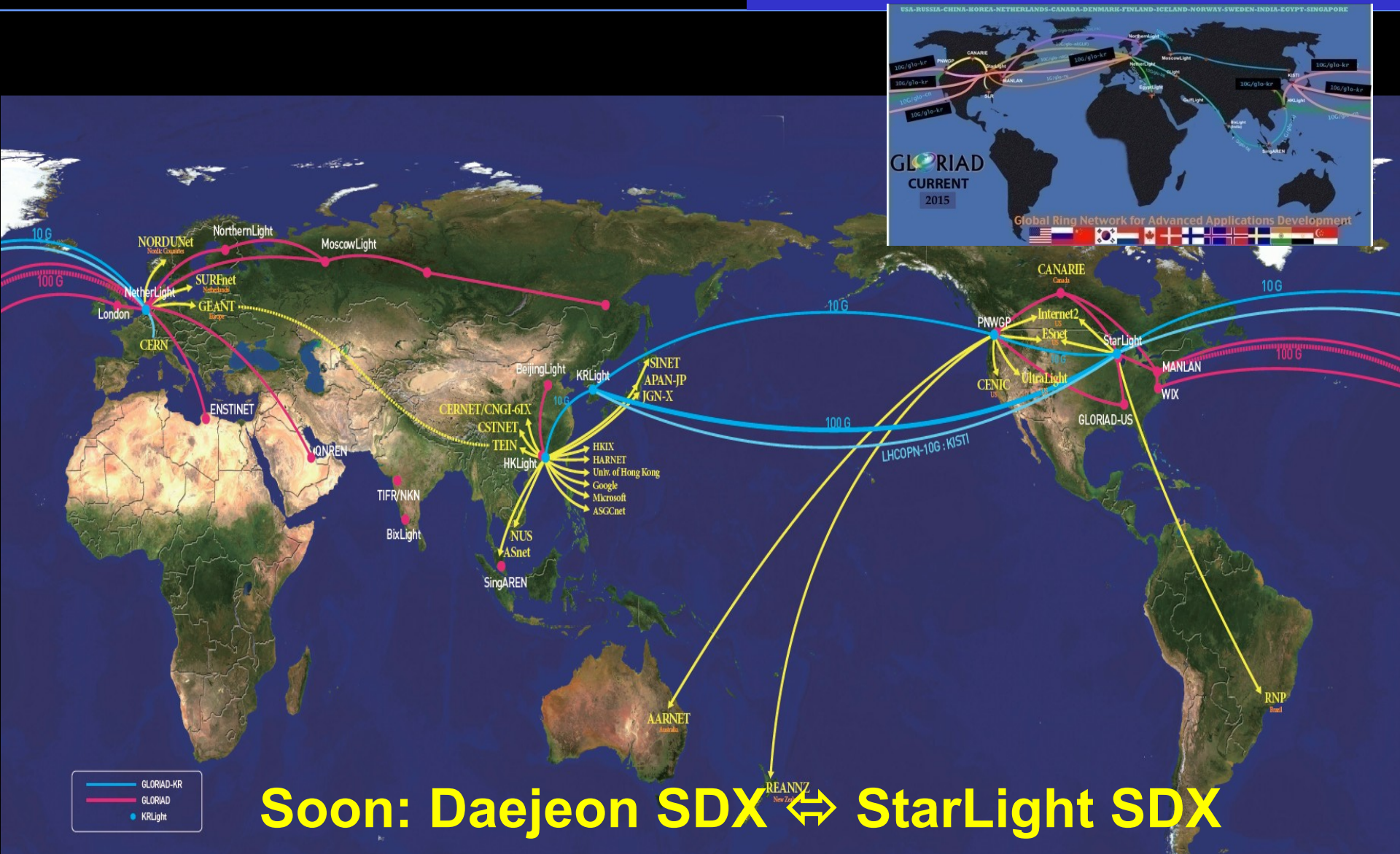
- Fully-meshed topology with redundancy
- Non-resource-consuming secondary paths

— : MPLS-TP Path (Primary)
- - - : MPLS-TP Path (Secondary)



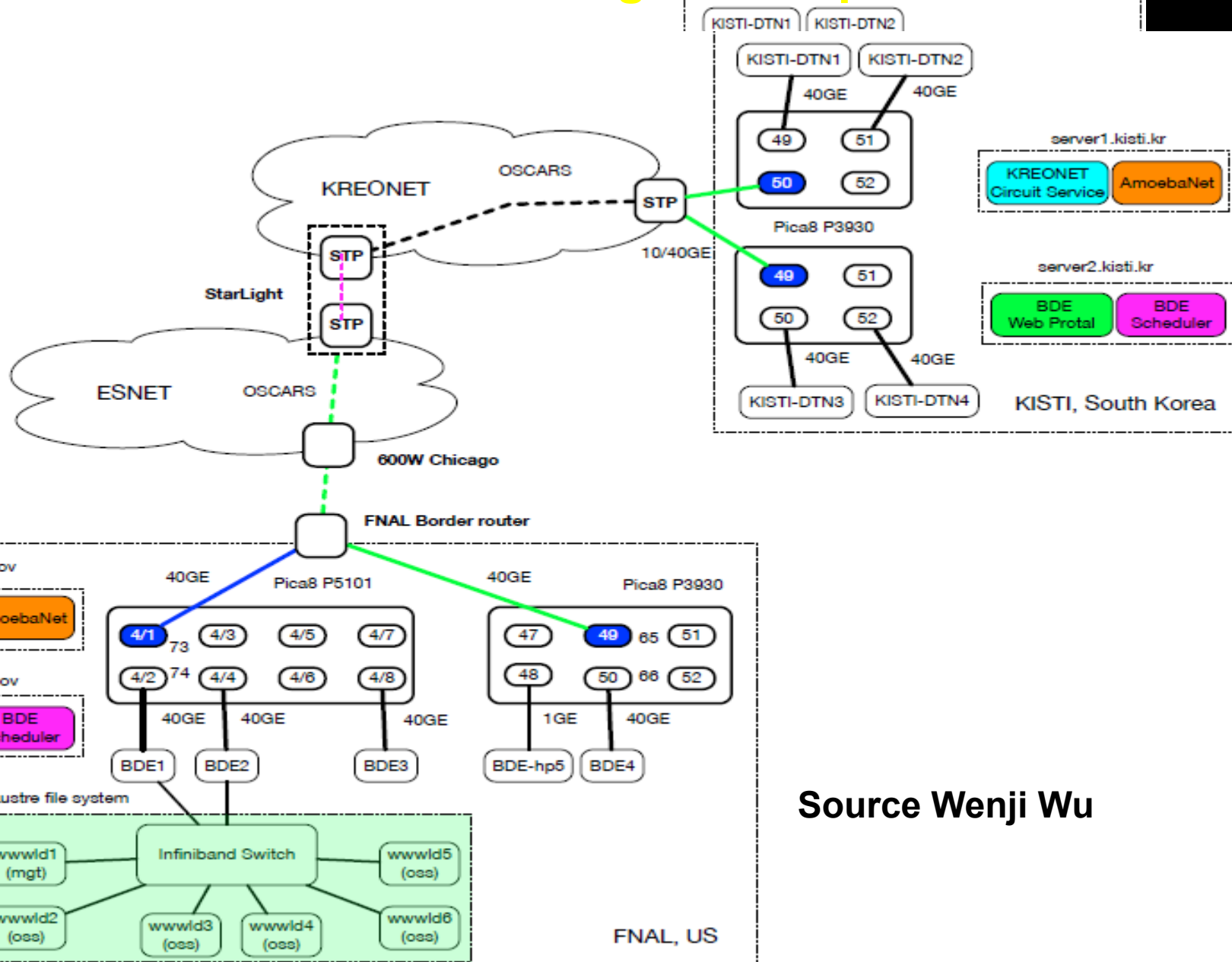
KREONet2 SD-WAN GLORIAD-KR

KISTI Daejeon ↔ 100 G ↔ StarLight



Soon: Daejeon SDX ↔ StarLight SDX

KISTI - FNAL International Big Data Express Testbed



Source Wenji Wu

www.startup.net/starlight

Thanks to the NSF, DOE, DARPA,
NIH, USGS, NASA,
Universities, National Labs,
International Partners,
and Other Supporters

