

# Global Research Platform

**Joe Mambretti, Director, ([j-mambretti@northwestern.edu](mailto:j-mambretti@northwestern.edu))**

**International Center for Advanced Internet Research ([www.icaair.org](http://www.icaair.org))**

**Northwestern University**

**Director, Metropolitan Research and Education Network ([www.mren.org](http://www.mren.org))**

**Director, StarLight International/National Communications Exchange Facility  
([www.startap.net/starlight](http://www.startap.net/starlight)),**

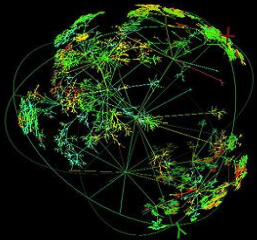
**PI: StarLight SDX, Co-PI Chameleon, PI-iGENI, PI-OMNINet**

**LHCOPN LHCONE Meeting**

**Cittadella Univeritaria**

**Catania, Italy**

**April 9-11, 2024**



# Global Collaborative Research Communities

- **Science Is Global**
- **Open Information Sharing, A Cornerstone of The Science Process**
- **Concepts, Experiments, Instruments, Methods, Techniques, Data, Technologies And Results Are Openly Communicated and Shared Among Collaborative Science Communities World-Wide**
- **The Global Research Platform Is An International Collaborative Partnership Creating A Distributed Environment for International Data Intensive Science**
- **The GRP Facilitates High Performance Data Gathering, Analytics, Transport (100 Gbps-Tbps E2E), Computing, And Storage**
- **[www.theglobalresearchplatform.net](http://www.theglobalresearchplatform.net)**



# Selected Applications



**GENI**  
www.geni.net



**GLEON**  
www.gleon.org



**USGS EROS**  
www.usgs.gov/centers/eros



**NEON**  
www.neonscience.org



**Open Storage Network**  
www.openstorage.network.org



**OSIRIS**  
www.osris.org



**XSEDE**  
www.xsede.org



**Blue Waters**  
bluewaters.ncsa.illinois.edu



**PRAGMA**  
www.pragma-grid.net



**CENTRA**  
www.globalcentra.org



**OSG**  
www.openscience.grid.org



**GRP**  
theglobalresearchplatform.net/



**PRP**  
pacificresearchplatform.org



**CHASE-CI**  
www.calit2.net/newsroom/article.php?id=2910



**SAGE2**  
sage2.sagecommons.org



**Polar Geospatial Center**  
www.pgc.umn.edu



**IceCube**  
icecube.wisc.edu



**Chameleon**  
www.chameleoncloud.org



**Jetstream**  
www.jetstream-cloud.org



**Genomic Science Program**  
genomicscience.energy.gov



**LSST**  
www.lsst.org



**Pierre Auger Observatory**  
www.auger.org



**Belle II**  
www.belle2.org



**LBNF/DUNE/ProtoDUNE**  
lbnf.fnal.gov



**ISS**  
www.nasa.gov/station



**SKA**  
www.skatelescope.org



**XENON**  
xenon.astro.columbia.edu



**NOVA**  
novaexperiment.fnal.gov



**Virgo**  
www.virgo-gw.eu



**LIGO**  
www.ligo.caltech.edu



**SDSS**  
www.sdss.org



**ALMA**  
www.almaobservatory.org



**LHC**  
home.cern/science/accelerators/large-hadron-collider



**LHCONE**  
twiki.cern.ch/twiki/bin/view/LHCONE/WebHome



**LHCOPN**  
twiki.cern.ch/twiki/bin/view/LHCOPN/WebHome



**IVOA**  
www.ivoa.net



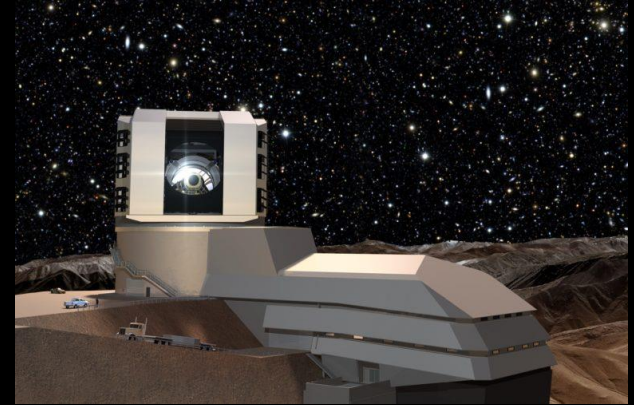
# Instruments: Exebytes Of Data



High Luminosity LHC



SKA Australia Telescope Facility



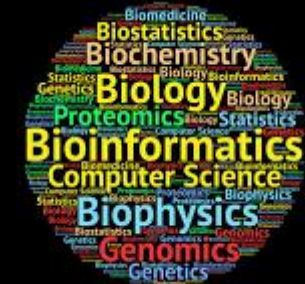
Vera Rubin Observatory



KSTAR Korea Superconducting Tokamak



Next Gen Advanced Photon Source



Bioinformatics/Genomics



# The GRP: A Platform For Global Science



## GLOBAL RESEARCH PLATFORM

*A Next Generation, Software Defined,  
Globally Distributed, Multi-Domain  
Computational Science Environment*



# Global Research Platform: Global Lambda Integrated Facility Available Advanced Network Resources



Visualization courtesy of Bob Patterson, NCSA; data compilation by Maxine Brown, UIC.



[www.glif.is](http://www.glif.is)

**STARLIGHT**<sup>SM</sup>



# Annual Global Research Platform Workshop – Co-Located With IEEE International Conference On eScience Oct 9-10, 2023

'23 eScience

CALLS - PROGRAM - TRAVEL

## '23 eScience

**October 9-13, 2023**

**Limassol, Cyprus**

IEEE eScience 2023 brings together leading interdisciplinary research communities, developers and users of eScience applications and enabling IT technologies. The objective of the eScience Conference is to promote and encourage all aspects of eScience and its associated technologies, applications, algorithms and tools with a strong focus on practical solutions and challenges. eScience 2023 interprets eScience in its broadest meaning that enables and improves innovation in data- and compute-intensive research across all domain sciences ranging from traditional areas in physics and earth sciences to more recent fields such as social sciences, arts and humanities, and artificial intelligence for a wide variety of target architectures including

### Important Dates

February 10, 2023 **Friday, February 24, 2023**  
Workshop Submissions

February 24, 2023 **Friday, March 10, 2023**  
Workshop Acceptance Notification

**Friday, May 26, 2023**  
Paper Submissions

**Friday, June 30, 2023**  
Notification of Paper Acceptance



HT<sup>SM</sup>



A photograph of Osaka Castle, a large white building with multiple tiers and green roofs, situated on a hill. The castle is surrounded by trees with vibrant autumn foliage in shades of yellow, orange, and red. A stone wall runs across the foreground, and a weeping willow tree is visible in the bottom left corner. The sky is a clear, bright blue.

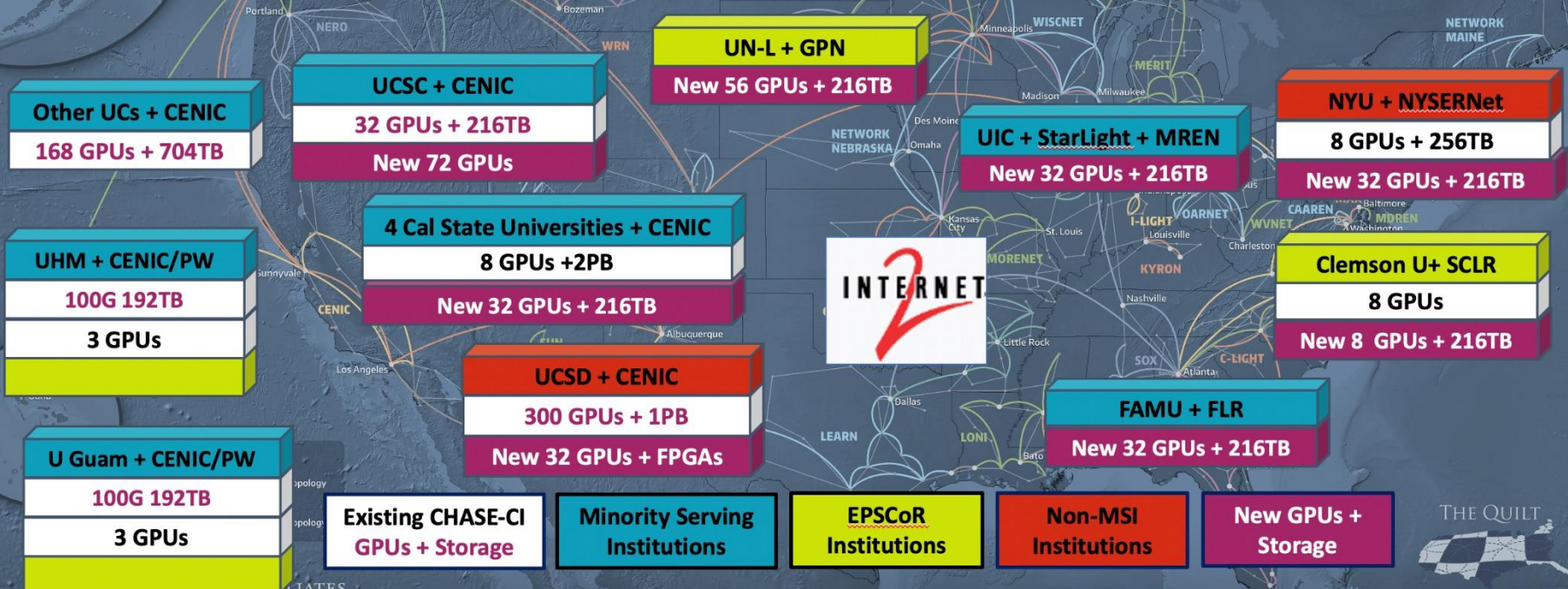
*Next Global Research  
Platform Workshop  
Osaka University, Osaka,  
Japan,  
Co-located with IEEE  
International Conference on  
eScience Sept 16-19, 2024*



# National Research Platform

## REGIONAL RESEARCH AND EDUCATION NETWORKS IN THE UNITED STATES

### Proposed Extension of Nautilus 2021-2024



=> 5<sup>th</sup> NRP Workshop March 19-22, 2024 UCSD LIGHT<sup>SM</sup>

# Selected GRP Themes

- **Orchestration Among Multiple Domains**
- **Large-Scale High Capacity Data WAN Transport**  
(Highlighted at SC23: 400 Gbps, 800 Gbps, 1.2 Tbps  
WAN Services For Data Intensive Science)
- **High-Fidelity Data Flow Monitoring, Visualization,  
Analytics, Diagnostic Algorithms, Event Correlation  
AI/ML/DL**
- **International Testbeds for Data-Intensive Science**





# Global Scale Science Highlighted At Prior GRP Workshops

- **The Square Kilometer Array: Data Transport, Processing, Archiving and Access, Shaun Amy, Australia Telescope National Facility**
- **Large Synoptic Survey Telescope Distributed Computing and Networks, Jeff Kantor, LSST**
- **Korean Fusion Program: KSTAR, ITER and K-DEMO and International Collaborators, Si-Woo Yoon, National Fusion Research Institute**
- **Square Kilometer Array (SKA), Richard Hughes-Jones, GÉANT**
- **Vera C. Rubin Observatory, Large Synoptic Survey Telescope (LSST), Nate Lust, LSST/Rubin Observatory**
- **Belle II, Super B-Factory Experiment, Silvio Pardi, National Institute for Nuclear Physics, (INFN)**
- **Deep Underground Neutrino Experiment (DUNE) – Kenneth Herner, Fermi National, Accelerator Laboratory**
- **Distributed Computing Operations For HL-LHC With Operational Intelligence, Federica Legger, National Institute of Nuclear Physics (INFN)**
- **Next-Generation Cyberinfrastructures for LHC, High-Luminosity LHC and Data Intensive Sciences, Harvey Newman, Caltech**
- **KAUST Genomics Cloud, Alex Moura, KAUST**

*"The global advancement of science by realizing a multiresource infrastructure through international collaboration."*



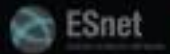
Schematic overview of the GNA-G AutoGOLE



**AutoGOLE Open R&E Exchanges**

**STARLIGHT<sup>SM</sup>**

# ESnet 6



Office of Science

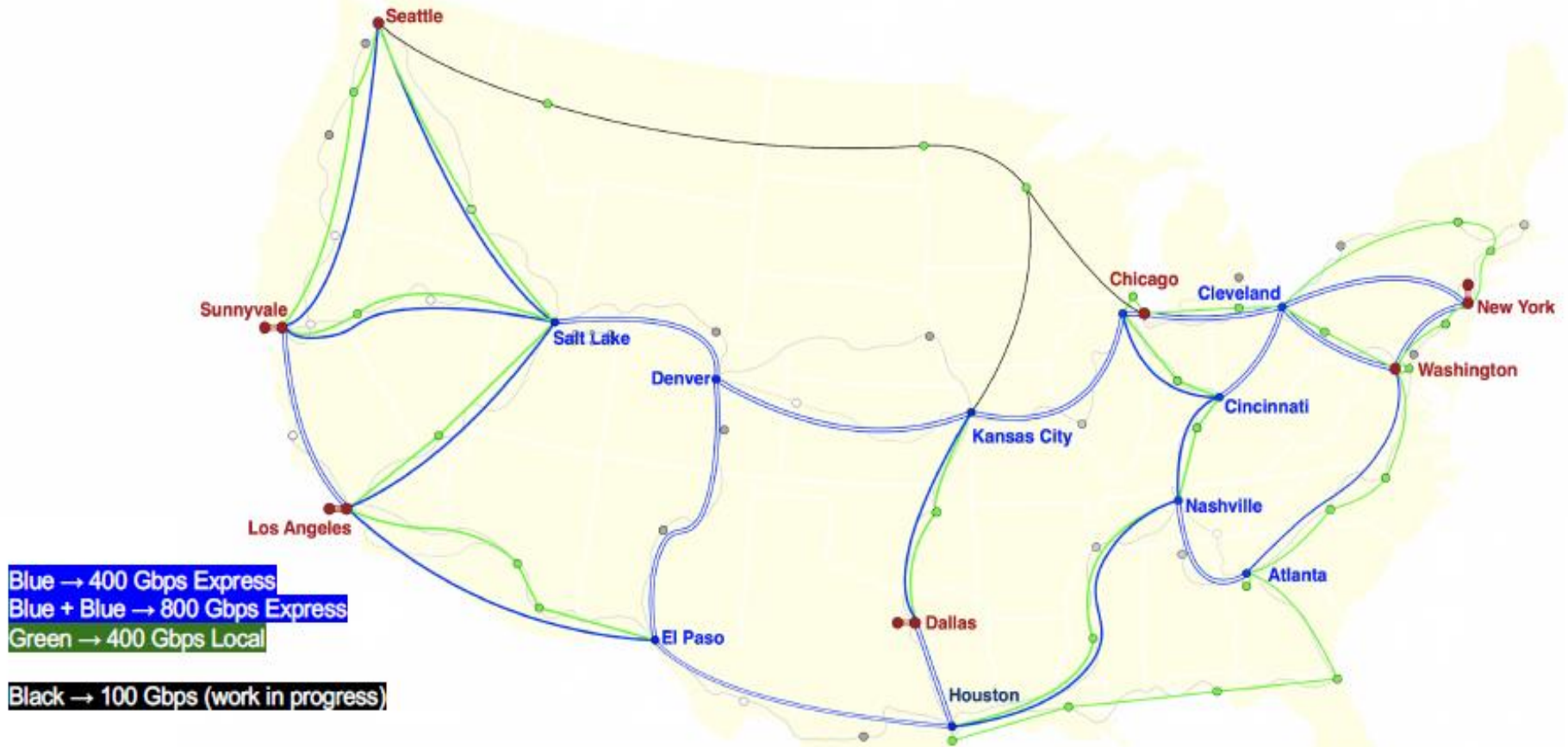
STARLIGHT<sup>SM</sup>



# Internet2 Backbone Topology

## Backbone Topology - Capacity and Traffic Management

Chris Wilkinson, Director of Planning and Architecture



# REGIONAL RESEARCH & EDUCATION NETWORKS IN THE UNITED STATES

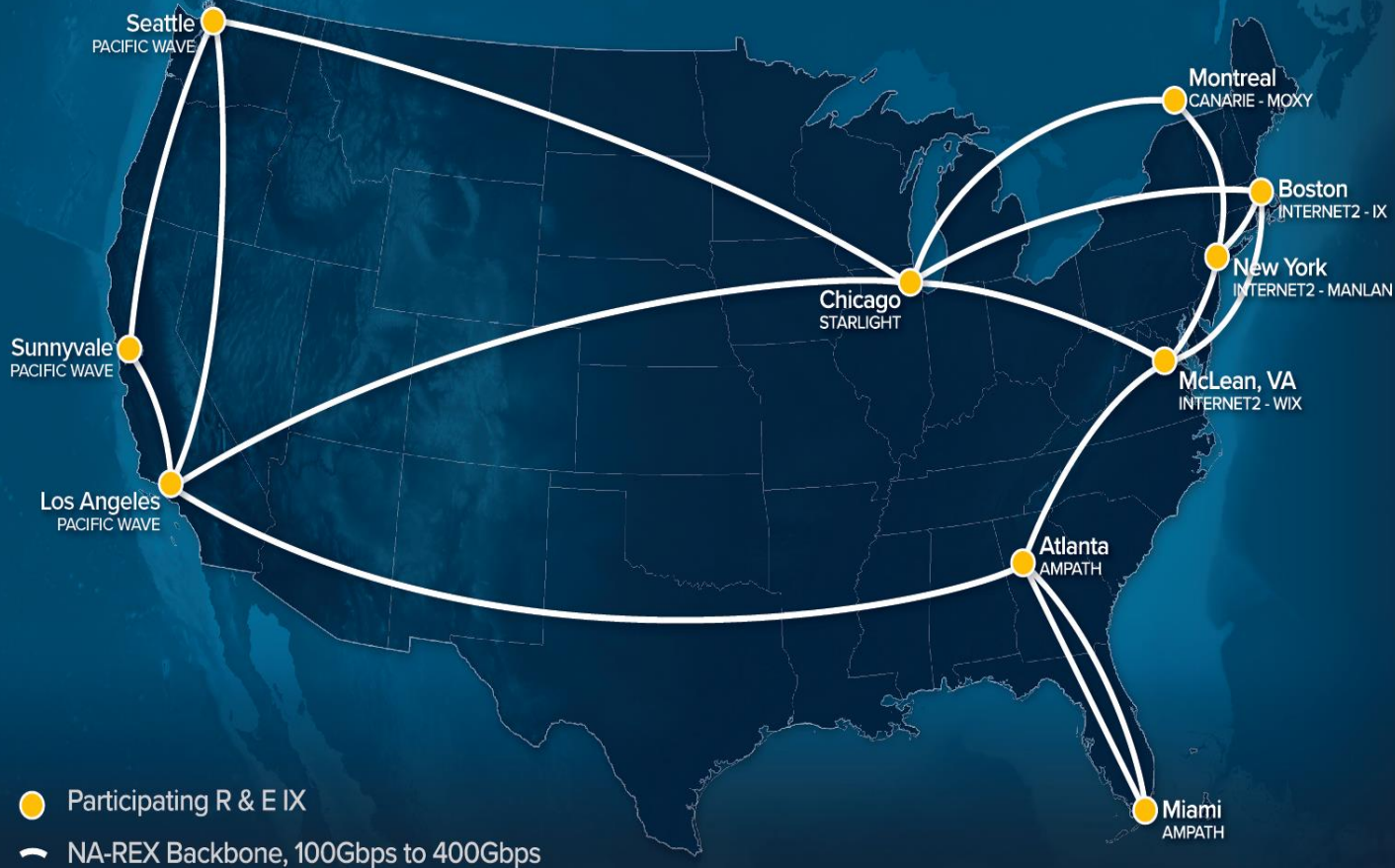


## QUILT MEMBERS & AFFILIATES





# NA-REX North America Research & Education Exchange Collaboration



November 2023

# StarLight – “By Researchers For Researchers”

**StarLight: Experimental Optical Infrastructure/Proving Ground For Next Gen Network Services**  
Optimized for High Performance Data Intensive Science  
Multiple 100 Gbps  
(110+ Paths)  
**StarWave**  
100 G Exchange  
World's Most Advanced Exchange  
Multiple First of a Kind  
Services and Capabilities



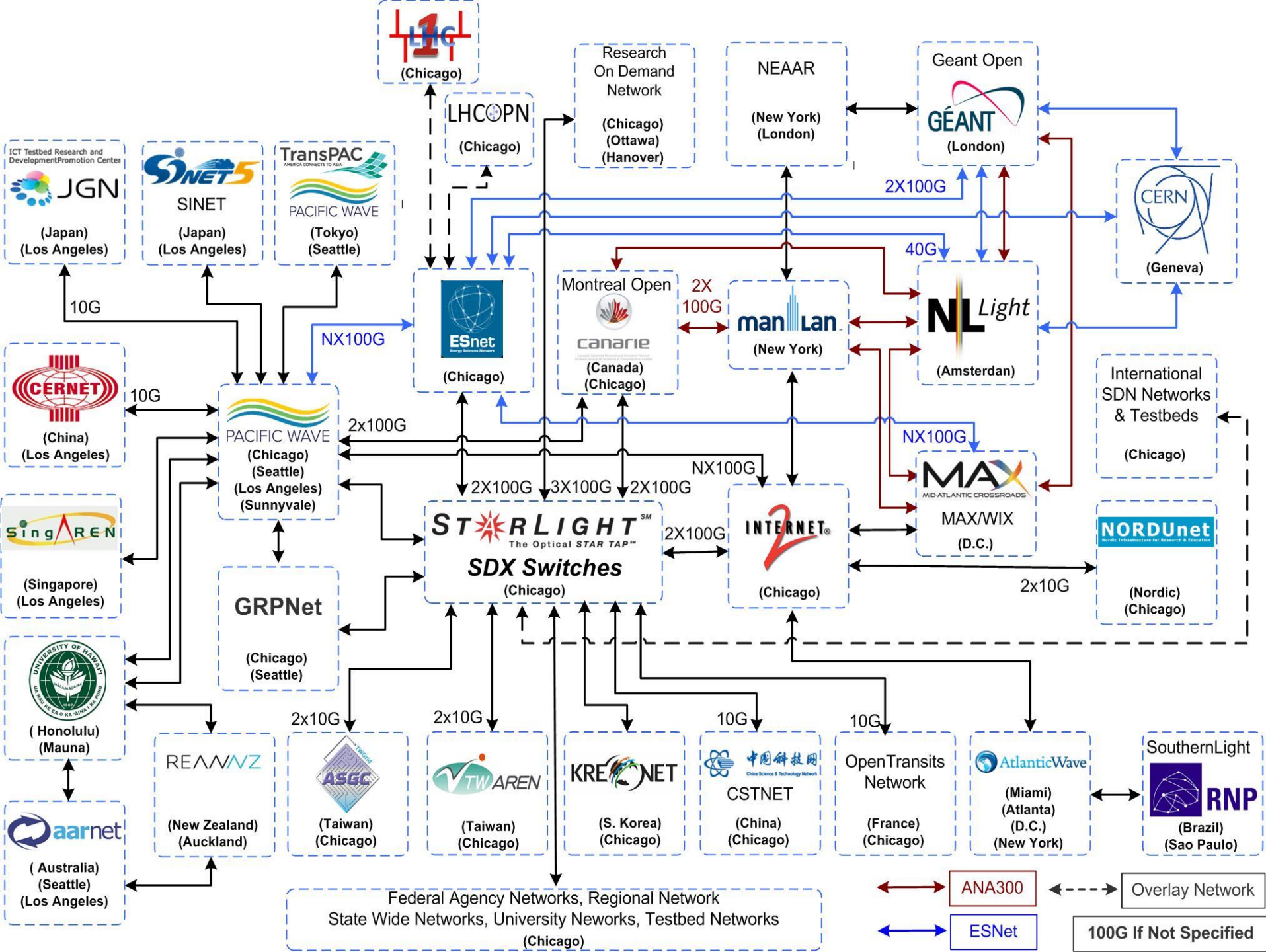
View from StarLight



Abbott Hall, Northwestern University's Chicago Campus

**Currently: 20+ 400 Gbps Paths Prototyping 800 Gbps** **STARLIGHT**<sup>SM</sup>





# **International Federated Testbeds As Instruments for Computer Science/Network Science**

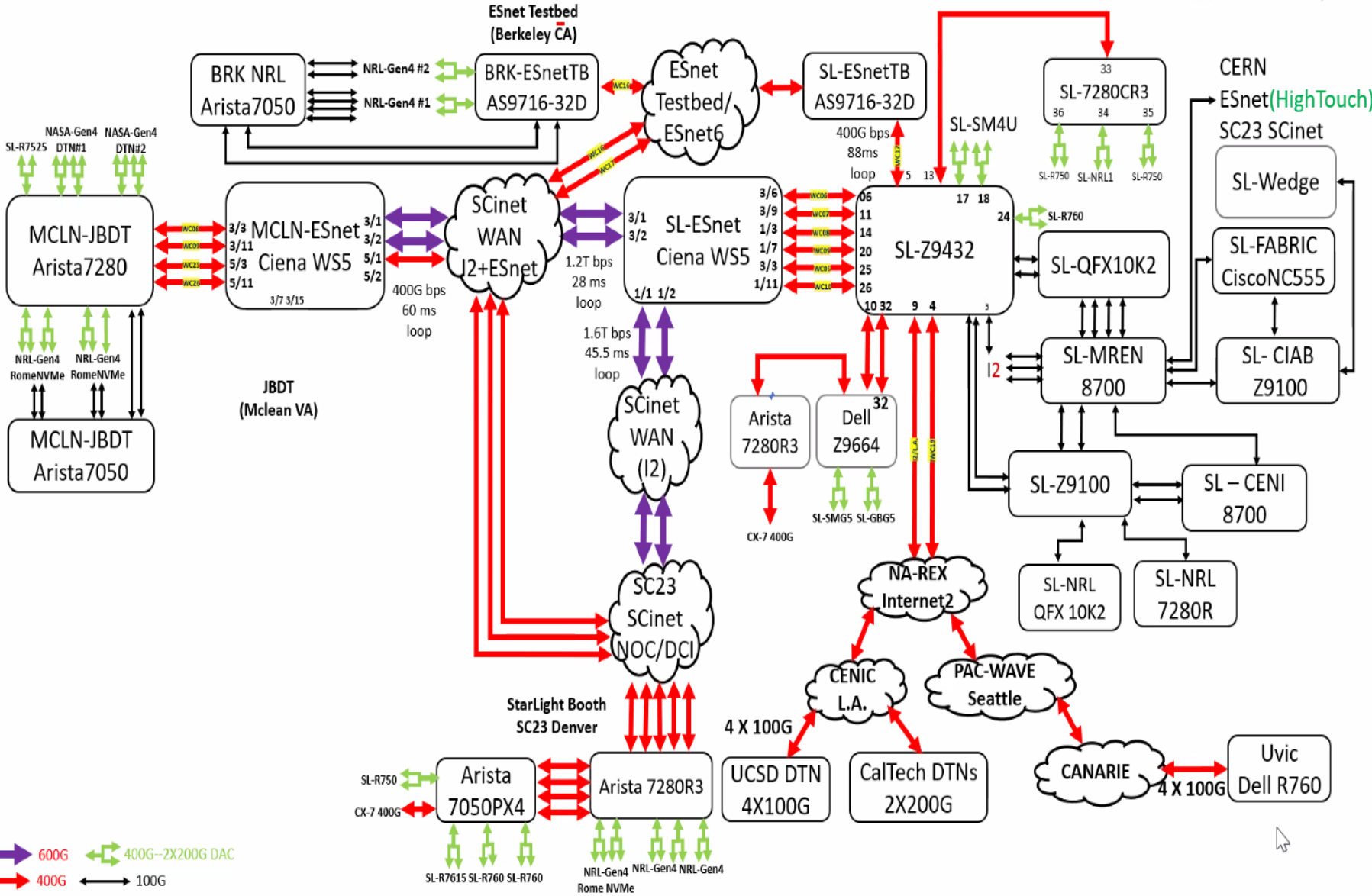
- **The StarLight Communications Exchange Facility Supports ~ 28 Network Research Testbeds (Instruments For Computer Science/Networking Research)**
- **StarLight Supports Two Software Defined Exchanges (SDXs), An NSF IRNC SDX & A Network Research GENI SDX (Global Environment for Network Innovations)**
- **The GENI SDX Supports National and International Federated Testbeds**





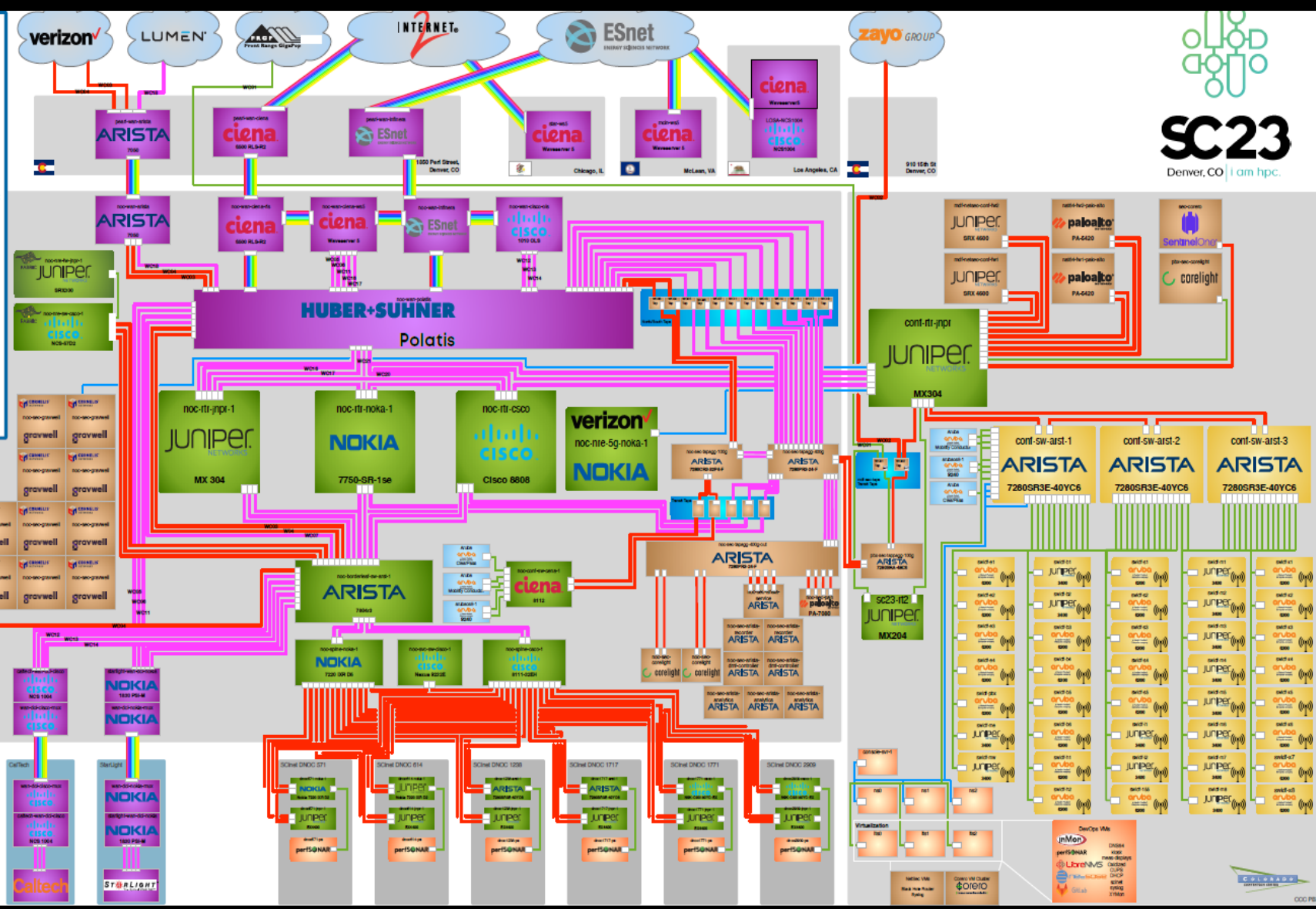
# 9 X 400G WAN Testbed by ESnet(ESnet Testbed)-I2(NA-REX)-CENIC-PAC-WAVE-CANARIE-SCinet-StarLight-JBDT

10/21/2023



Legend:  
- Blue double arrow: 600G  
- Green double arrow: 400G-2X200G DAC  
- Red double arrow: 400G  
- Black single arrow: 100G

- 1 Gigabit Ethernet
- 10 Gigabit Ethernet
- 100 Gigabit Ethernet
- 400G Ethernet
- 400G DCI
- Dark Fiber
- DWDM OTN
- ⊙ Wi-Fi Access Point
- Routing
- WAN
- Edge
- DevOps
- Security
- Wireless

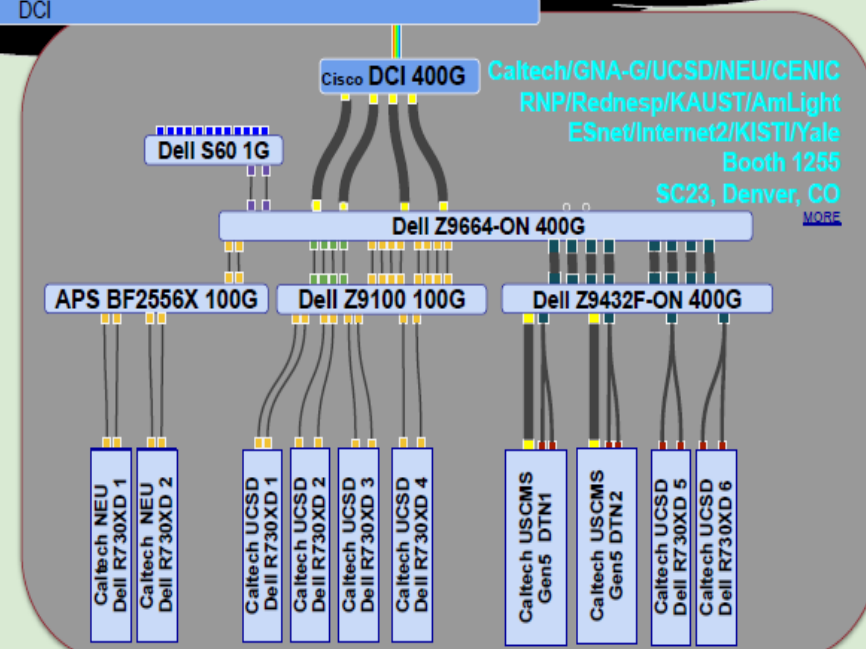
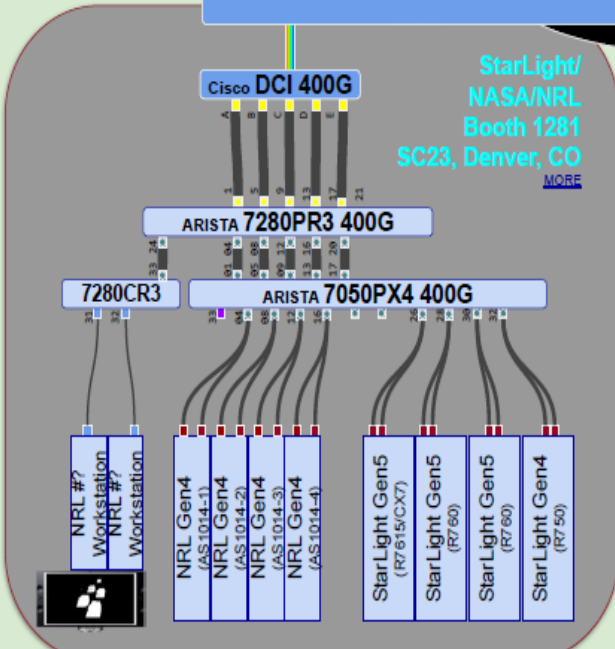
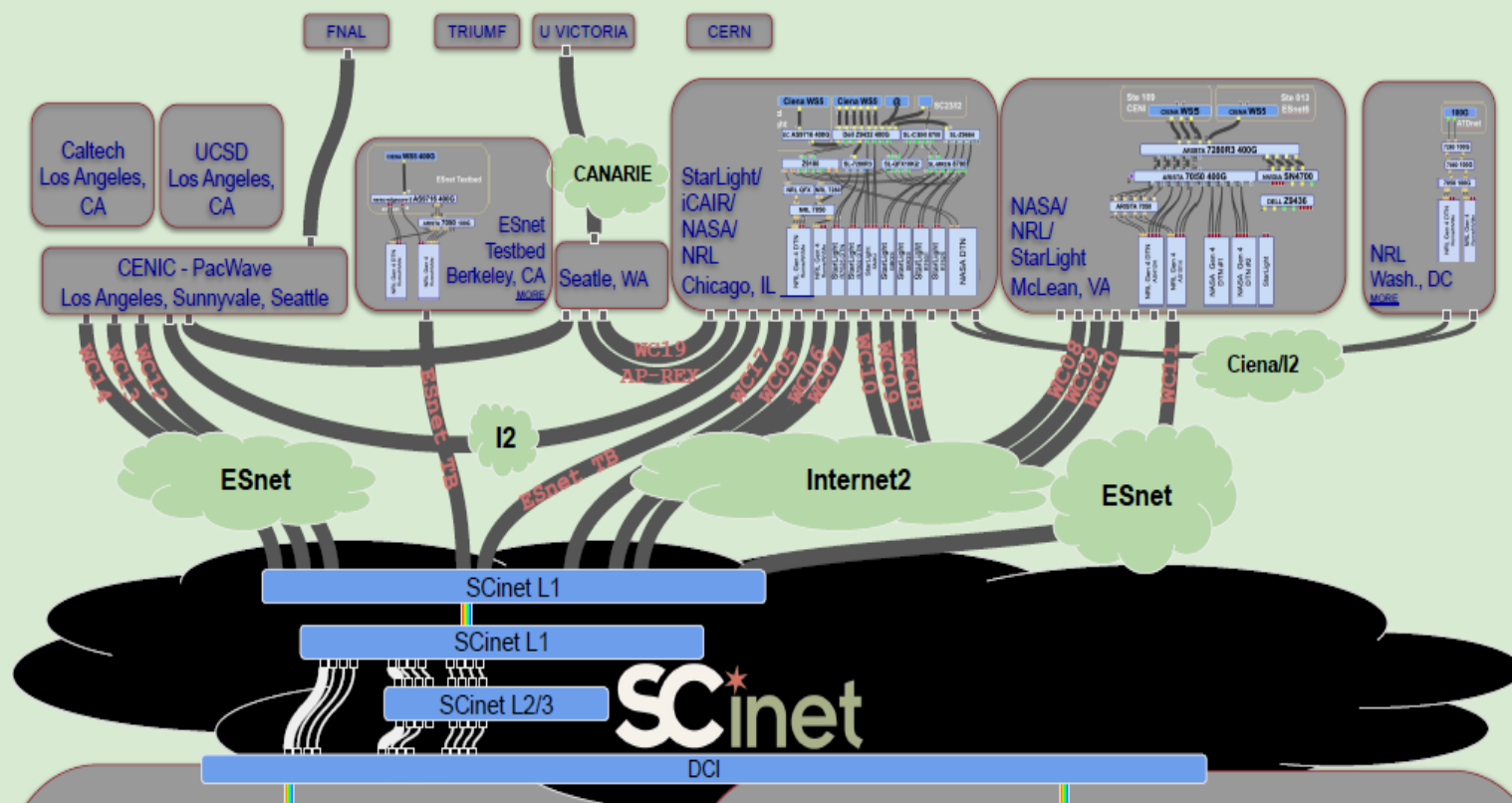






**SC23**  
Denver, CO | i am hpc.

# JOINT BIG DATA TESTBED



- 400G - LR4
- 400G - FR4
- 400G - DAC
- 200G - SR4 or DAC
- 100G - CWDM4
- 100G - LR4
- 100G - SR4
- 100G - DAC
- 40G - SR4
- 40G - DAC
- 10G
- 1G

10/16/2023

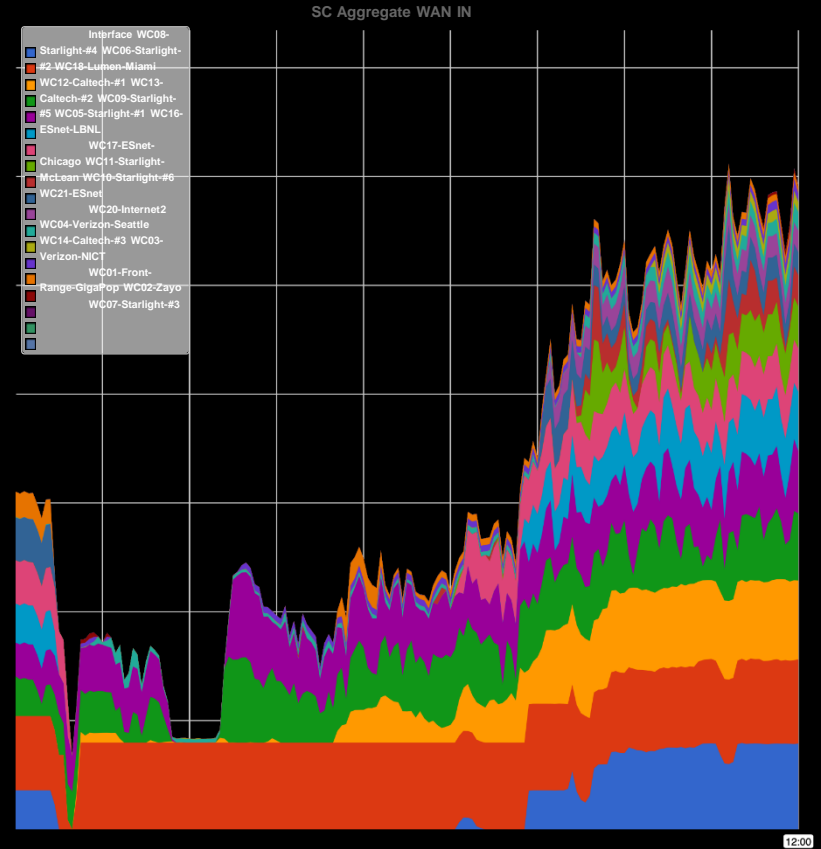
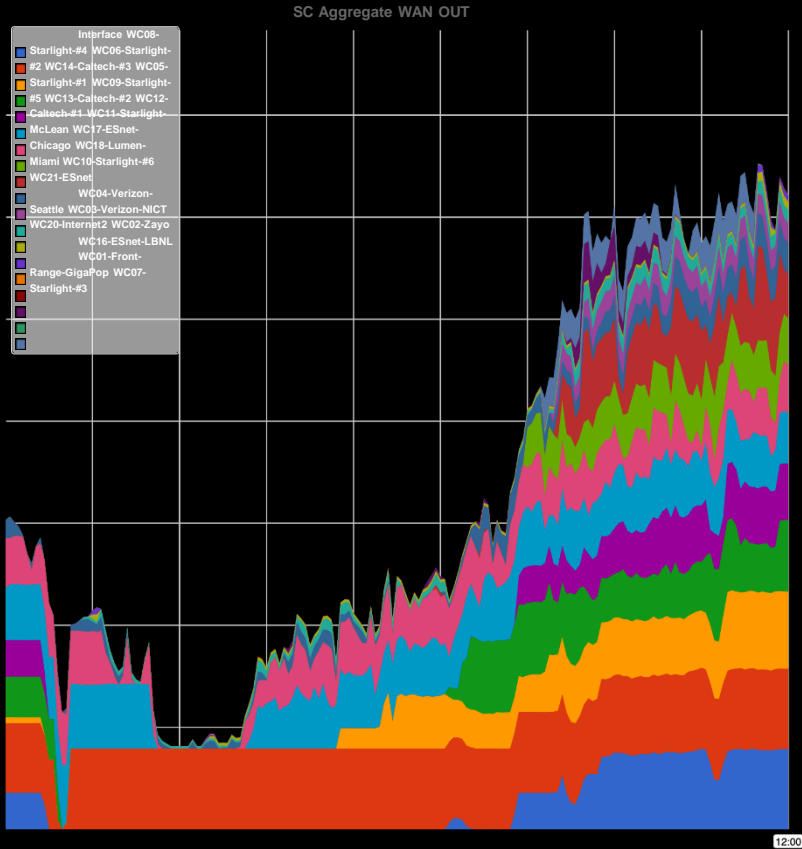
Latest Version at:  
<https://tinivul.com/SC23-JBDT>  
To request changes, please leave a comment

[SC23 floorplan](#)

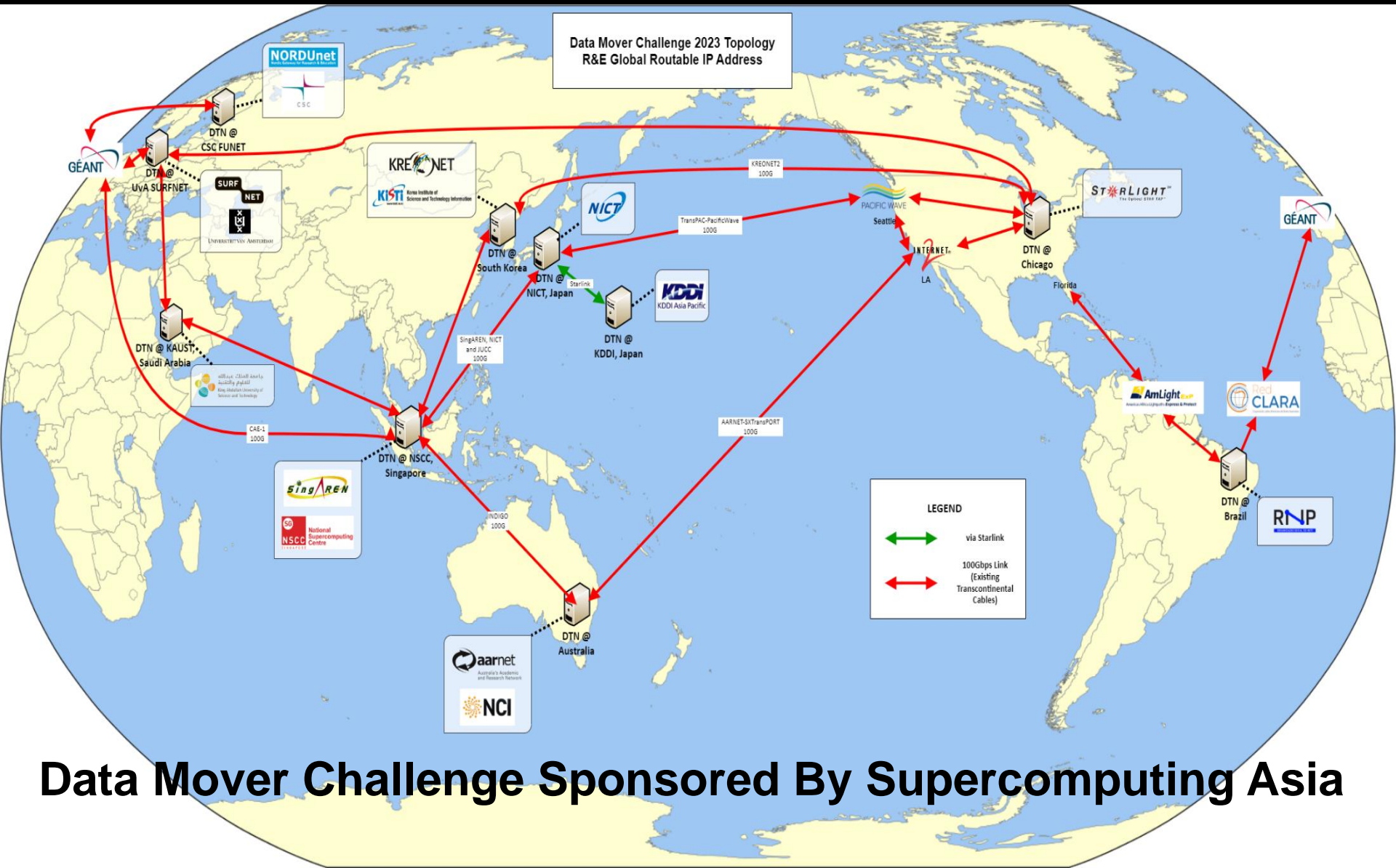
# SC23 Bandwidth Challenge

StarLight contributes 4 of Top 5

StarLight contributes 2 of Top 5

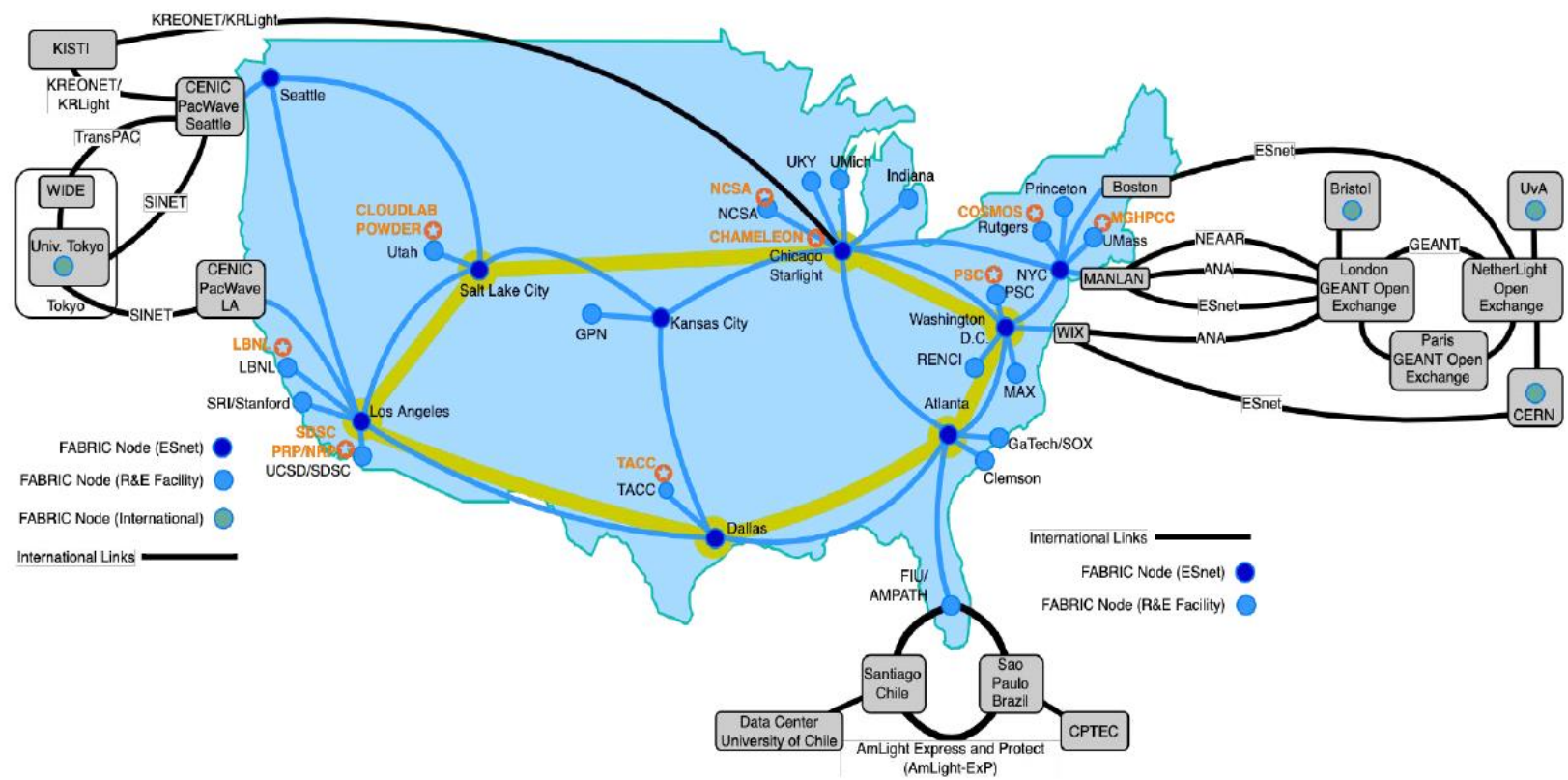






# Data Mover Challenge Sponsored By Supercomputing Asia

# FABRIC Testbed (+FAB)

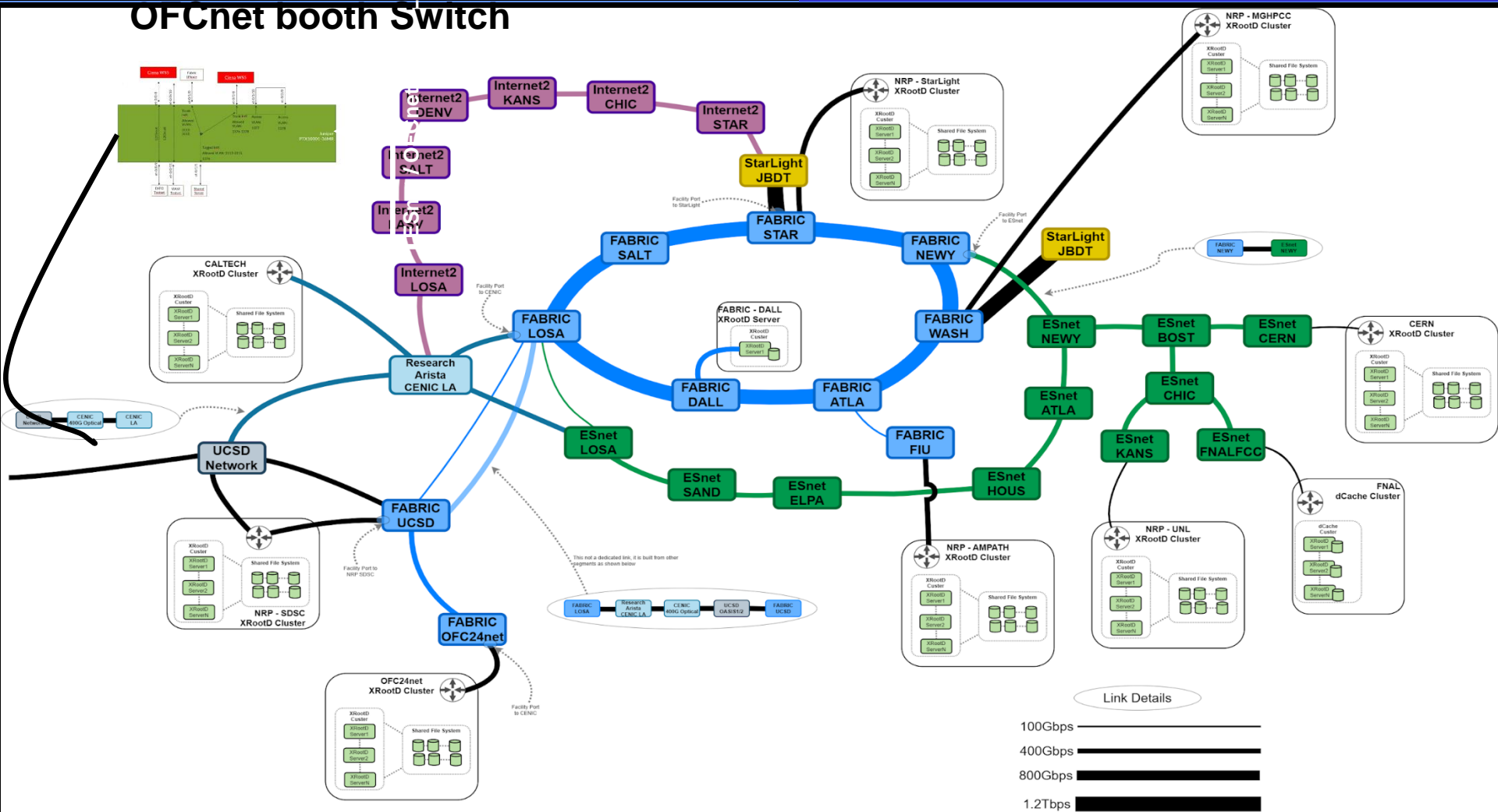


FABRIC Topology - with FAB Sites

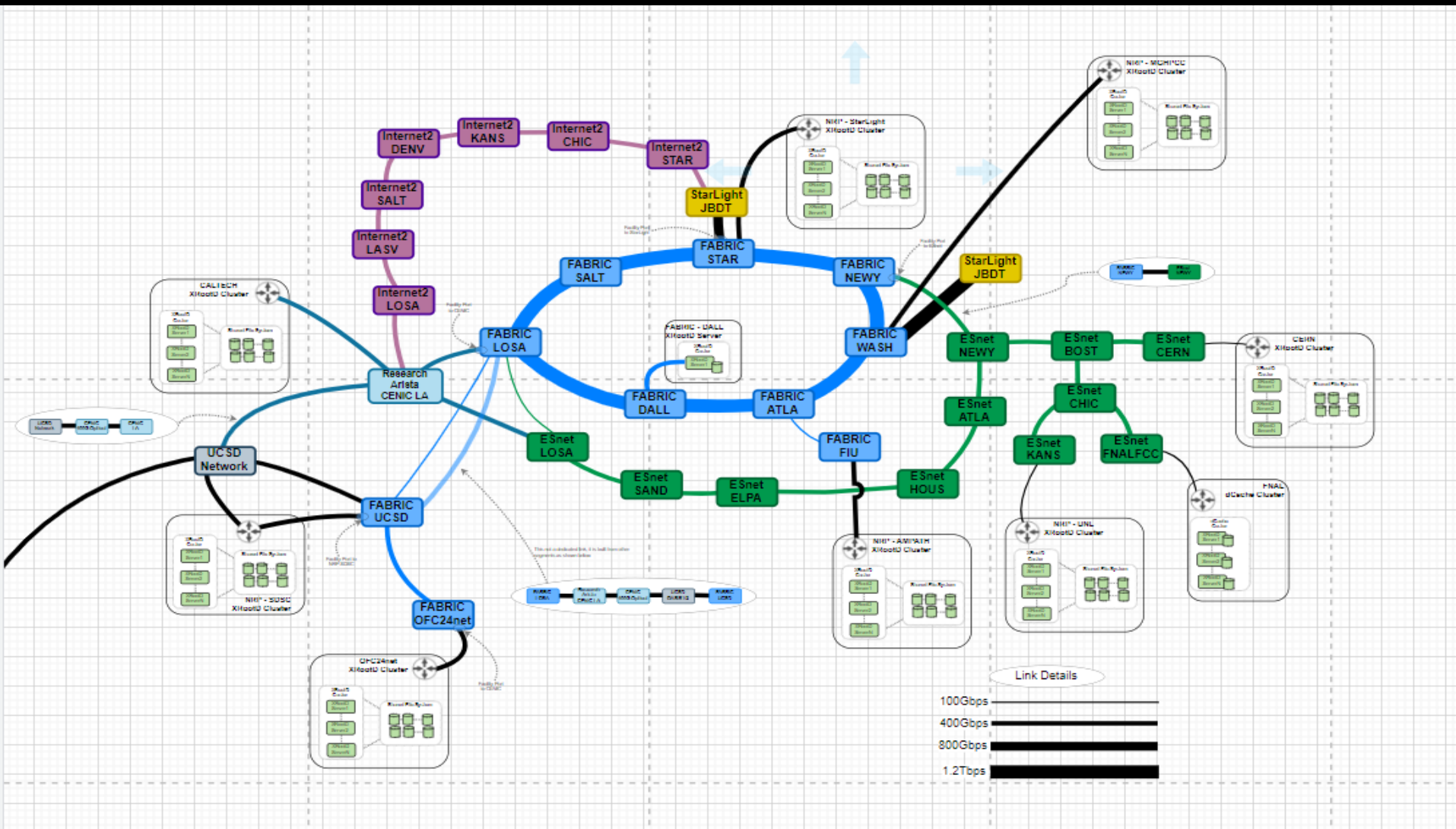


# FABRIC+NA-REX for OFCnet Demo

## OFCnet booth Switch



# NRP+FABRIC

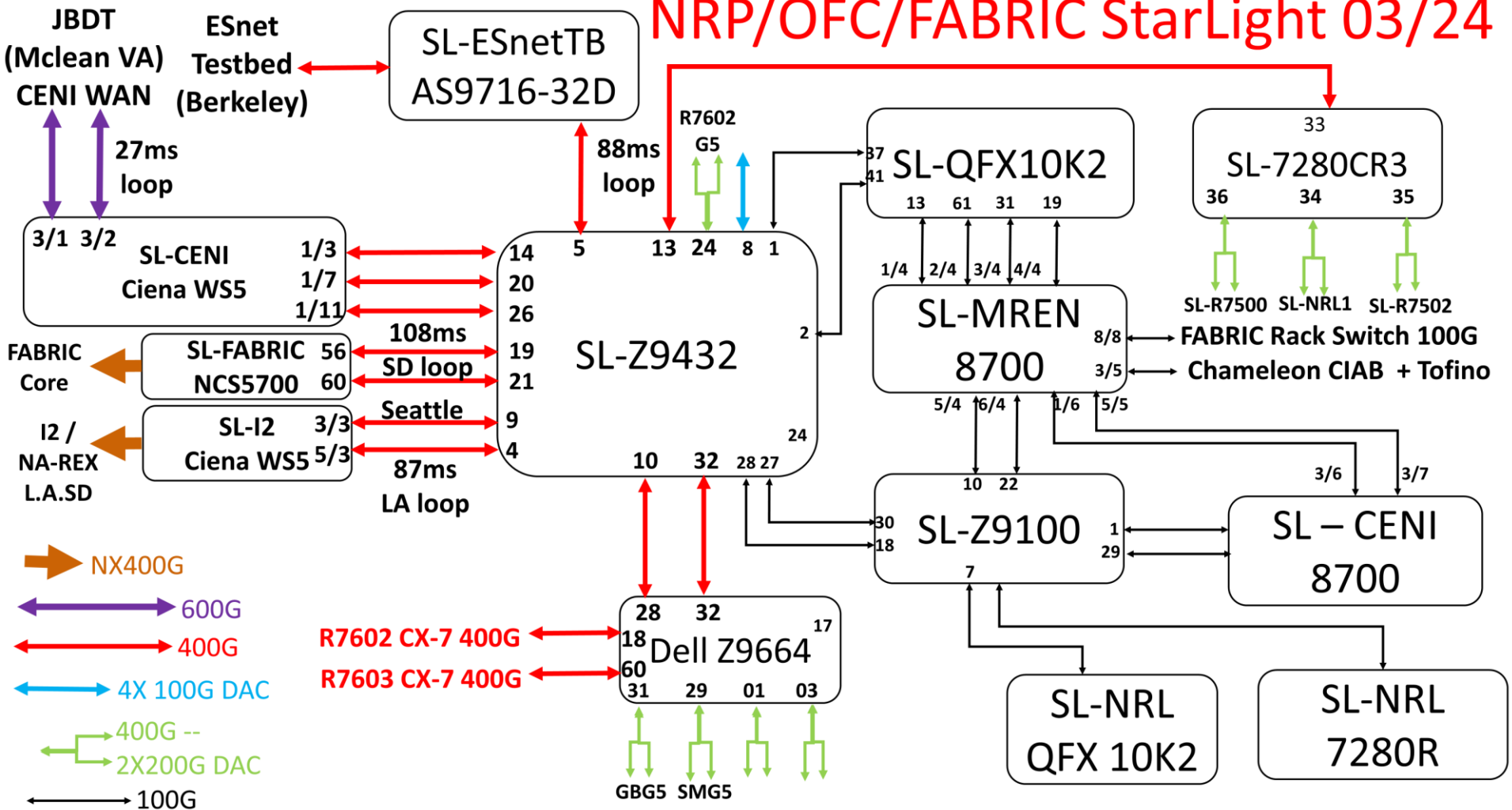


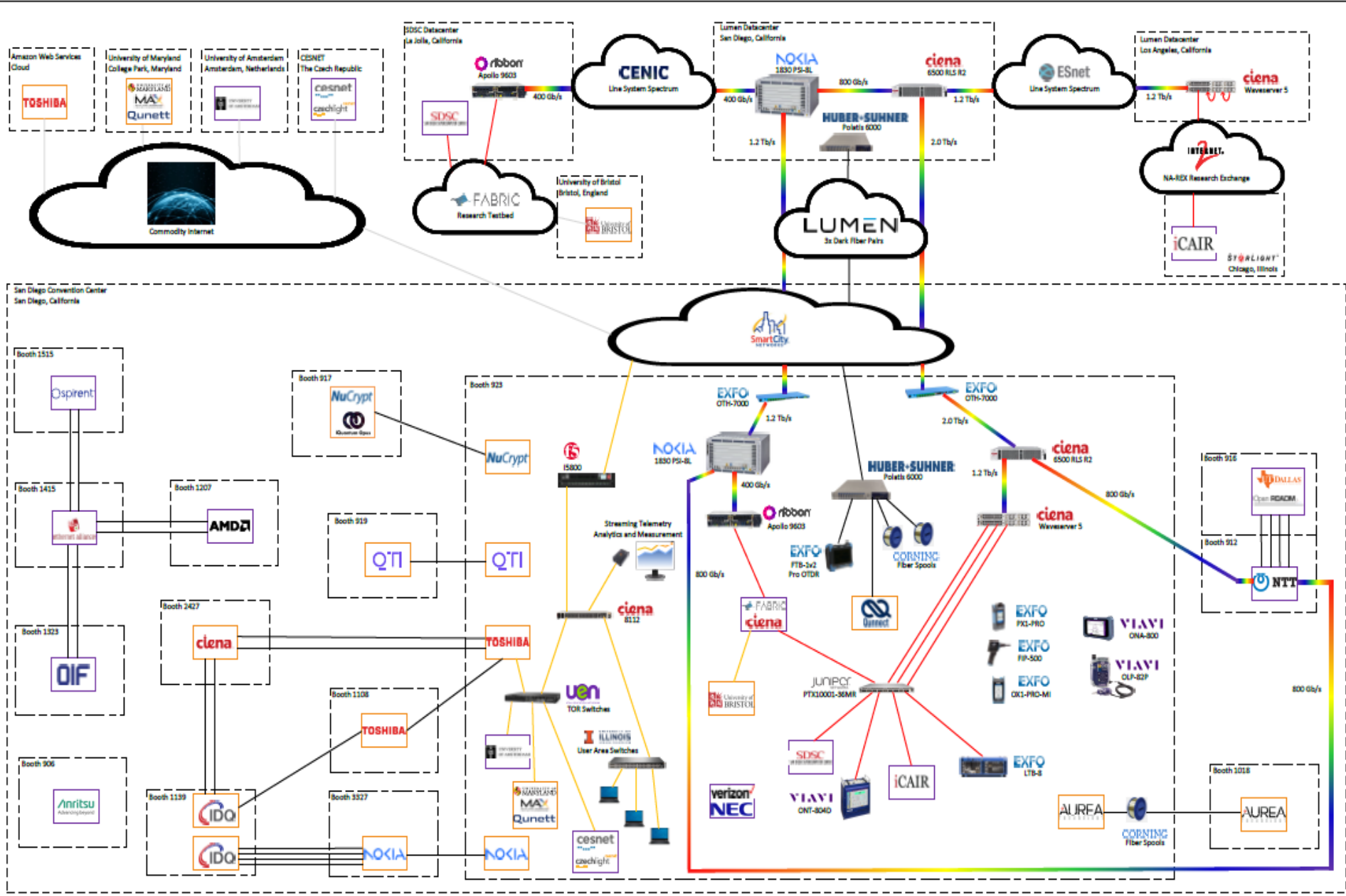
Source: Tom Lehman

STARLIGHT<sup>SM</sup>



# NRP/OFC/FABRIC StarLight 03/24





# OFC

## OFC 2024 - OFCnet Architecture



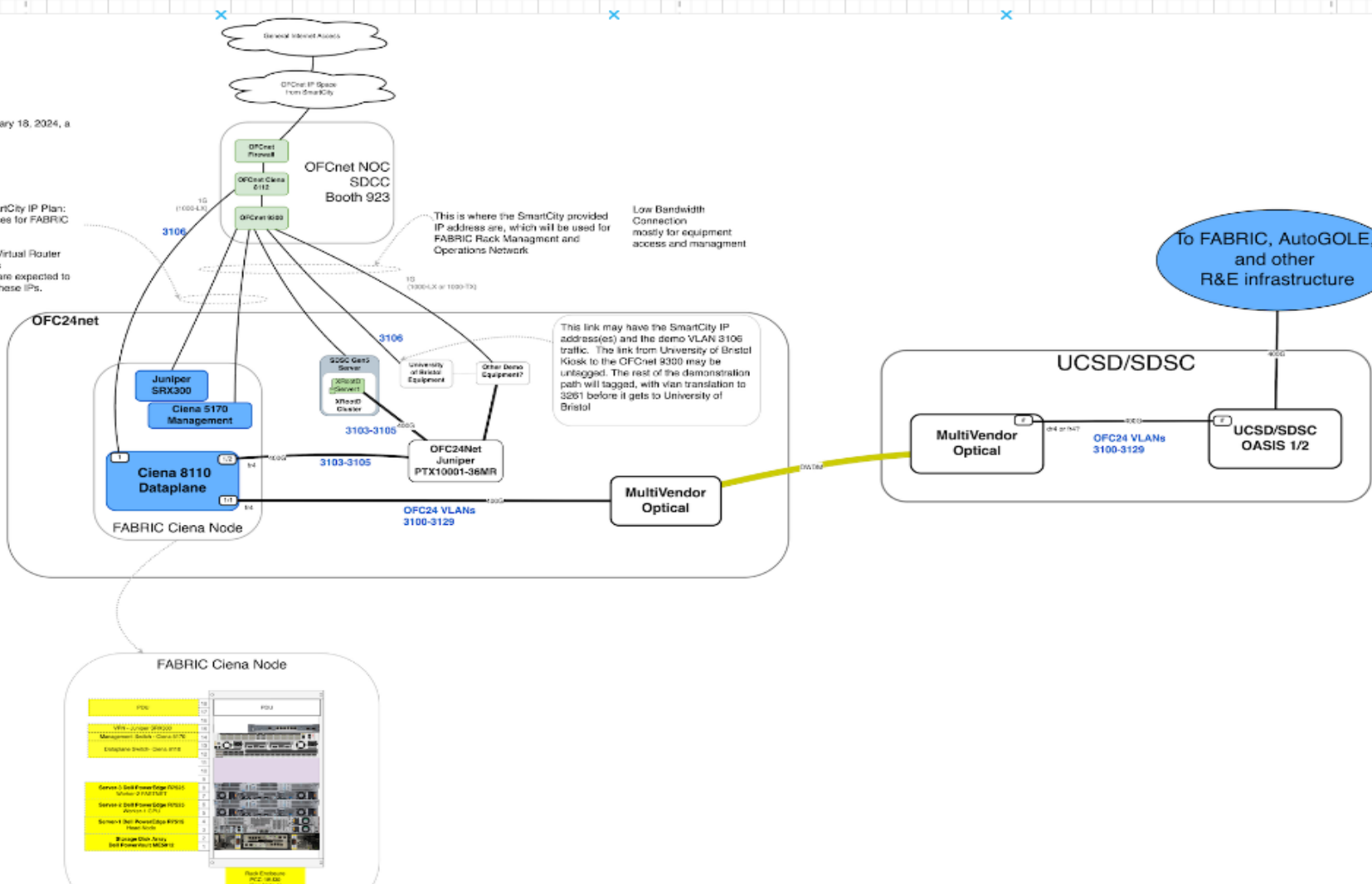
- Abstracted Connectivity
- Dark Fiber
- 10 Gb Ethernet
- 400 Gb Ethernet
- DWDM
- Quantum Demonstration
- Classical Demonstration



February 18, 2024, a

FABRIC SmartCity IP Plan:  
-5 IP addresses for FABRIC SRX300  
Headnode  
Open Stack Virtual Router  
2 IPs for VMs  
-no firewalls are expected to be inline for these IPs.

VLAN Demo Assignments:  
3100-3102: FABRIC Infrastructure  
3103-3105: SDSC Gen5 Server  
3106: Bristol



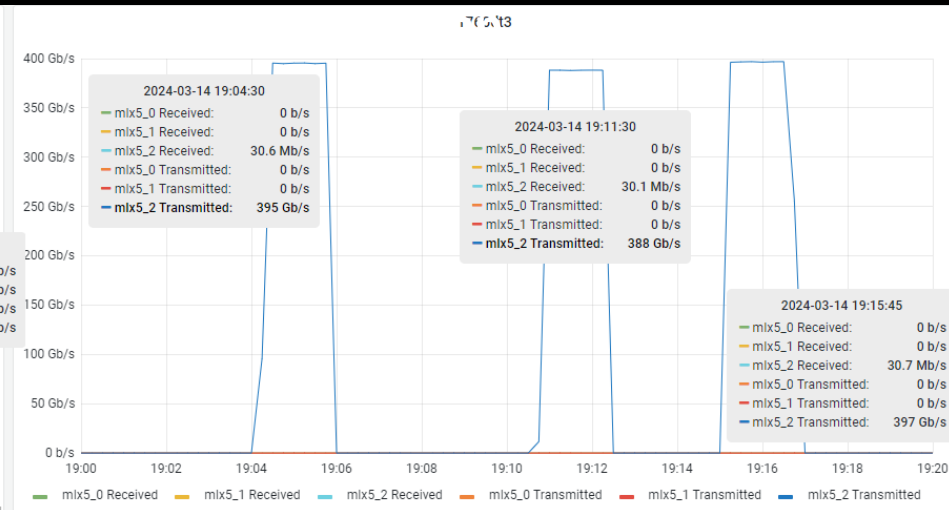
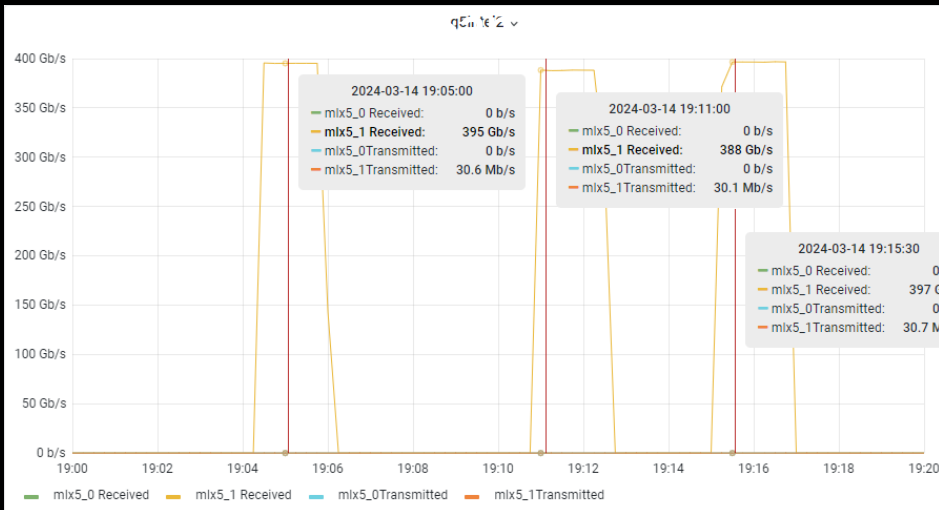
# Extending Data Center Services Over 400G WANs

## Prototype Solution Initial Results:

Single stream RDMA/RoCE over 400G network at different distance

(1) CENI (2) NA-REX (3) FABRIC +  
Chicago -Chicago -L.ANA-REX

(1) CENI (2) NA-REX (3) FABRIC +  
Chicago -Chicago -L.ANA-REX



SL loopbacks: (1) Rtt 27 ms @ 395G (2) Rtt 87 ms @ 388G (3) Rtt 108 ms @ 397G





# Extended Data Center Services Over 400G WAN

## Prototype Solution Initial Results: Single Stream RDMA/RoCE Over 400G Network



Chicago-San Diego OFCnet loopback: Rtt 96.4 ms, Peak @ 397G X 2



March 24, 2024



# Exploring OFCnet-land

397 Gbps  
4k WAN Miles

## OFCnet WAN Overview

OFCnet Traffic Last 1 minute



OFCnet Traffic rate

Bitrate  
**1.58 Tb/s**

Simultaneous Phone calls  
**24.7 Mil**

DVDs/sec  
**42.1**

Library of Congress (digital)/sec  
**0.00267**

OFCnet Data transferred Last 1 hour

Bytes  
**746 TB**

Total Hour-long calls  
**25.9 Mil**

DVDs  
**159 k**

Library of Congress (digital)  
**10.1**

OFCnet Management Traffic

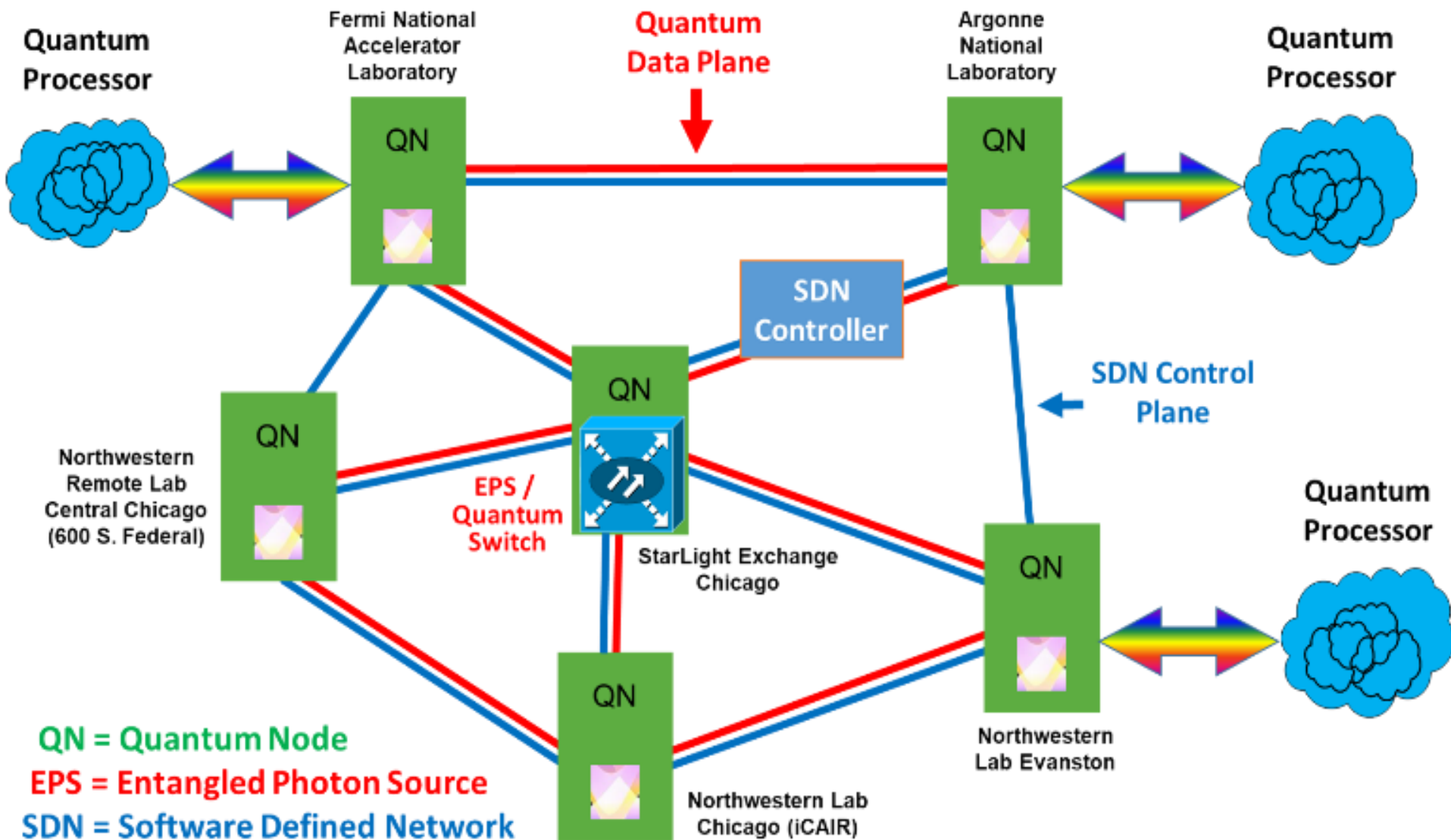


OFCnet Kiosk Traffic

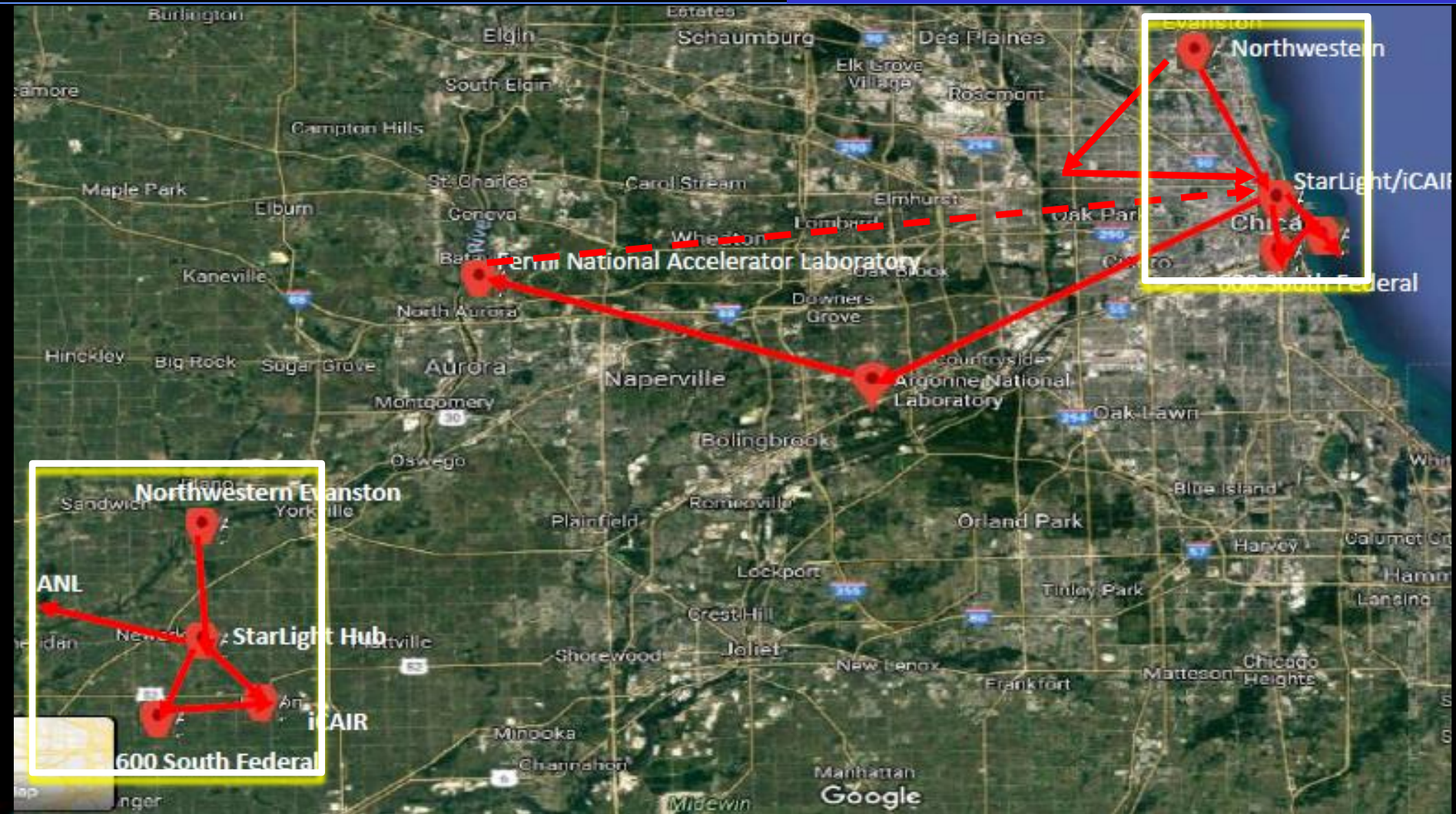




# Emerging Chicago Quantum Exchange Testbed



# Energizing IEQnet Testbed Topology



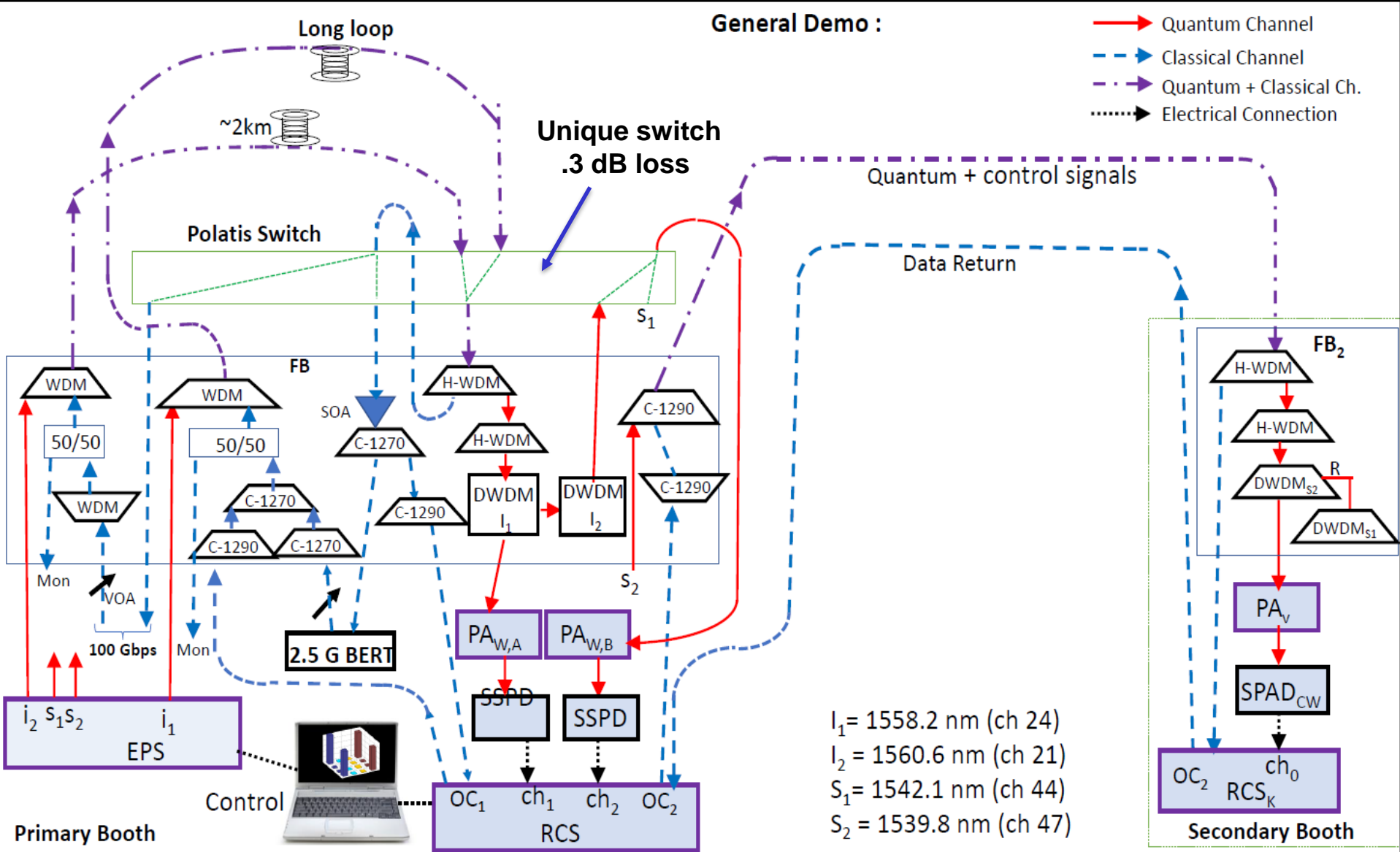




**Demo Lead Partner - NuCrypt (1) - Distribution of Quantum Entanglement Through Fiber With Co-Propagating Classical Data**

**(1) Spin Off From Northwestern University's Center for Photonic Communications and Computing, Which Was Also A Partner for the OFC 2023 Demonstrations (Prem Kumar, Director)**









**Co-Propagation  
And 400 Gbps WAN  
Demonstrations  
OFCnet Booth  
March 2023**

**STARLIGHT<sup>SM</sup>**

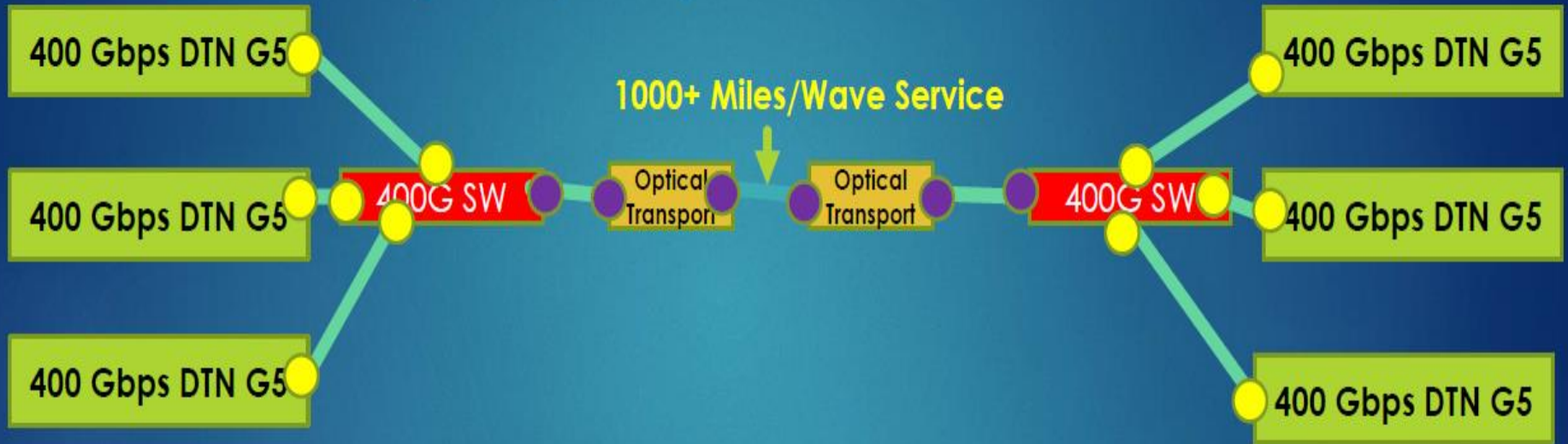




# 1.2 Tbps WAN Service Prototype for Data Intensive Science

StarLight International/National  
Communications Exchange Facility, Chicago, IL

Joint Big Data Testbed McLean, Va



● LR4 Transceiver + Smart NIC

● X Transceiver

# CENI TESTBED



Source: Ciena / Scott Kohlert

STARLIGHT<sup>SM</sup>

[www.startup.net/starlight](http://www.startup.net/starlight)

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

STARLIGHT<sup>SM</sup>