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

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Director, Metropolitan Research and Education Network (www.mren.org)
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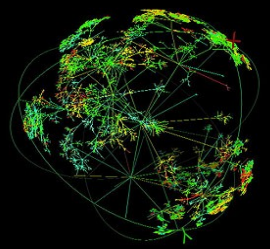
Co-Director, StarLight
Co-PI Maxine Brown, Director, (maxine@uic.edu)
Electronic Visualization Laboratory, University of Illinois at Chicago
Co-Director, StarLight
Jim Chen, Associate Director, International Center for Advanced Internet Research, Northwestern University



Global LambdaGrid Workshop
Miiami, Florida
September 29-30, 2016

IRNC: RXP: StarLight SDX Key Participants

- PI Joe Mambretti, Director, International Center for Advanced Internet Research
- Northwestern University, Director, Metropolitan Research and Education Network
- Director, StarLight, International/National Communications Exchange Facility
- Co-PI Tom DeFanti, Research Scientist, (tdefanti@soe.ucsd.edu)
- California Institute for Telecommunications and Information Technology (Calit2),
- University of California, San Diego
- Co-PI Maxine Brown, Director
- Electronic Visualization Laboratory, University of Illinois at Chicago
- Co-PI Jim Chen, Associate Director, International Center for Advanced Internet Research
- Northwestern University
- Senior Personnel
- Phil Papadopoulos, Program Director, UC Computing Systems, San Diego Supercomputer Center, UCSD, Associate Research Professor (Adjunct) Computer Science UCSD
- Tom Hutton, Network Architect, UC San Diego Supercomputing Center, SDSC/Calit2
- John Graham, Senior Development Engineer Calit2 UCSD
- Larry Smarr, founding Director of Calit2) a UC San Diego/UC Irvine partnership, Harry E. Gruber Professor in Computer Science and Engineering (CSE) at UCSD's Jacobs School.
- Linda Winkler, Senior Network Engineer, Math and Computer Science Division, Argonne National Laboratory, Senior Network Engineer, StarLight Facility, Technical Director, MREN
- Also, Other Members of the StarLight Consortium, Multi National and International Partners

STARLIGHT SDX

GriPhyN
Data Intensive Science

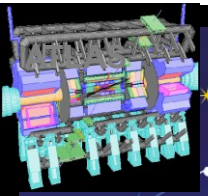
NEPTUNE
A Fiber-Optic Telescope to Inner Space

NEES

GENOMES to LIFE
BIOLOGICAL SOLUTIONS FOR ENERGY CHALLENGES
U.S. DEPARTMENT OF ENERGY

NG Digital Sky Survey

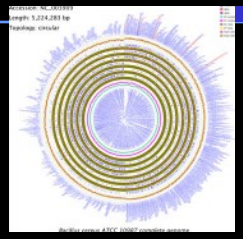
NEON
National Ecological Observatory Network



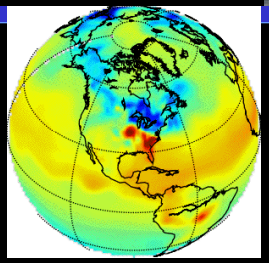
ALMA
ALMA: Atacama Large Millimeter Array

ANDRILL: Antarctic Geological Drilling
www.andrill.org

BIRN
BIRN: Biomedical Informatics Research Network
www.nbirn.net



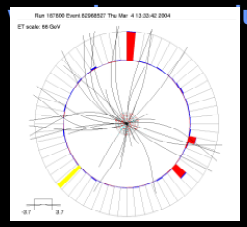
CAMERA metagenomics
camera.calit2.net



Carbon Tracker
www.esrl.noaa.gov/gmd/ccgg/carbontracker

CineGrid
CineGrid
www.cinegrid.org

LHCONE
www.lhcone.net



DØ (DZero)
www-d0.fnal.gov

GEON
GEON: Geosciences Network
www.geongrid.org

GLEON: Global Lake Ecological Observatory Network

OOI
OCEAN OBSERVATORIES INITIATIVE
CYBERINFRASTRUCTURE
Providing a link between ocean research and discovery
OOI-CI
ci.oceanobservatories.org

ISS: International Space Station
www.nasa.gov/station

CLASS
Comprehensive Large-Array Stewardship System
www.class.noaa.gov

LIGO
www.ligo.org

WLCG
Worldwide LHC Computing Grid
WLCG
lcg.web.cern.ch/LCG/public/

PRAGMA
Pacific Rim Applications and Grid Middleware Assembly
www.pragma-grid.net

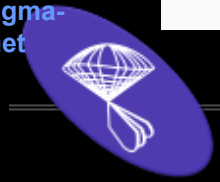
TeraGrid
TeraGrid
www.teragrid.org

IVOA
IVOA: International Virtual Observatory
www.ivoa.net

Open Science Grid
OSG
www.opensciencegrid.org

the globus alliance
Globus Alliance
www.globus.org

SKA
SQUARE KILOMETRE ARRAY
SKA
www.skatelescope.org



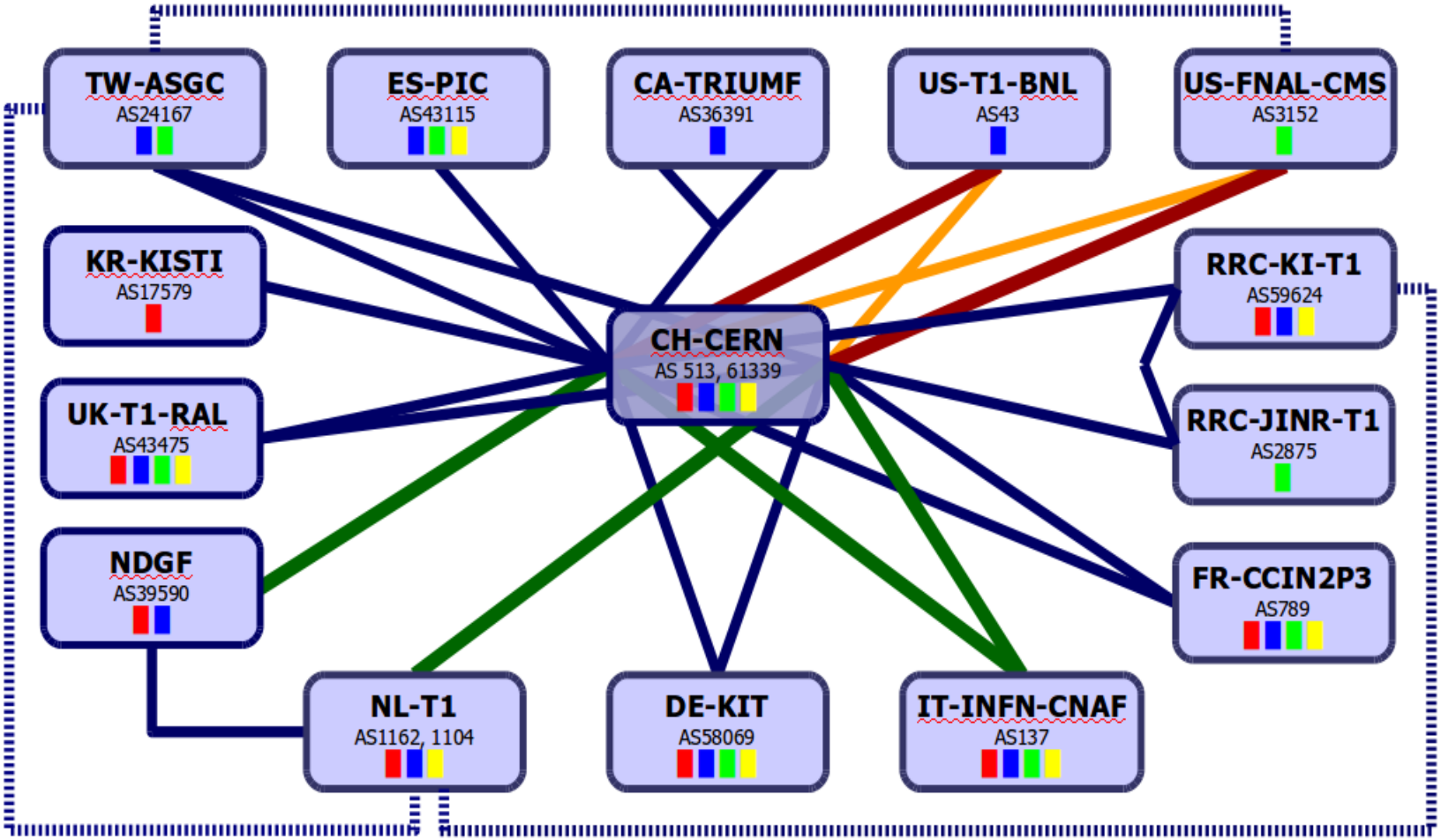
Sloan Digital Sky Survey
www.sdss.org

XSEDE
XSEDE
www.xsede.org

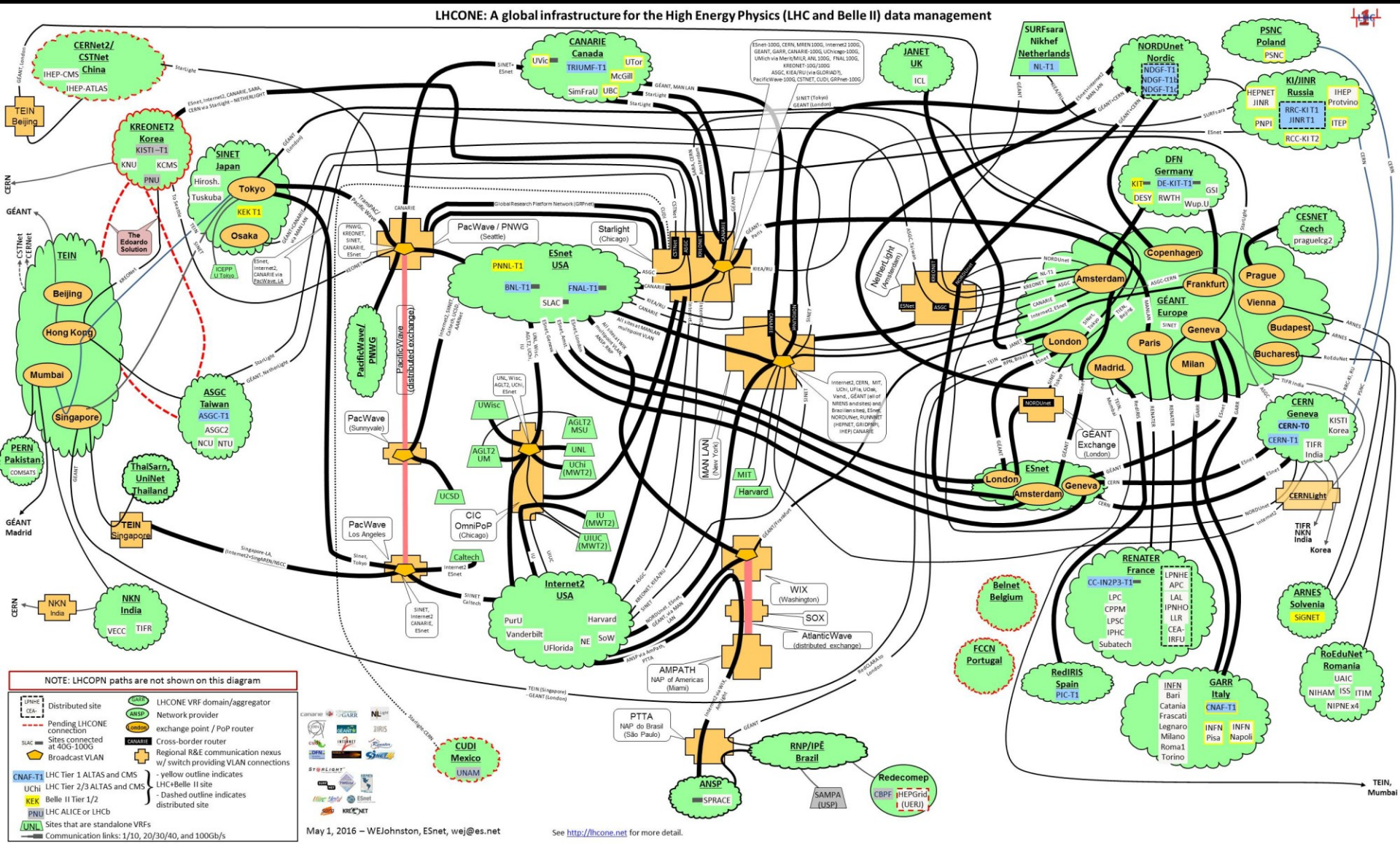
STARLIGHT

Compilation By Maxine Brown

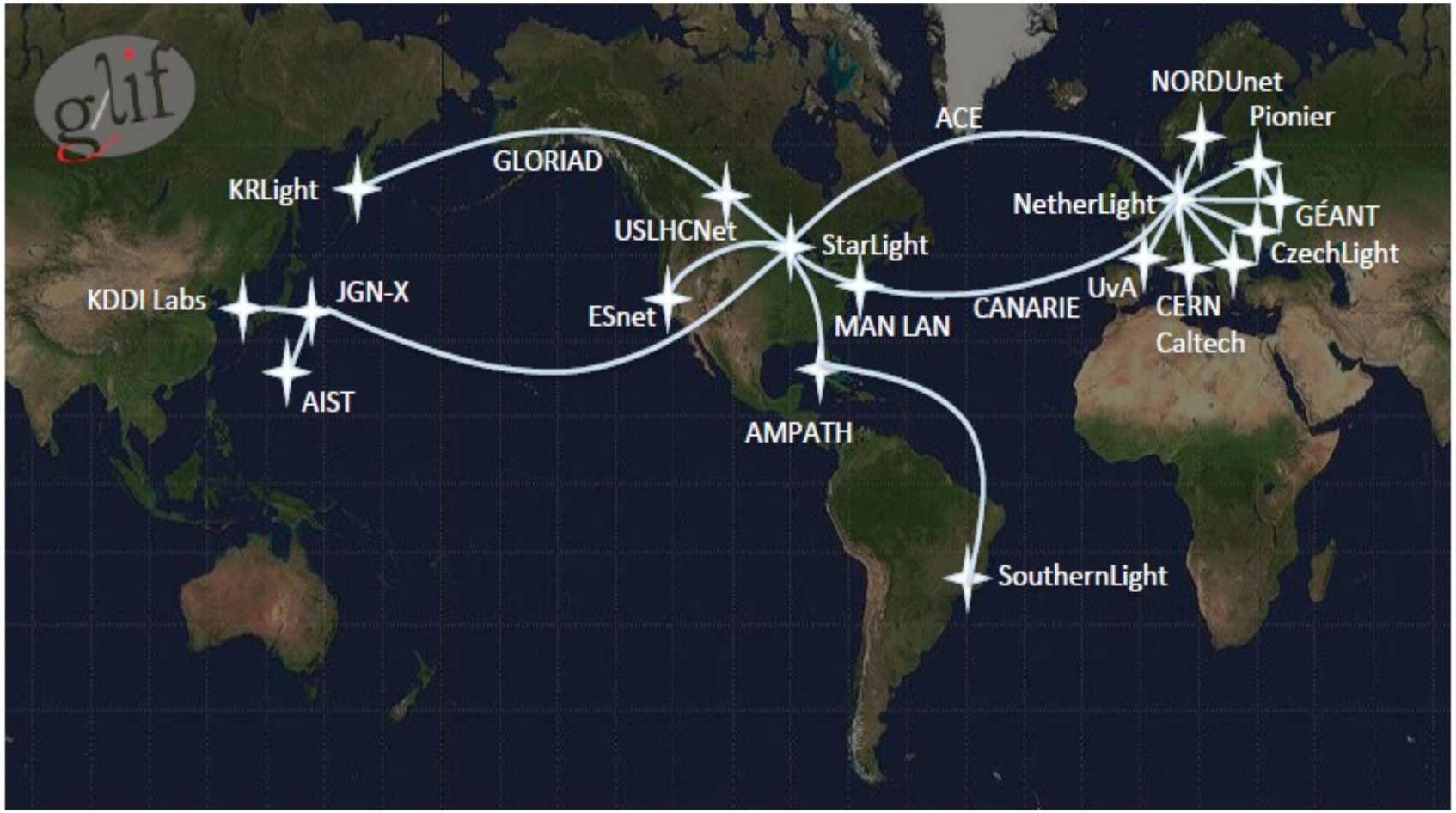
LHC Optical Private Network



LHCONE – LHC Open Network Environment

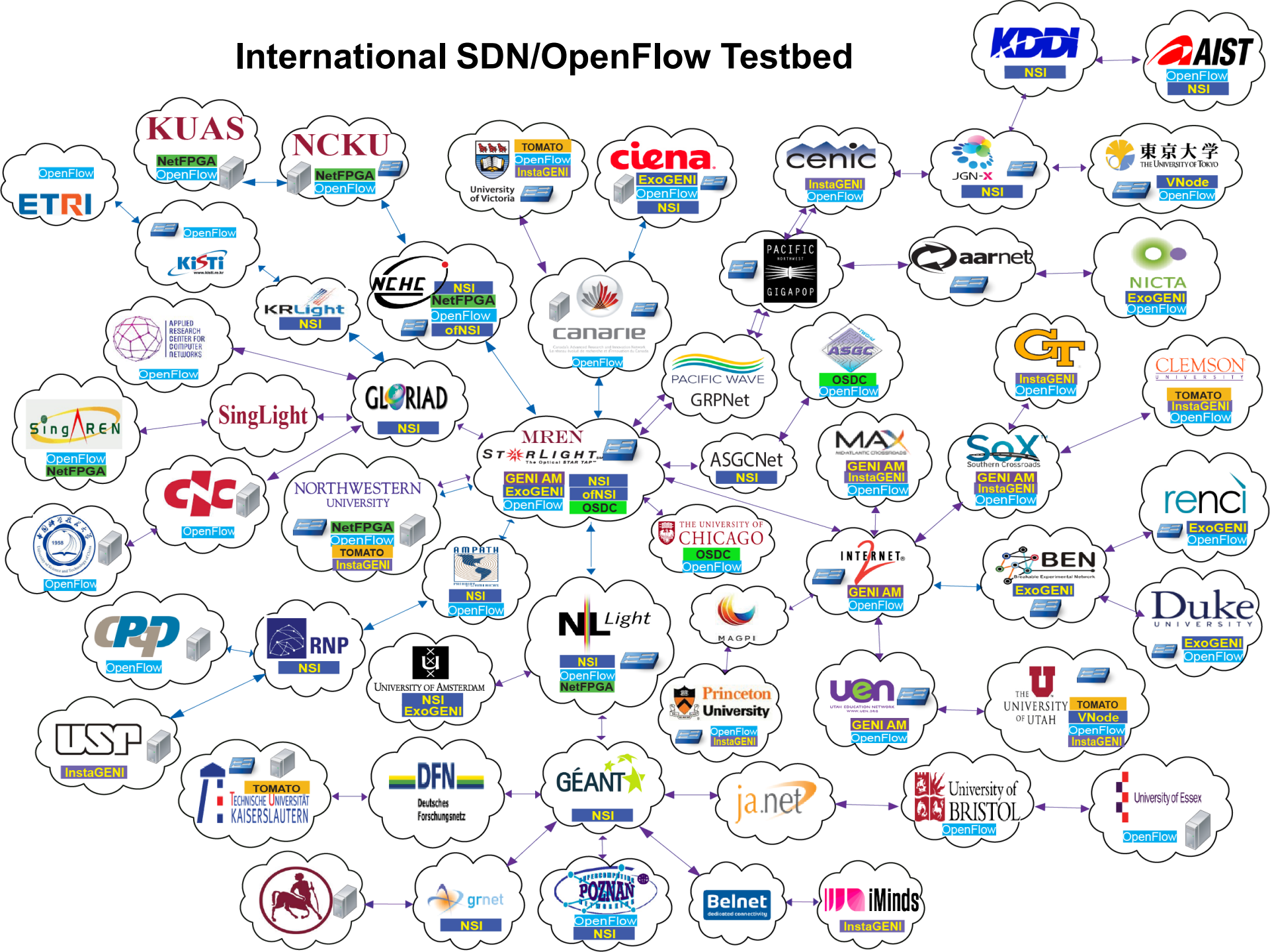


Automated GOLE Fabric



Source: GLIF Auto GOLE Group

International SDN/OpenFlow Testbed

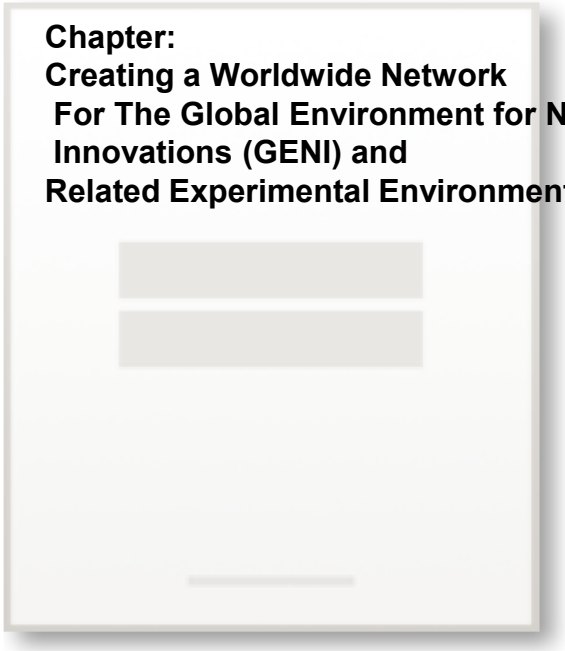


Forthcoming GENI Book: September 2016

Springer

springer.com

Chapter:
Creating a Worldwide Network For The Global Environment for Network Innovations (GENI) and Related Experimental Environments



1st ed. 2016, XVIII, 655 p. 216 illus., 183 illus. in color.

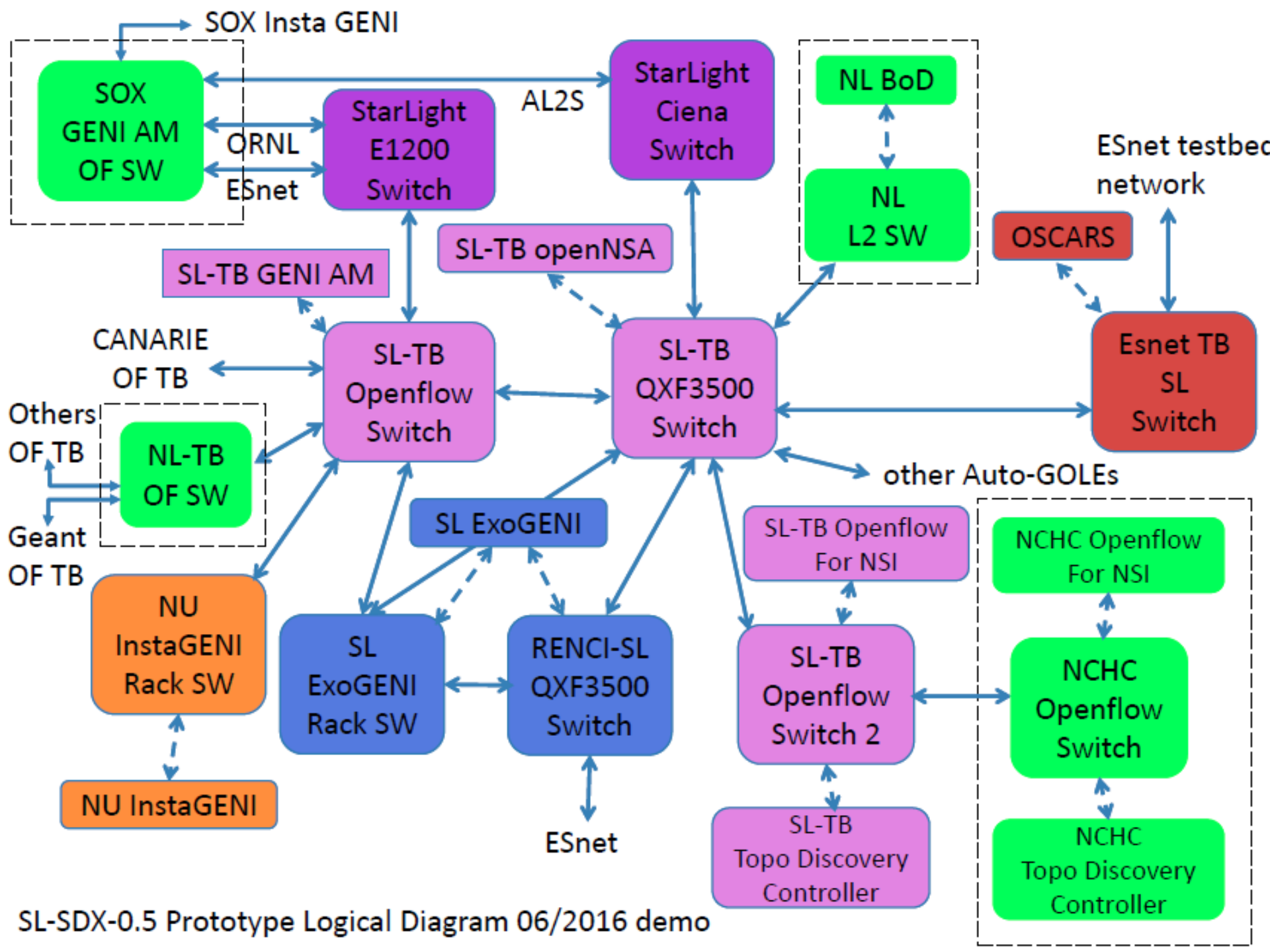
Printed book

R. **McGeer**, M. **Berman**, C. **Elliott**, R. **Ricci** (Eds.)

The GENI Book

- Provides a foundational overview of GENI's core architectural concepts
- Presents a detailed discussion of architecture and implementation
- Includes 24 chapters, divided into five sections, which outline GENI from precursors to architecture, development, applications, and then world federation
- Offers an extensive bibliography

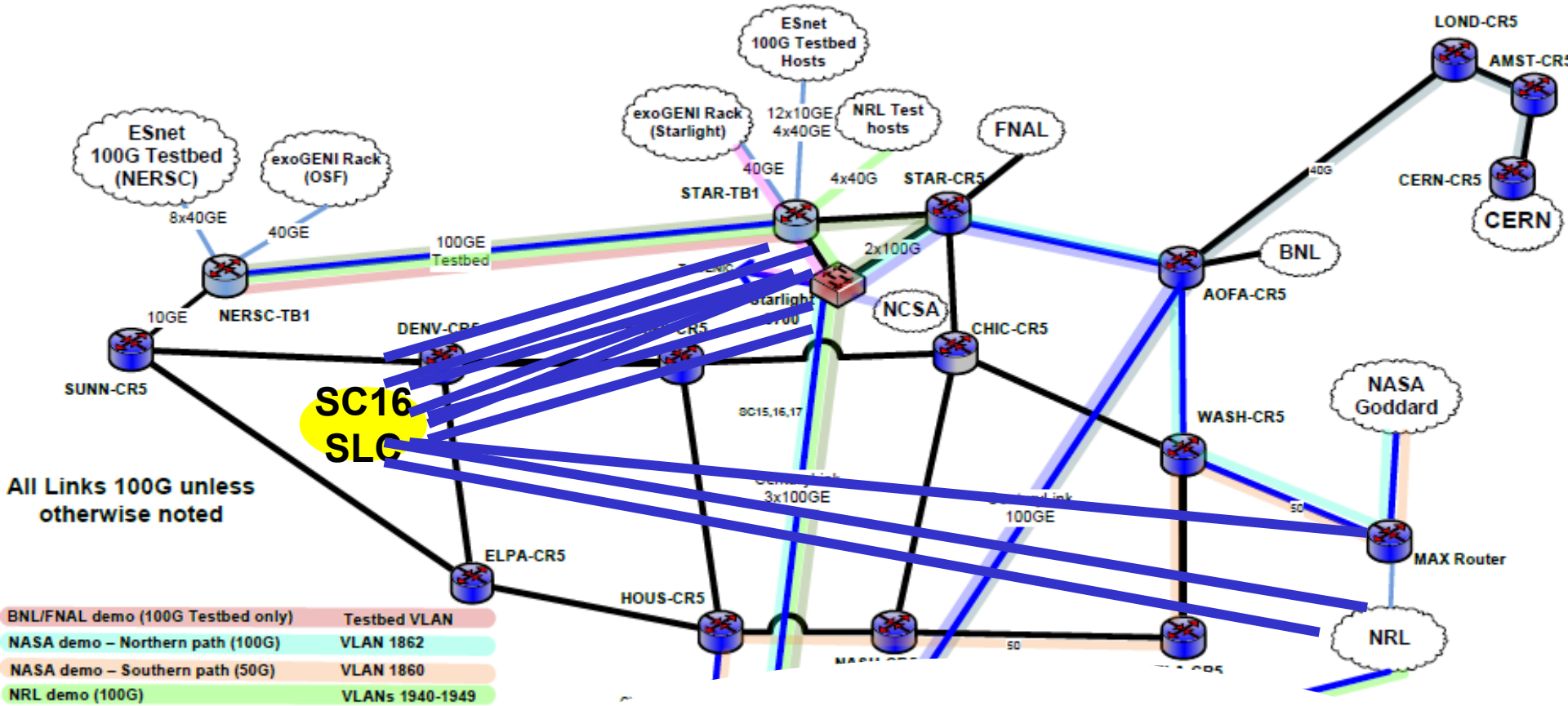
This book, edited by four of the leaders of the National Science Foundation's Global Environment and Network Innovations (GENI) project, gives the reader a tour of the history, architecture, future, and applications of GENI. Built over the past decade by hundreds of leading computer scientists and engineers, GENI is a nationwide network used daily by thousands of computer scientists to explore the next Cloud and Internet and the applications and services they enable, which will transform our communities and our lives. Since by design it runs on existing computing and networking equipment and over the standard commodity Internet, it is poised for explosive growth and transformational impact over the next five years.


SOX Insta GENI
SOX
GENI AM
OF SW
ORNL
ESnet
StarLight
E1200
Switch
AL2S
StarLight
Ciena
Switch
NL BoD
NL
L2 SW
ESnet testbed
network
OSCARS
SL-TB GENI AM
SL-TB openNSA
CANARIE
OF TB
SL-TB
Openflow
Switch
SL-TB
QXF3500
Switch
Esnet TB
SL
Switch
Others
OF TB
NL-TB
OF SW
Geant
OF TB
other Auto-GOLEs
SL ExoGENI
SL-TB Openflow
For NSI
NCHC Openflow
For NSI
NU
InstaGENI
Rack SW
SL
ExoGENI
Rack SW
RENCI-SL
QXF3500
Switch
SL-TB
Openflow
Switch 2
NCHC
Openflow
Switch
NU InstaGENI
ESnet
SL-TB
Topo Discovery
Controller
NCHC
Topo Discovery
Controller
SL-SDX-0.5 Prototype Logical Diagram 06/2016 demo

SC16 SDN/SDX/SDI 100 Gbps Demonstrations

- ~ 25 Sets of 100 Gbps Demonstrations at SC16, Almost All Which Involve Elements of SDN/SDX/SDI
- ***What's New=> Using Orchestrated SDX Services To Implement and Control WAN "Superchannels," In Part Enabled BY DTNs – Highly Scalable Dynamic Provisioning – A Scalability Not Possible On Today's Networks***

ESnet
ENERGY SCIENCES NETWORK



BNL/FNAL demo (100G Testbed only)	Testbed VLAN
NASA demo – Northern path (100G)	VLAN 1862
NASA demo – Southern path (50G)	VLAN 1860
NRL demo (100G)	VLANs 1940-1949
Caltech demo to NERSC (80G)	VLAN 2605
Caltech demo to CERN (40G)	VLAN 2606
StarLight/Ciena ExoGENI demo (40G)	VLAN 1779-1782
Aspera/NCSA demo (100G)	VLAN 2035

6*100 Gbps From StarLight
3* 100 Gbps from Wash DC

Other Demos 10G or Less:
- ESnet/RENCI demo: NERSC to ANL
- ESnet ENOS Demo: WASH, AMST, CERN
- ANL QoS Demo: DENV, ATLA

SC15 demos – ESnet
Brian Tierney, ESnet 11/6/2015
FILENAME SC15-DEMOS-V9.VSD

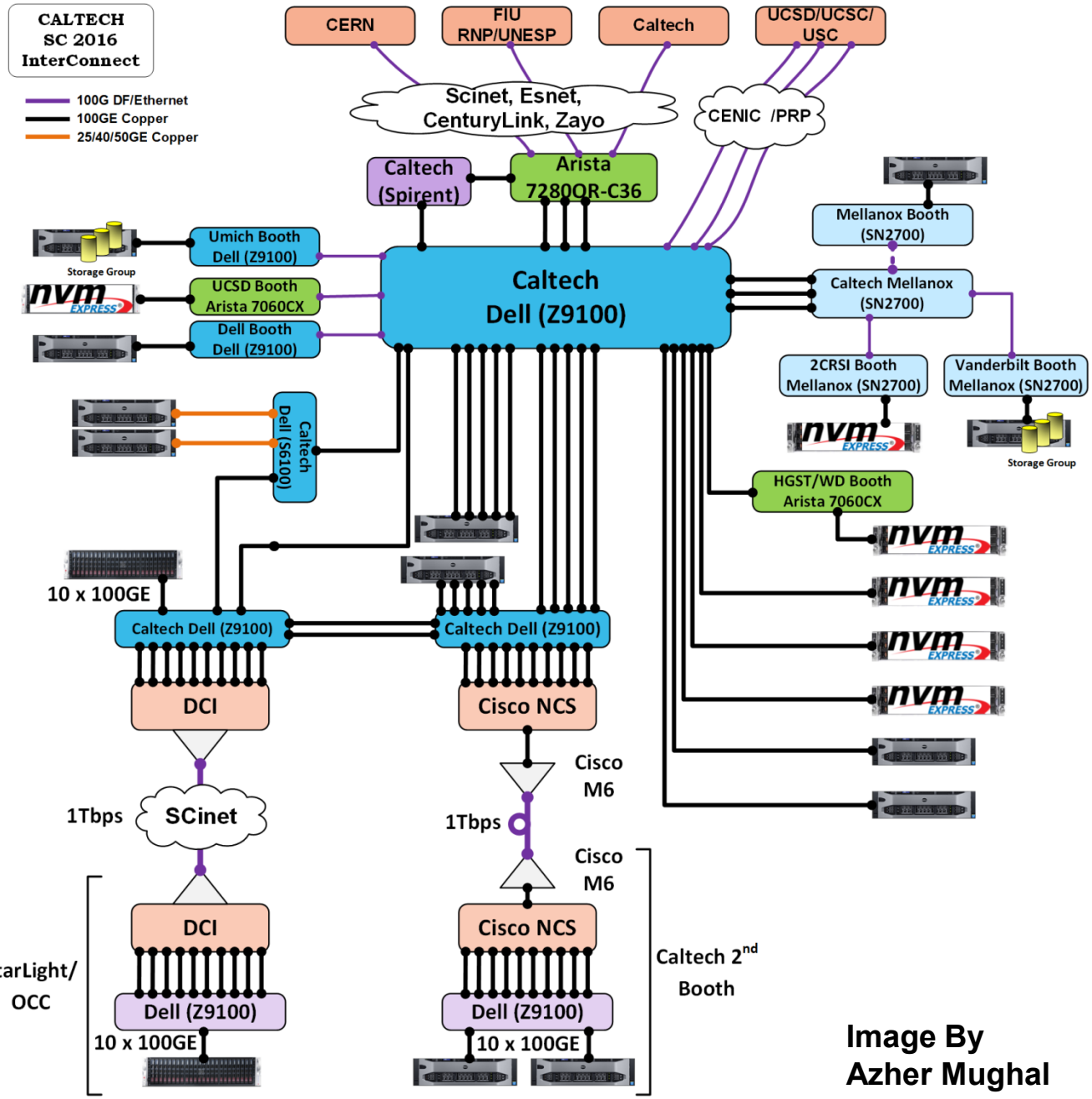
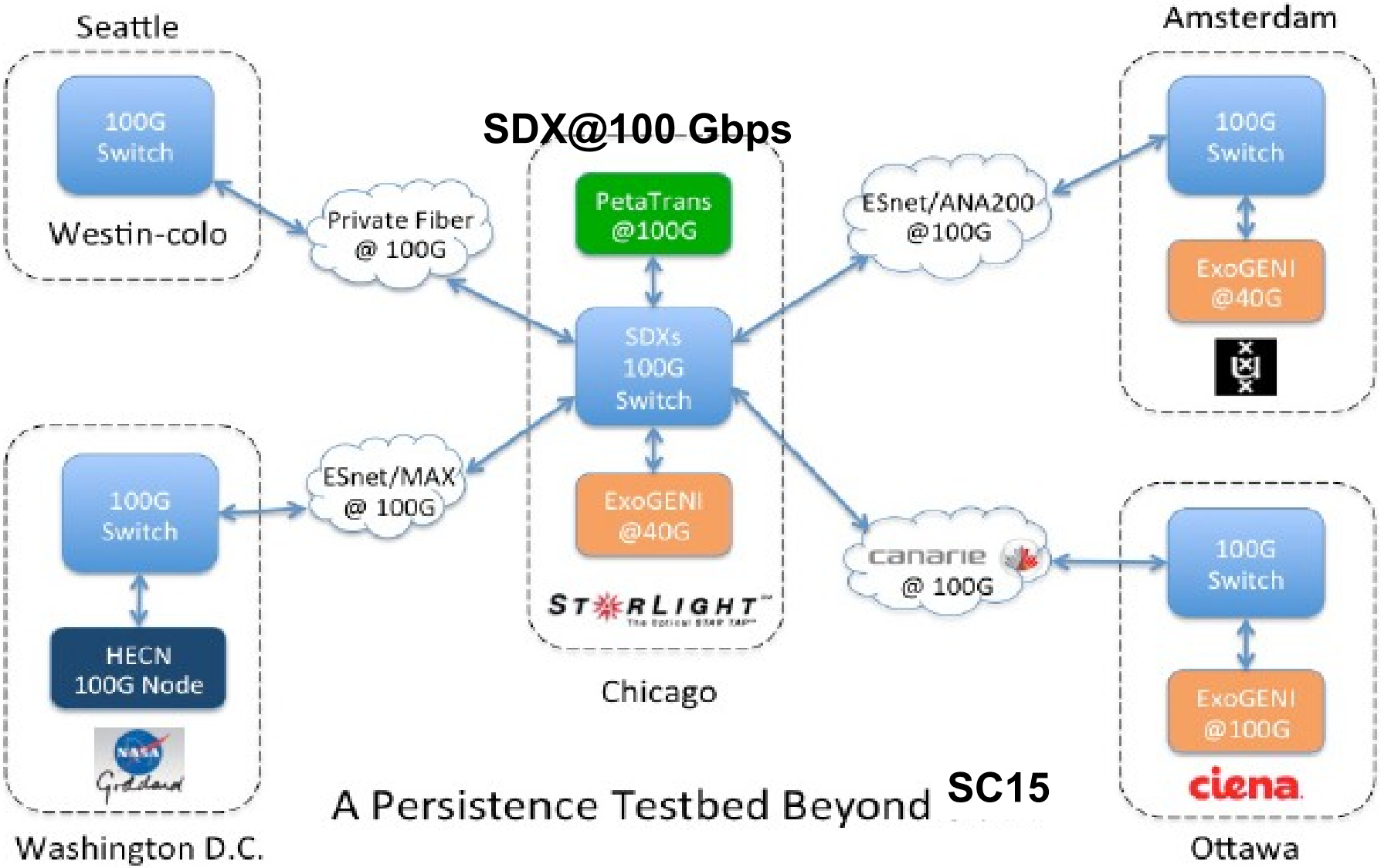


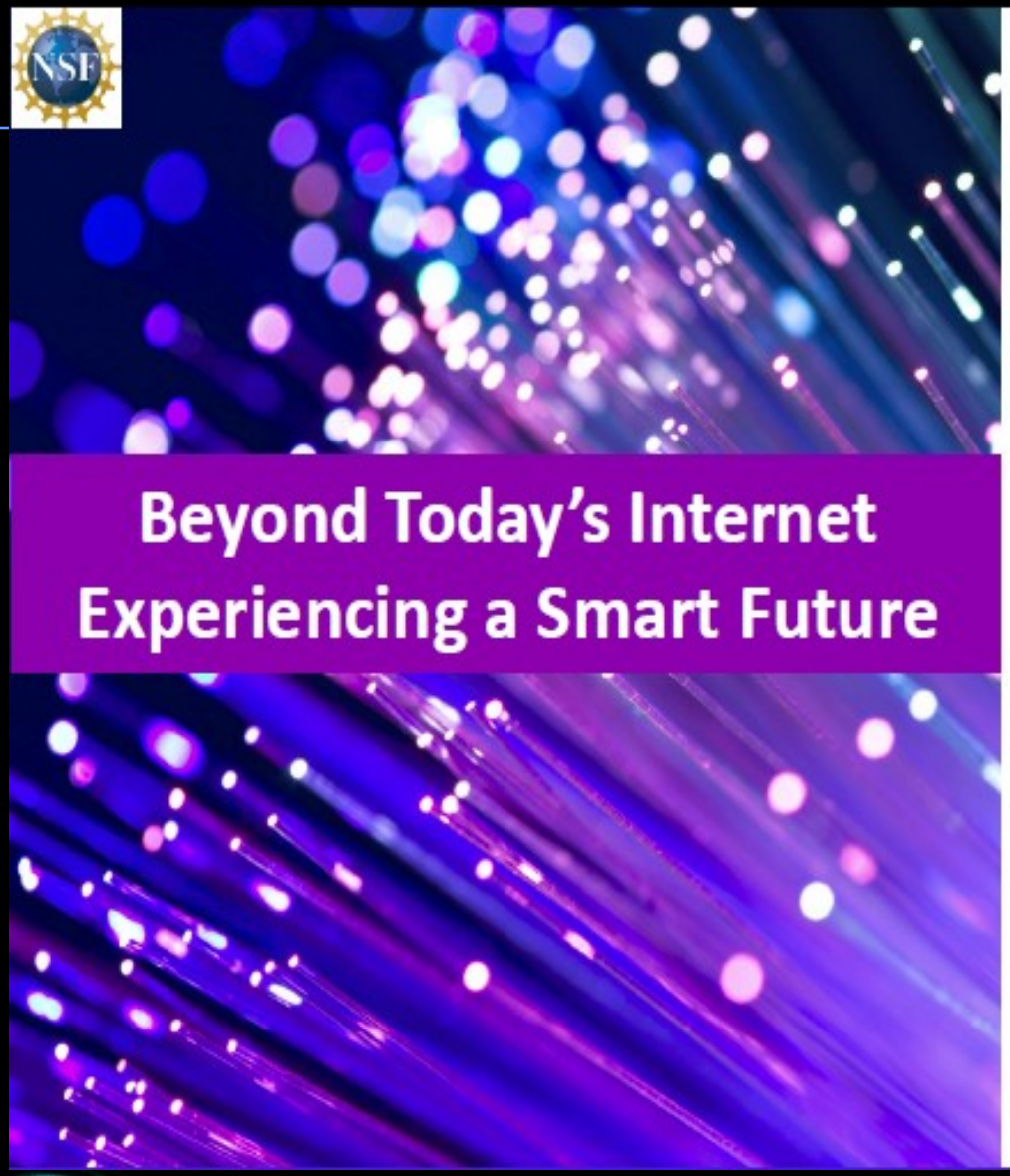
Image By
Azher Mughal

PetaTrans: **Petascale** Science Data Transfer



A Persistence Testbed Beyond **SC15**

Global Software-Defined Dynamic Circuits for Data Intensive Science
(PhEDEx – ANSE – PANDA - OpenDayLight)

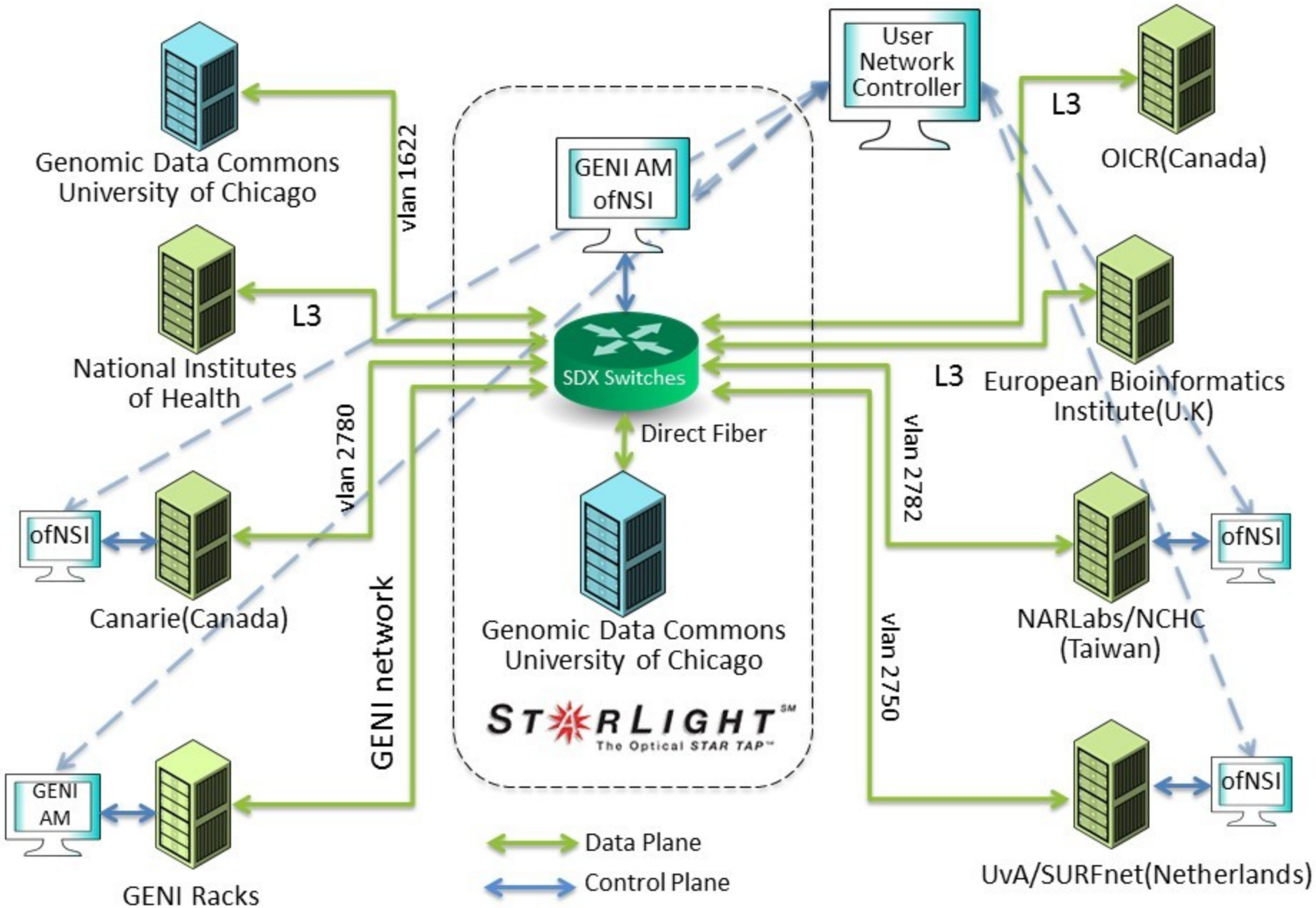


Prototype SDX Bioinformatics Exchange: Demonstrating an Essential Use-Case for Personalized Medicine

Robert Grossman, Piers Nash, Allison Heath, Renuka Arya
University of Chicago

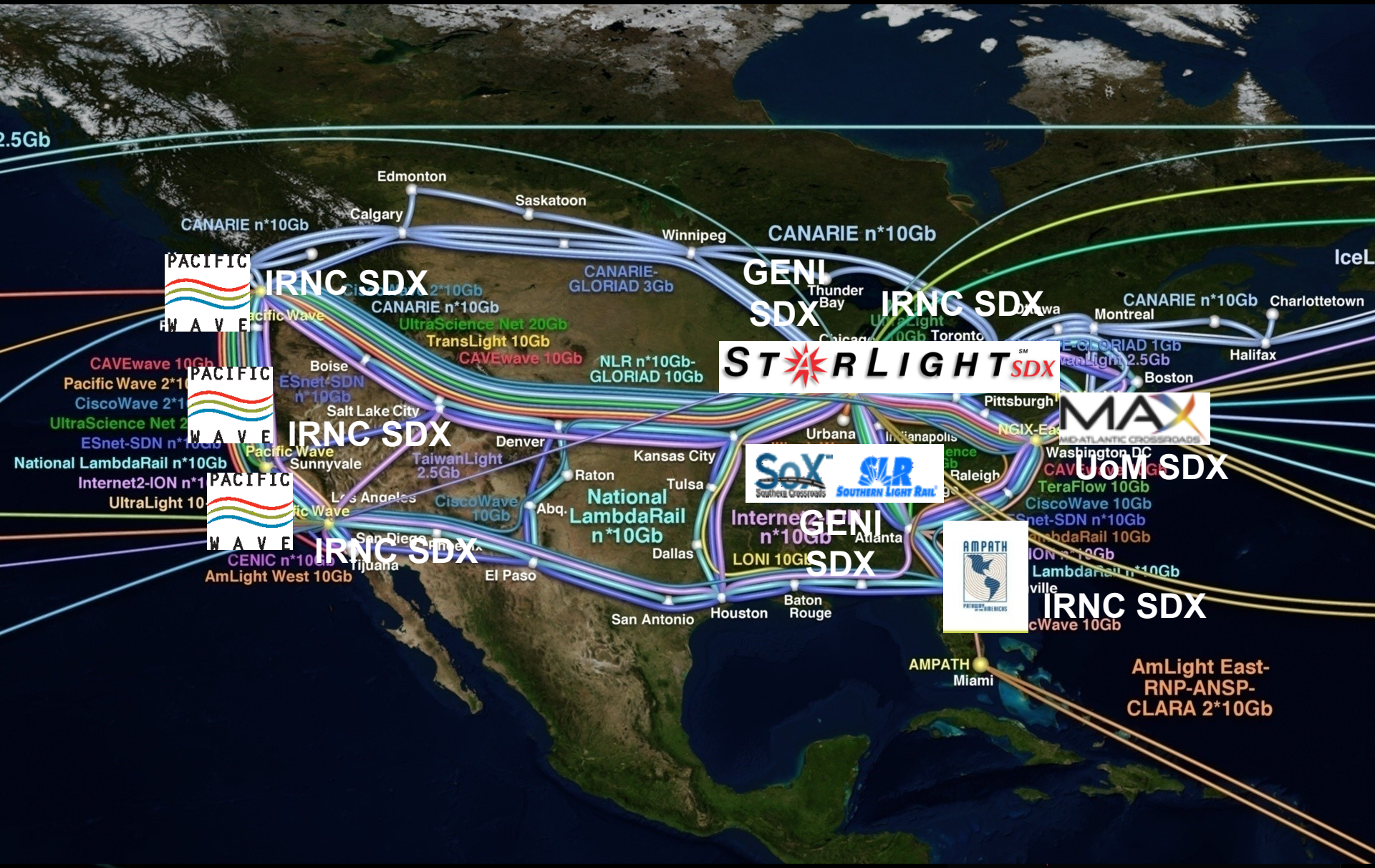
Joe Mambretti, Jim Chen
Northwestern University

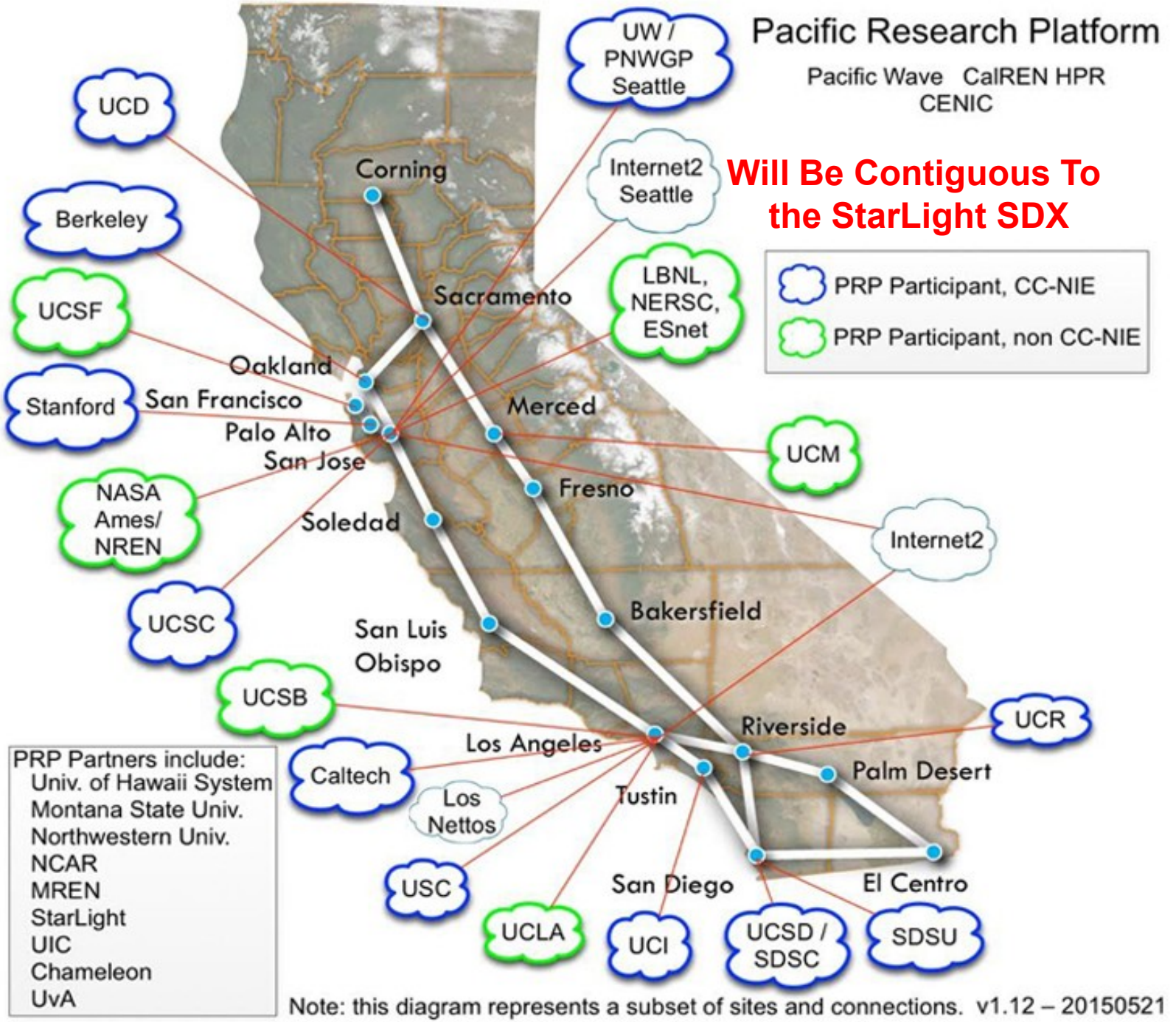
GEC22 Bioinformatics SDXs Demo Network



Vice President Biden visiting the CDIS Data Commons Operation Center on June 6, 2016.

Planned US SDX Interoperable Fabric

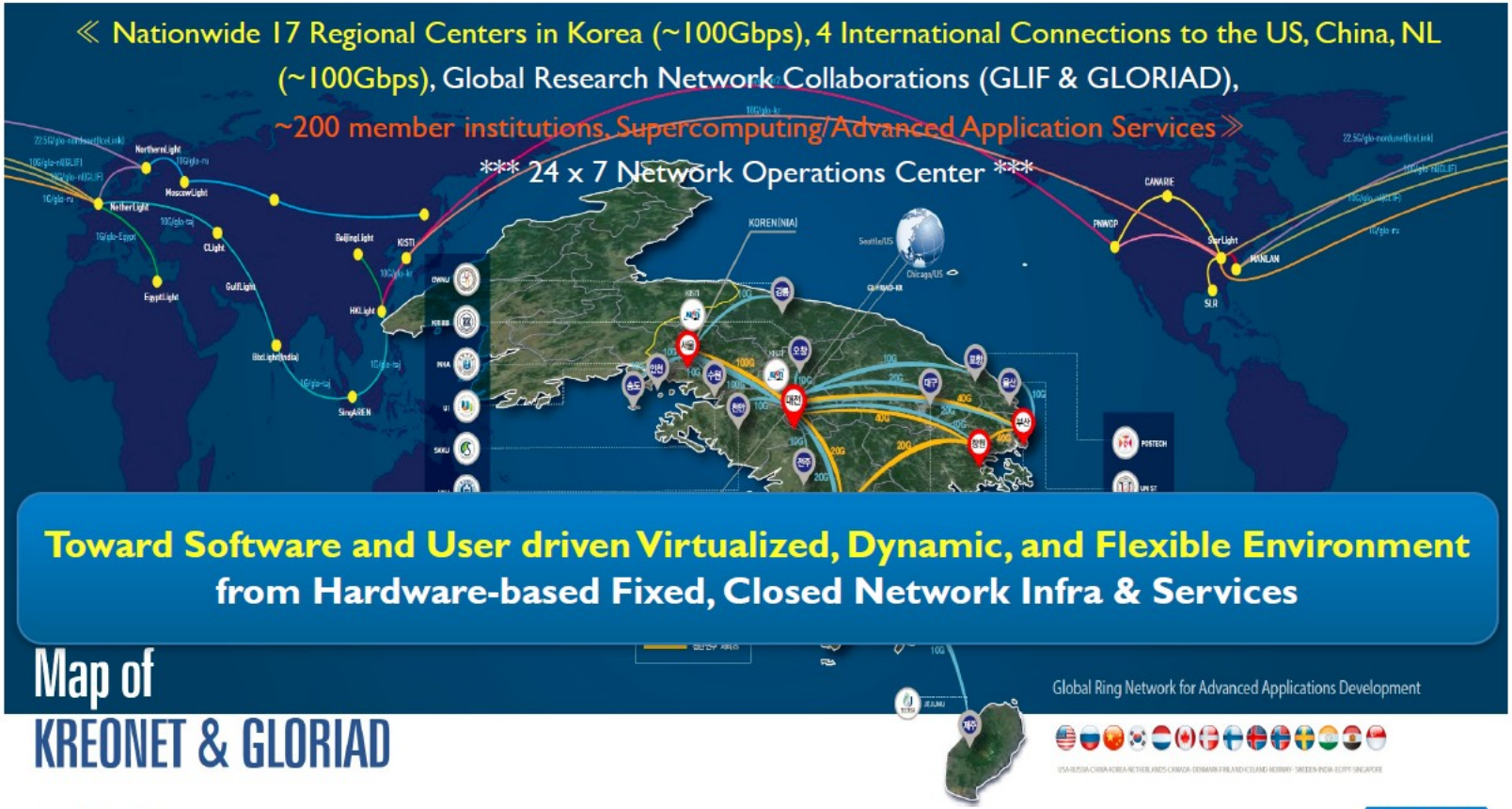



Pacific Research Platform
Pacific Wave CalREN HPR
CENIC
Will Be Contiguous To
the StarLight SDX
PRP Participant, CC-NIE
PRP Participant, non CC-NIE
UW / PNWGP Seattle
Internet2 Seattle
LBNL, NERSC, ESnet
UCD
Berkeley
UCSF
Stanford
NASA Ames/ NREN
UCSC
UCSB
Caltech
Los Nettos
USC
UCLA
UCI
UCSD / SDSC
SDSU
UCM
Internet2
UCR
Corning
Sacramento
Oakland
San Francisco
Palo Alto
San Jose
Soledad
Merced
Fresno
Bakersfield
San Luis Obispo
Los Angeles
Riverside
Palm Desert
Tustin
San Diego
El Centro
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

Next Step: Global Research Platform Building On CENIC/PacificWave/StarLight/GLIF

Current International GRP Partners

KREONET vs. KREONET-S



An Experimental Testbed For Computer Science Research

www.chameleoncloud.org

CHAMELEON:
A LARGE-SCALE, RECONFIGURABLE EXPERIMENTAL ENVIRONMENT FOR CLOUD RESEARCH

Principal Investigator: Kate Keahey

Co-PIs: J. Mambretti, D.K. Panda, P. Rad, W. Smith, D. Stanzione

Another SDX Opportunity – Especially For Federation!
SDX=> "Federation As A Service" Federated With GENI and Canadian SAVI, EU FIRE, Grid'5000 etc

www.startap.net/starlight

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