Next Generation Infrastructure For High Performance Global Data Intensive Science

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Large Scale Networking (LSN) Workshop on Huge Data:

A Computing, Networking and Distributed Systems Perspective

April 13-14, 2020

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Large Scale Data Intensive Science Motivates the Creation of Next Generation Communications

- **Large Scale, Data, and Compute Intensive Sciences Encounter Technology Challenges Many Years Before Other Domains**

- **Resolving These Issues, Especially For Global Science, Creates Solutions That Later Migrate To Other Domains**

- **30+ Year History of Communication Innovations Has Been Driven Primarily By Data and Compute Intensive Sciences**

- **Window To the Future: Requirements For Data and Compute Intensive Science Research**

- **Science Has Added To Two Classic Building Blocks, Theory and Experimentation a Third – Modeling, Simulation, and Analytics Using Massive Amounts of Data**

- **Petabytes, Exabytes, Zettabytes**

- **For Communication Service Supporting Global Data Transport, Capacity And Programmability Are Major Issues**

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Selected Applications

GENI
www.geni.net

Open Storage Network
www.openstorage network.org

OSG
www.opensolence grid.org

Polar Geospatial Center
www.pgc.umn.edu

LSST
www.lsst.org

NASA

Virgo
www.virgo-gw.eu

CERN

OSIRIS
www.carla.org

GRP
theglobalresearch platform.net/

IceCube
icecube.wisc.edu

ISS
www.nasa.gov/ station

LIGO

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

GLEON
www.gleon.org

XSEDE
www.xsede.org

PRP
pacificresearch platform.org

Chameleon
www.chameleon cloud.org

Pierre Auger Observatory
www.auger.org

SKA
www.skatelescope. org

LIGO
www.ligo.caltech. edu

USGS EROS
www.usgs.gov/ centers/eros

Blue Waters
bluewaters.ncsa. illinois.edu

Jetstream
www.jetstream-cloud.org

Belle II
www.belle2.org

XENON
Dark Matter Project

SDSS
www.sdss.org

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

PRAGMA
www.pragma-grid.net

CHASE-CI
www.calit2.net/ newsroom/artic le.php?id=2910

Genomic Science Program
genomicscience. energy.gov

XENON
xenon.astro. columbia.edu

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

NEON
www.neonscience. org

CENTRA
www.global centra.org

SAGE2
sage2.sagecommons. org

LBNF/DUNE/ ProtoDUNE
lbnf.fnal.gov

NOvA
novaexperiment. fnal.gov

ALMA
www.alma observatory.org

IVOA
www.ivoa.net

LHCONE – B. Johnston

LHCONE L3VPN: A global infrastructure for High Energy Physics data analysis (LHC, Belle II, Pierre Auger Observatory, NOvA, XENON)
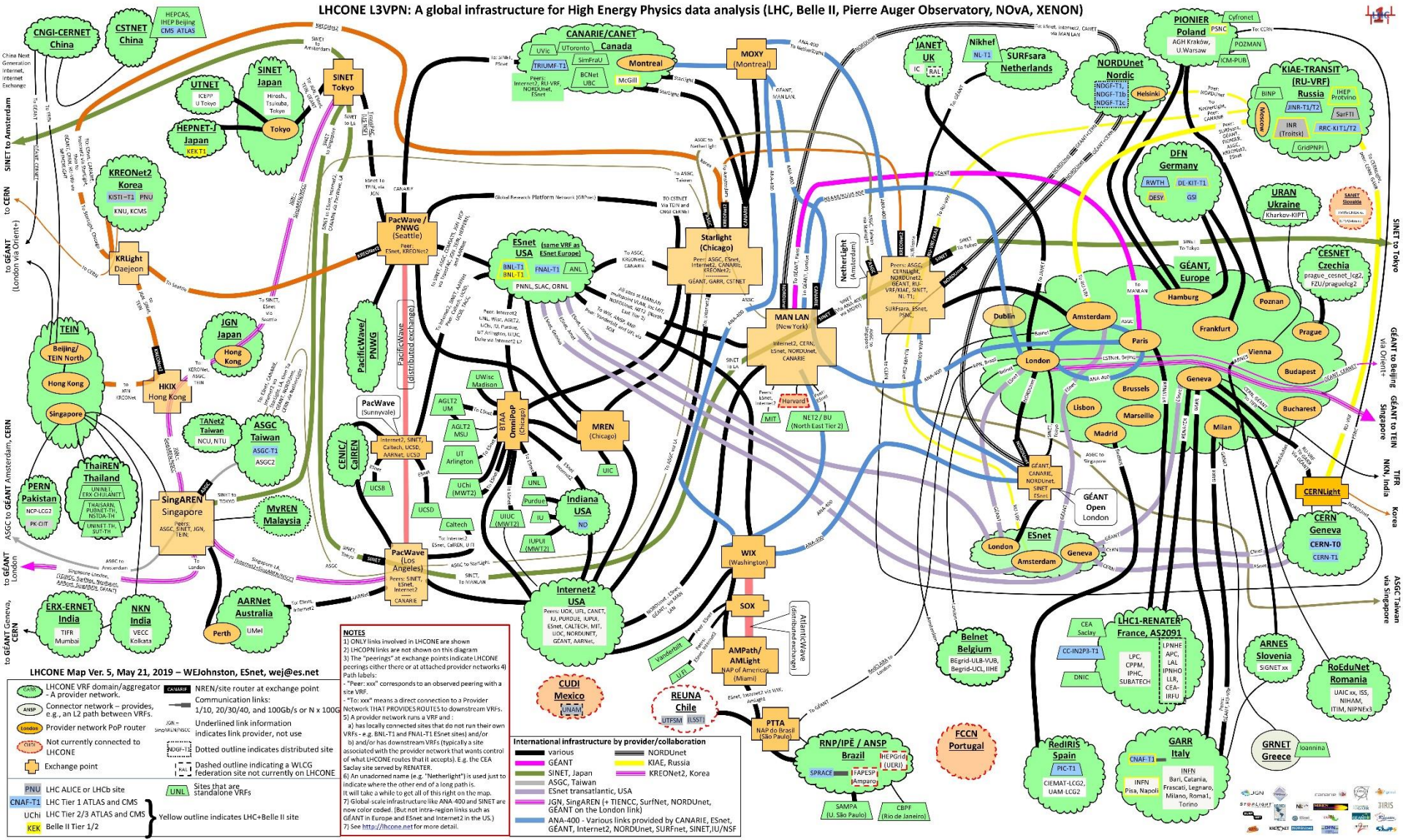
Selected Research Topics In Networking

- **Transition From Legacy Networks To Networks That Take Full Advantage of IT Architecture and Technology**
- **Extremely Large Capacity (Multi-Tbps Streams)**
- **Specialized Network Services, Architecture and Technologies for Data Intensive Science**
- **High Degrees of Communication Services Customization**
- **Highly Programmable Networks**
- **Network Facilities As Enabling Platforms for Any Type of Service**
- **Network Virtualization**
- **Tenet Networks**
- **Network Virtualization**
- **Network Programming Languages (e.g., P4) API (e.g., Jupyter)**
- **Disaggregation**
- **Orchestrators**
- **Highly Distributed Signaling Processes**
- **Network Operations Automation (Including Through AI/Machine Learning)**
- **SDN/SDX/SDI/OCX/SDC/SDE**

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Next Generation Distributed Enviroment
For Global Science

PRP/TNRP and MREN Research Platform

Nautilus Mesh Dashboard

Nautilus Mesh - Latency - Loss

My perfSONAR Dashboard

≡ Dashboards   ▤ Reports   ● Settings

MREN Mesh Dashboard

MREN Mesh - Latency_v555 - Loss

MREN Mesh - throughput_v555 - Throughput

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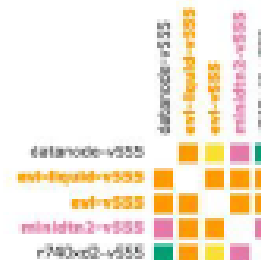
STARLIGHTSDX

Global Lambda Integrated Facility
Available Advanced Network Resources

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

www.glif.is

StarLight – "By Researchers For Researchers"

StarLight: An Advanced Optical Based Exchange And Proving Ground For Next Gen Network Services And Technology - Optimized for High-Performance Data Intensive Science (Over 60 100 Gbps Paths) Also Supporting ~ 40 Major Network Testbeds Many National & International

View from StarLight

Abbott Hall, Northwestern University's Chicago Campus

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

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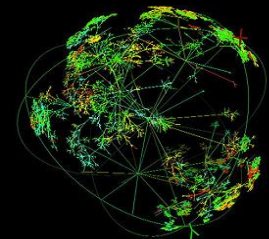
National Science Foundation
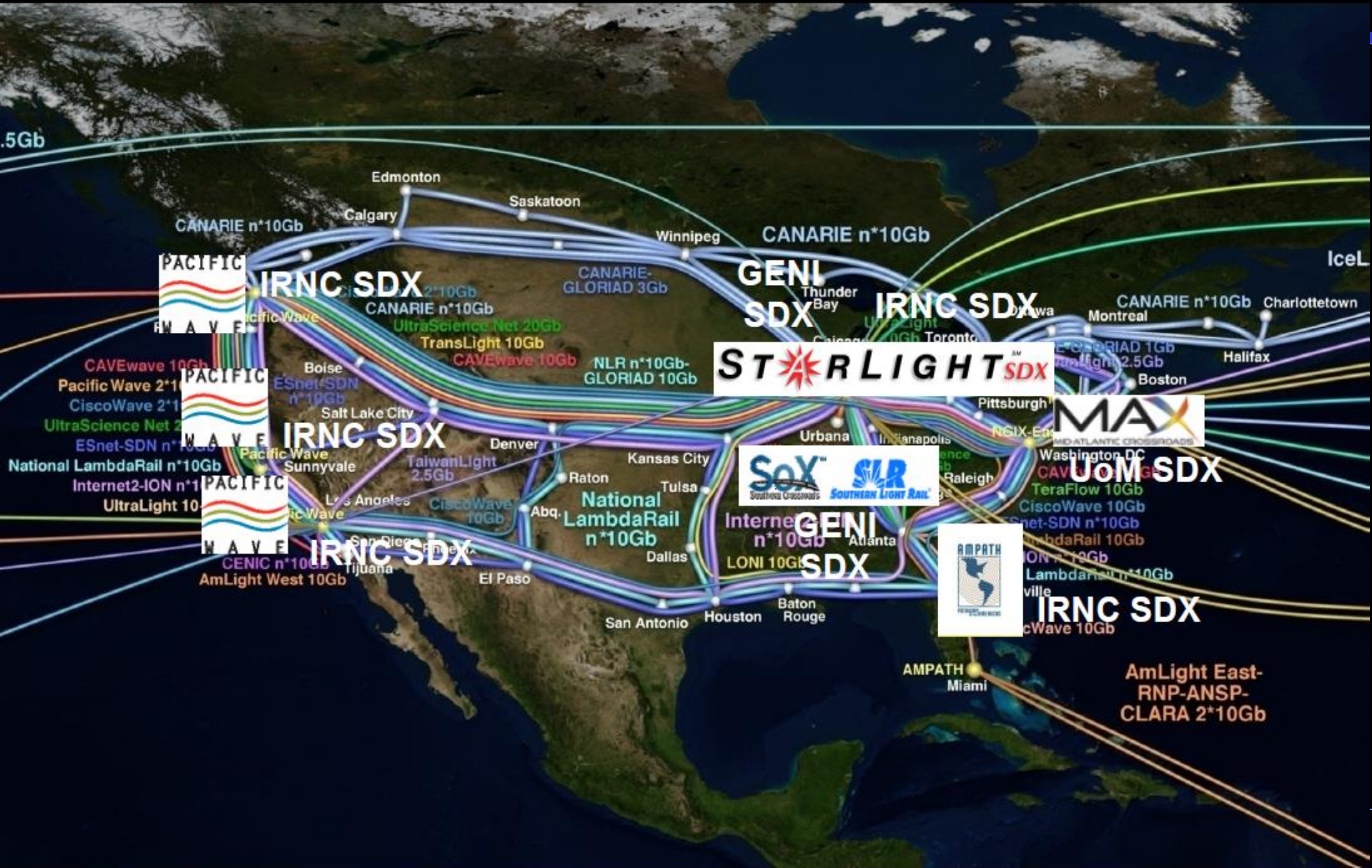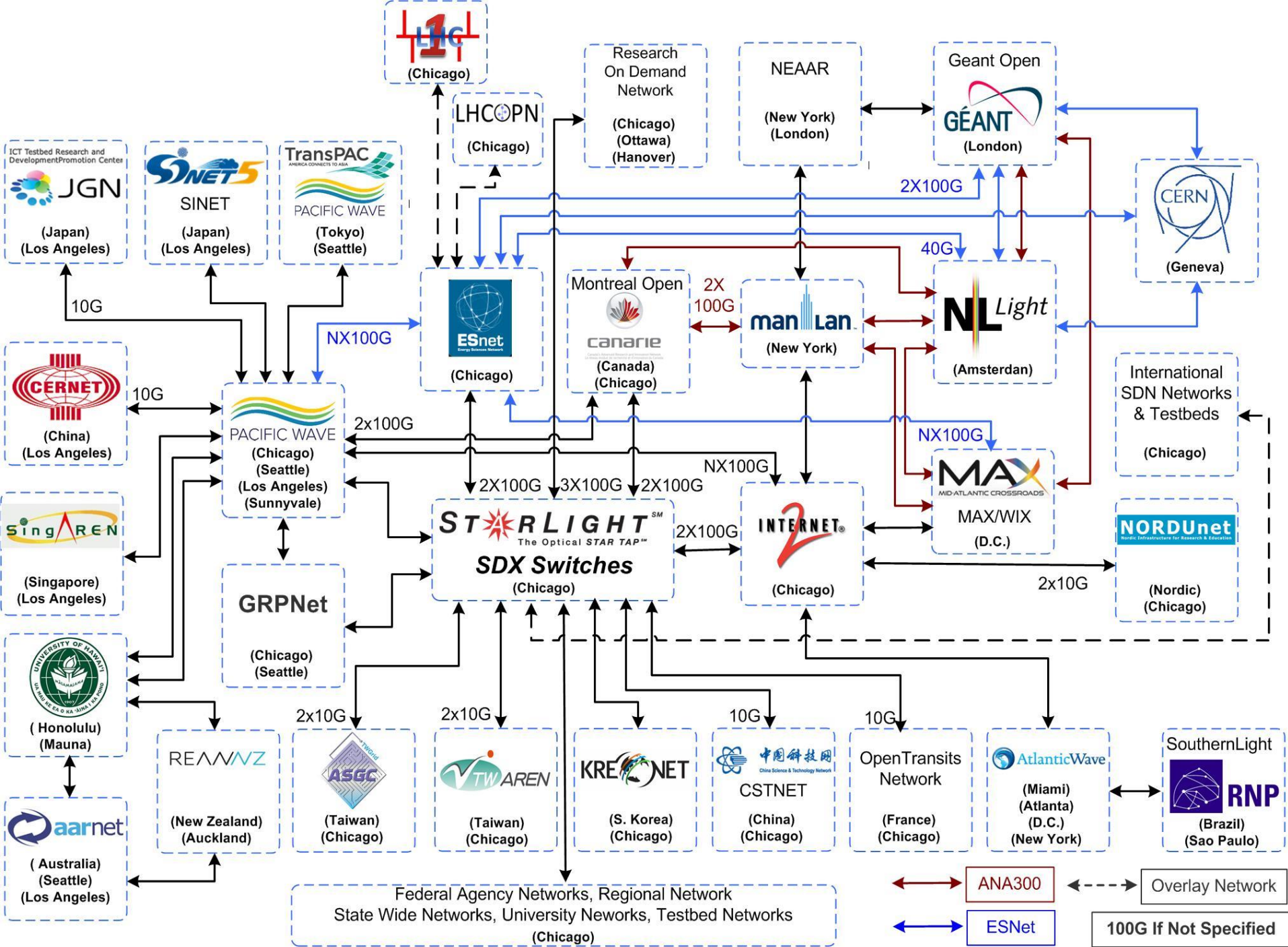**International Research Network Connections Program**
Workshop
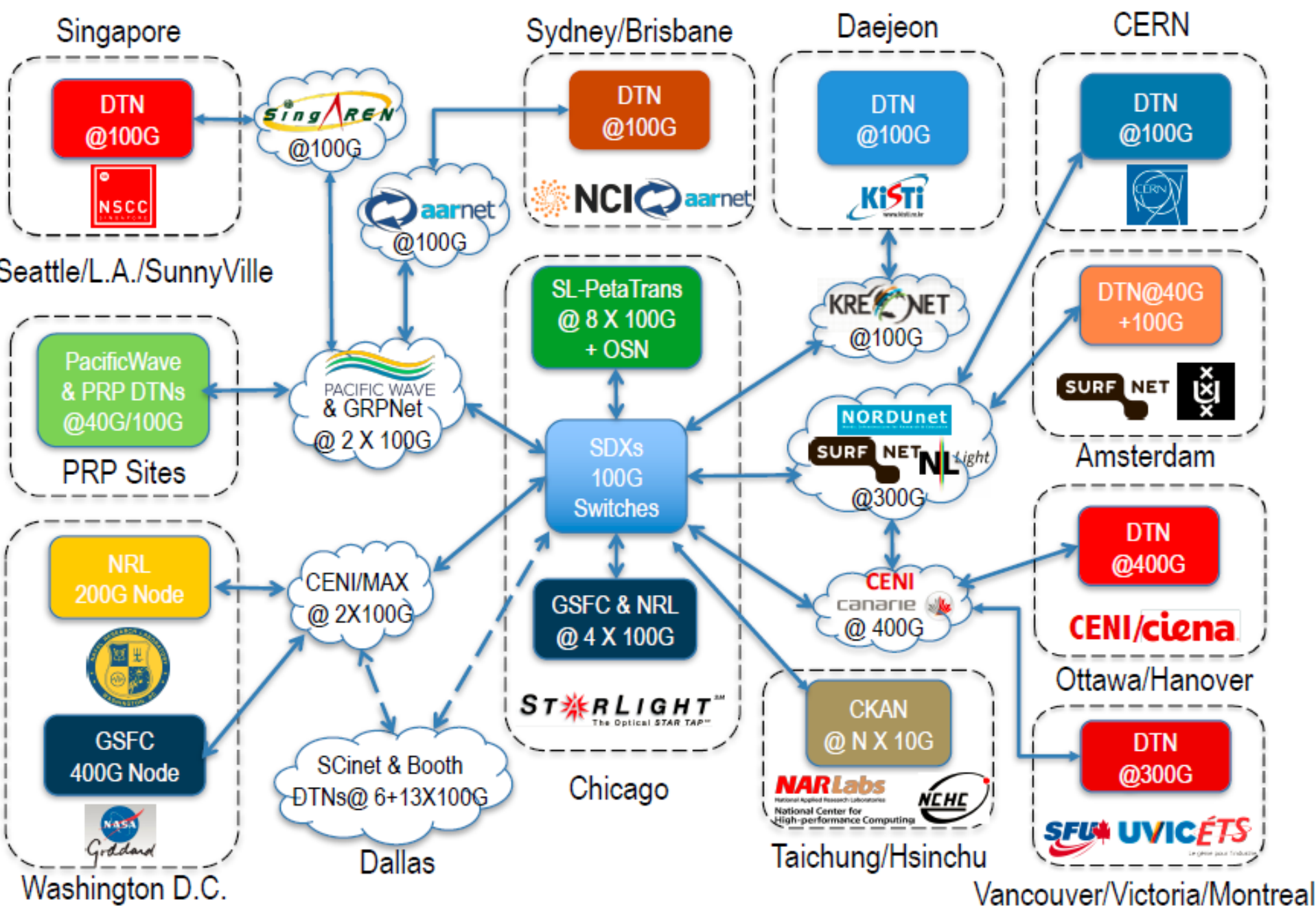**Chicago, Illinois**
May 15, 2015

Emerging US SDX Interoperable Fabric

PetaTrans: Petascale Sciences Data Transfer

Ilya Baldine PI, RENCI: FABRIC

www.startap.net/starlight

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