Global Research Platform Workshop: An Overview

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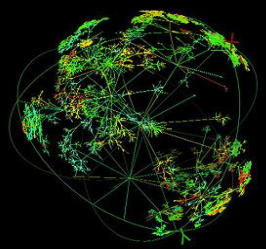
PI IRNC: RXP: StarLight SDX, Co-PI Chameleon, PI-iGENI, PI-OMNINet

National Research Platform Workshop
UCSD, La Jolla, California
January 28-30, 2025



iCAIR

STARLIGHT SDX

Next Generation Distributed Environment For Global Science

A Next Generation Ecosystems for New Knowledge Discovery

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NSF's Cyberinfrastructure Framework for the 21st Century (CIF21)

- Large Scale, Powerful and Sophisticated Instrumentation Integrated With New Computational Science Methods Are Revolutionizing New Knowledge Discovery In all Major Science Disciplines.
- According to the US National Science Foundation: *"This Revolution Will Transform Research, Practice, And Education In Science and Engineering As Well As Advance Innovation In Society"*
- NB: Policy Statements Published By Related Agencies In Multiple Countries
- This Transformation Is Made Possible By *"A Comprehensive, Scalable, Cyberinfrastructure That Bridges Diverse Scientific Communities and Integrates High--Performance Computing, Data, Software, and Facilities …Bringing Theoretical, Computational, Experimental, and Observational Approaches Together To Advance the Frontier."*

Large Scale Science Ecosystems

- Science Domains Are Creating Cyberinfrastructure Ecosystems, Including Those That Are Large Scale And Distributed World Wide, Both Devoted To Domains and Shared Among Domains
- Planning Projections Define Future, Specialized Requirements.
- In Response Cyberinfrastructure ***Blueprints*** Are Created: Architecture, Services, Techniques, Technologies, Processes, et al
- Many Current Studies Are Examining Relationships Between Science Workflows Are Foundation Resource Services and Resources, Particularly With AI/ML/DL Overlays
- Results Define Next Generation Ecosystems

Global Collaborative Research Communities

- ***Science Is Global***
- **The Global Research Platform (GRP) Is An International Collaborative Partnership Creating A Distributed Environment (Ecosystem) for International Data Intensive Science**
- **Open Information Sharing, A Cornerstone of The Science Process, Motivates This Forum**
- **The GRP Provides Opportunities For eScience Environment Information Sharing To Among Collaborative Science Communities World-Wide -- Concepts, Experiments, Instruments, Methods, Techniques, Data, Architecture, Implementation, Technologies, Operations, and Results**
- **The GRP Facilitates High Performance World-Wide Data Gathering, Analytics, Transport (100 Gbps-Tbps E2E), Computing, And Storage**
- **www.theglobalresearchplatform.net**


Annual Global Research Platform Workshop – Co-Located With
IEEE International Conference On eScience Sept 16-17, 2024
2025 Edition = Co-Located With
IEEE International Conference On eScience
Chicago, Illinois Sept 15-19, 2025

Selected Applications/Instruments

GENI
www.geni.net

Open Storage Network
www.openstorage network.org

OSG
www.openscience grid.org

Polar Geospatial Center
www.pgc.umn.edu

LSST
www.lsst.org

ISS
www.nasa.gov/ station

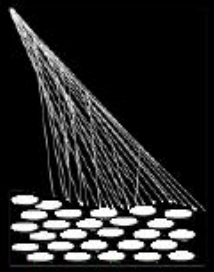
Virgo
www.virgo-gw.eu

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

GLEON
www.gleon.org

GRP
theglobalresearch platform.net/

IceCube
icecube.wisc.edu



Pierre Auger Observatory
www.auger.org

LIGO
www.ligo.caltech. edu

SKA
www.skatelescope. org

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

USGS EROS
www.usgs.gov/ centers/eros

Blue Waters
bluewaters.ncsa. illinois.edu

Chameleon
www.chameleon cloud.org

Jetstream
www.jetstream-cloud.org

Belle II
www.belle2.org

XENON
xenon.astro. columbia.edu

SDSS
www.sdss.org

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

PRAGMA
www.pragma-grid.net

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

Genomic Science Program
genomicscience. energy.gov

LBNF/DUNE/ ProtoDUNE
lbnf.fnal.gov

NOvA
novaexperiment. fnal.gov

ALMA
www.alma observatory.org

NEON
www.neonscience. org

CENTRA
www.global centra.org

SAGE2
sage2.sagecommons. org

IVOA
www.ivoa.net

Compilation by Maxine Brown and Joe Mambretti

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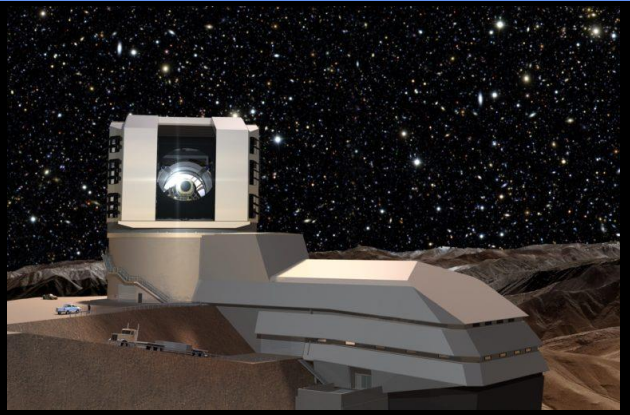
Instruments: Exebytes Of Data

High Luminosity LHC

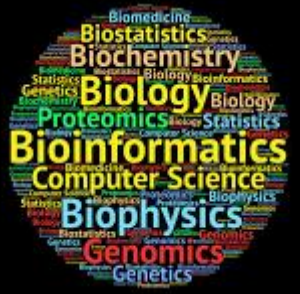
SKA Australia Telescope Facility



Vera Rubin Observatory

KSTAR Korea Superconducting Tokamak

Next Gen Advanced Photon Source



Bioinformatics/Genomics

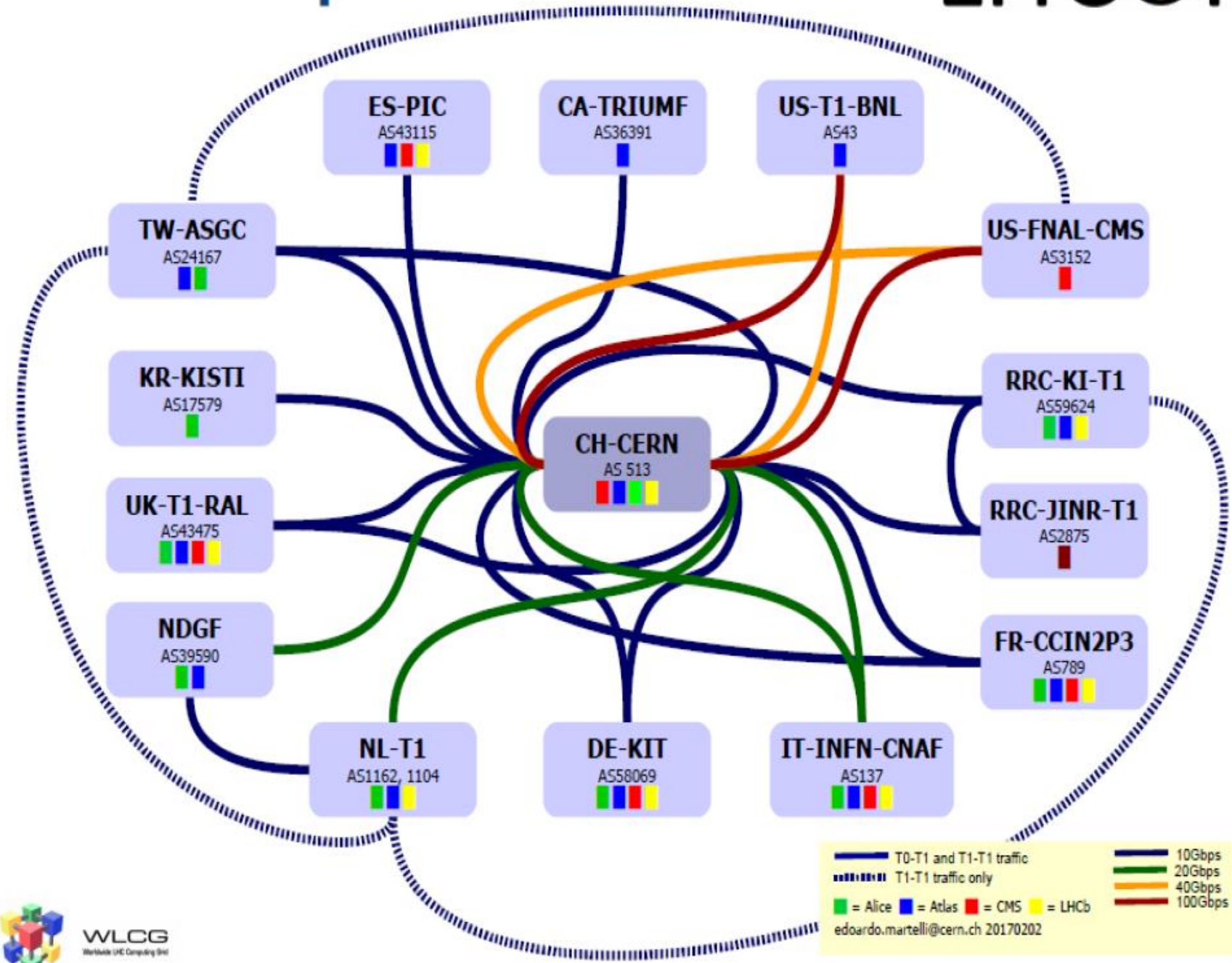
Next Generation Research Platforms

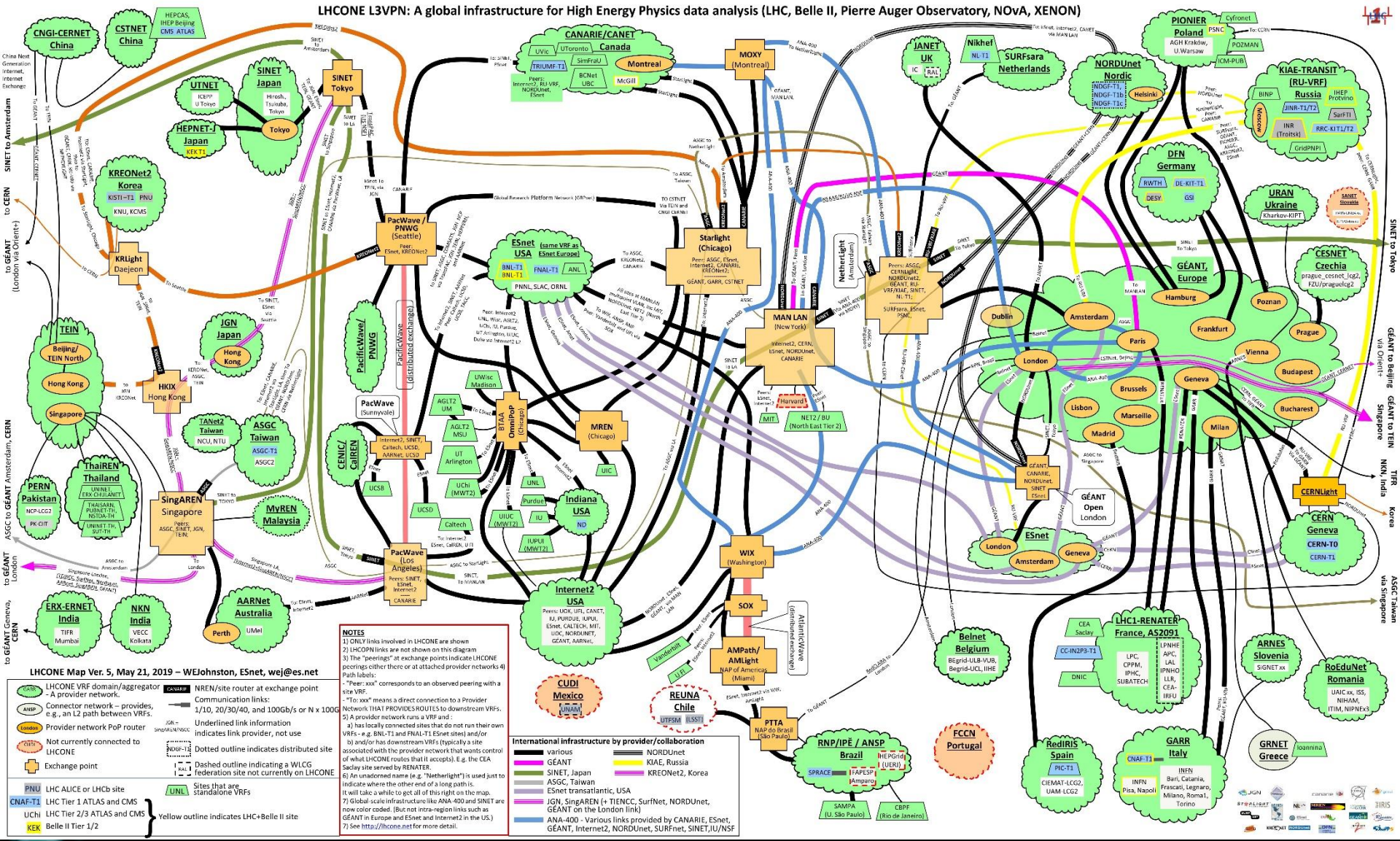
- US National Research Platform
- Asia Pacific Research Platform
- Korean Research Platform
- EU SLICES
- Worldwide LHC Computing Grid (WLCG)
- DOE Integrated Research Infrastructure (IRI)
- Open Science Grid
- Open Science Data Grid
- Et Al

Worldwide LHC Computing Grid

- The Worldwide LHC Computing Grid (WLCG): Global Collaboration Of ~ 170 Computing Centres In More Than 40 Countries, Integrating National and International Grid Infrastructures.
- WLCG Provides Global Resources To Gather, Store, Distribute and Analyse ~200 Petabytes of LHC Data Each Year
- WLCG – Partnership of EGI (European Grid Infrastructure), OSG (Open Science Grid), and NeIC (Nordic e-Infrastructure Collaboration).

LHCOPN map


ES-PIC
AS43115
CA-TRIUMF
AS36391
US-T1-BNL
AS43
TW-ASGC
AS24167
US-FNAL-CMS
AS3152
KR-KISTI
AS17579
RRC-KI-T1
AS59624
CH-CERN
AS 513
UK-T1-RAL
AS43475
RRC-JINR-T1
AS2875
NDGF
AS39590
FR-CCIN2P3
AS789
NL-T1
AS1162, 1104
DE-KIT
AS58069
IT-INFN-CNAF
AS137
T0-T1 and T1-T1 traffic
T1-T1 traffic only
= Alice = Atlas = CMS = LHCb
edoardo.martelli@cern.ch 20170202
10Gbps
20Gbps
40Gbps
100Gbps

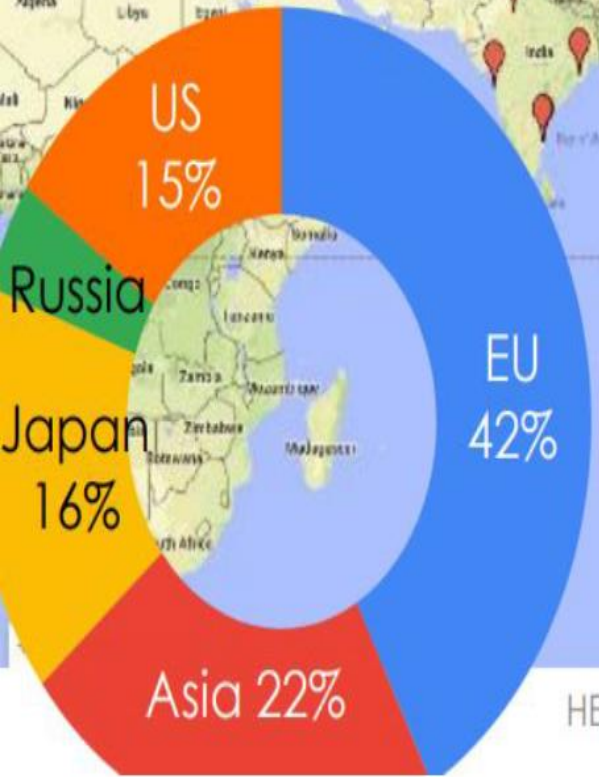


Non-LHC Scientific Communities Using LHCONE

- Belle II Experiment, Particle Physics Experiment Designed To Study Properties od B Mesons (Heavy Particles Containing a Bottom Quark)
- Pierre Auger Observatory, Studying Ultra-High Energy Cosmic Rays, the Most energetic and Rarest Particles in The Universe
- LIGO and Virgo (In August 2027 This Collaboration Measured a Gravitational Wave Originating From a Binary Neutron Star Merger.
- NOvA Experiment: Designed To Answer Fundamental Questions In Neutrino Physics
- XEON Dark Matter Project: Global Collaboration Investigating Fundamental Properties of Dark Matter, Largest Component of the Universe
- DUNE/ProtoDUNE – Deep Underground Nutrino Experiment

Belle II Collaboration

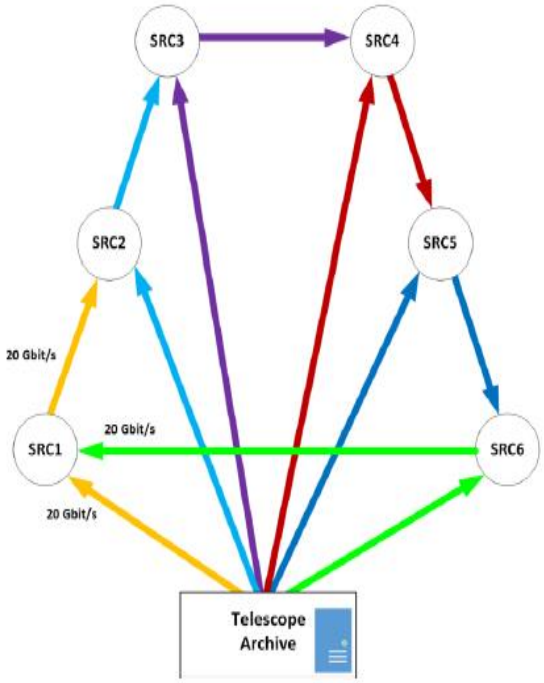
A Global Collaboration
as wide as an LHC experiment

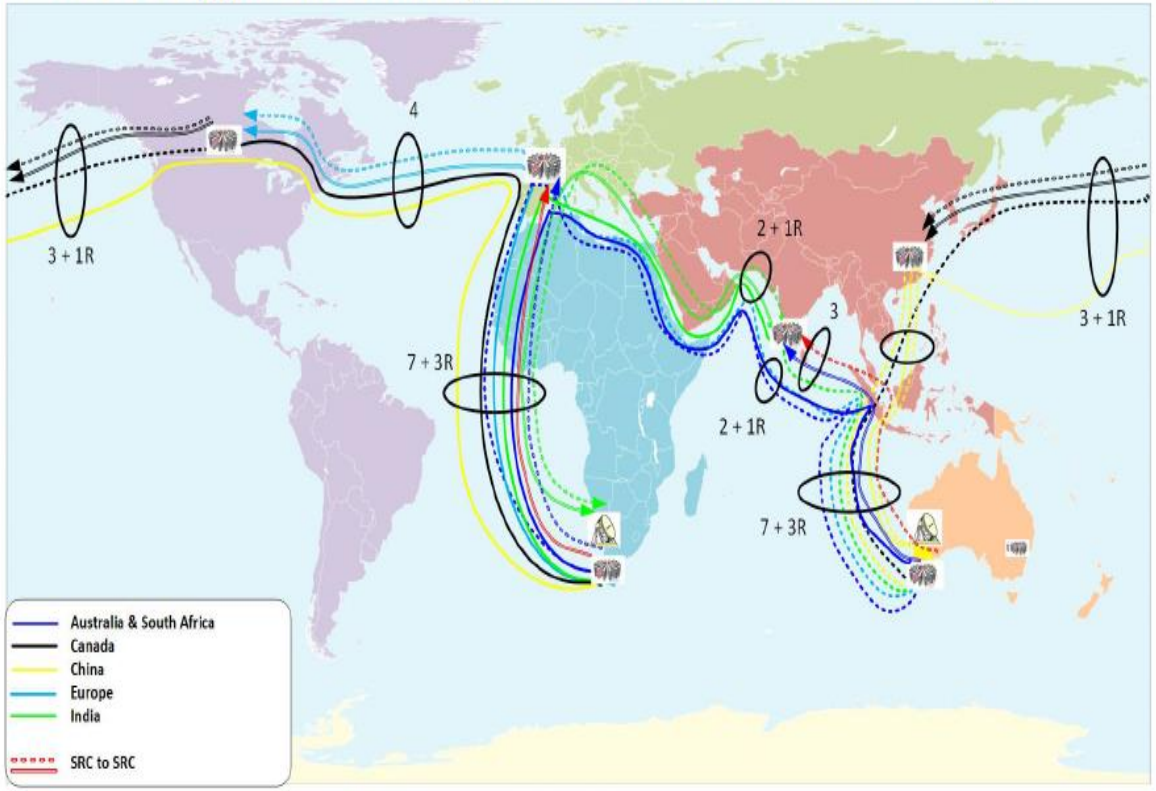


26 countries/regions
123 institutes
1,075 researchers

Global Data Flows if the SRC Re-distribute data – 2 Replicas

- Each SRC accepts its fraction of the Observatory Data Products and re-distributes to another SRC.
- SRC has 20 Gbit/s flow from the telescope & a second continuous 20 Gbit/s flow from another SRC.
- Each SRC sends out a 20 Gbit/s flow.
- Makes substantial use of the shared academic network which would imply charges to the SKA community.
- **Probable cost to SKA community Very approx. ~ 0.8 M USD/year not allowing for the extra BW from the telescopes**





DUNE Collaboration

An international effort

The Deep Underground Neutrino Experiment brings together over 1,000 scientists from more than 30 countries around the world.

Armenia
Brazil
Bulgaria
Canada
Chile
China
Colombia
Czech Republic
Finland
France
Greece
India
Iran
Italy
Japan
Madagascar
Mexico
Netherlands
Paraguay
Peru
Poland
Romania
Russia
South Korea
Spain
Sweden
Switzerland
Turkey
Ukraine
United Kingdom
United States

Orchestration Among Multiple Domains

- Instrumentation and Analytic, Storage Resources Are Highly Distributed Among Multiple Domains Interconnected With High Performance Networks
- A Key Issues Is Discovering Resources, Claiming Them, Integrating Them, Utilizing Them and Releasing Them
- Increasingly, New Software Defined Infrastructure Architecture, Services, Techniques And Technologies Are Addressing These Issues

Large-Scale High Capacity Data WAN Transport

- Large-Scale High Capacity Data WAN Transport Has Always Been And Remains A Major Challenge, Especially Over Global Paths
- This Issue Is Emphasized By A Next Generation Of Instrumentation That Will Generate Exponentially Large Volumes Of Data That Has To Be Distributed Across the Globe
- More Than Network Capacity - An E2E Issue, Especially Given Advances In Core Optical Networking Technologies

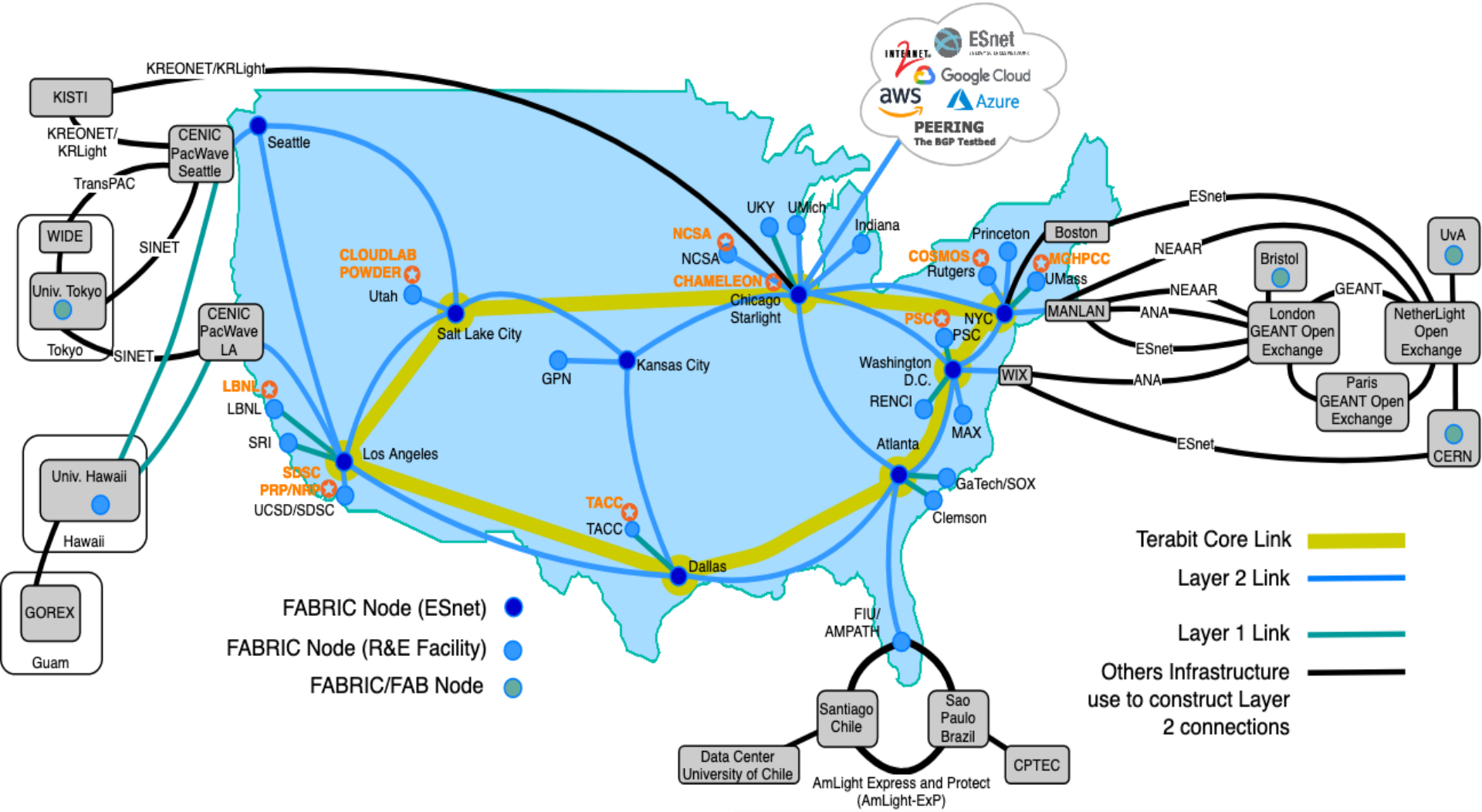
High-Fidelity Data Flow Monitoring, Visualization, Analytics, Diagnostic Algorithms, Event Correlation AI/ML/DL

- A Major Opportunity For Data Transport Optimization Is Being Provided By New Methods For Directly Detecting And Analyzing All Data Flows And Their Characteristics
- Because These Techniques Enable High-Fidelity Views Of All Flows, Real Time, Dynamic Traffic Engineering Is Possible With Much More Sophistication Than Traditional Approaches
- These Techniques Can Be Significant Enhanced Using AI/ML/DL, Which (Although Still Emerging) Are Becoming Critically Important Tools In The Near Term

International Testbeds for Data-Intensive Science

- Challenging Requirements Of Anticipated Large Scale Science Projects Along With Accelerated Rates Of Innovation Require International Testbeds For Pre-Production Investigations And Prototyping Of New Technologies And Techniques Specifically Related To Data Intensive Science, e.g., Tbps E2E WAN Services Among Sites
- Global Experimental Research Testbeds Are Being Developed With Enhanced Capacities, Additional Sites, And Innovative Capabilities

Paul Ruth PI, RENCI: FABRIC



Core = 1.2 Tbps

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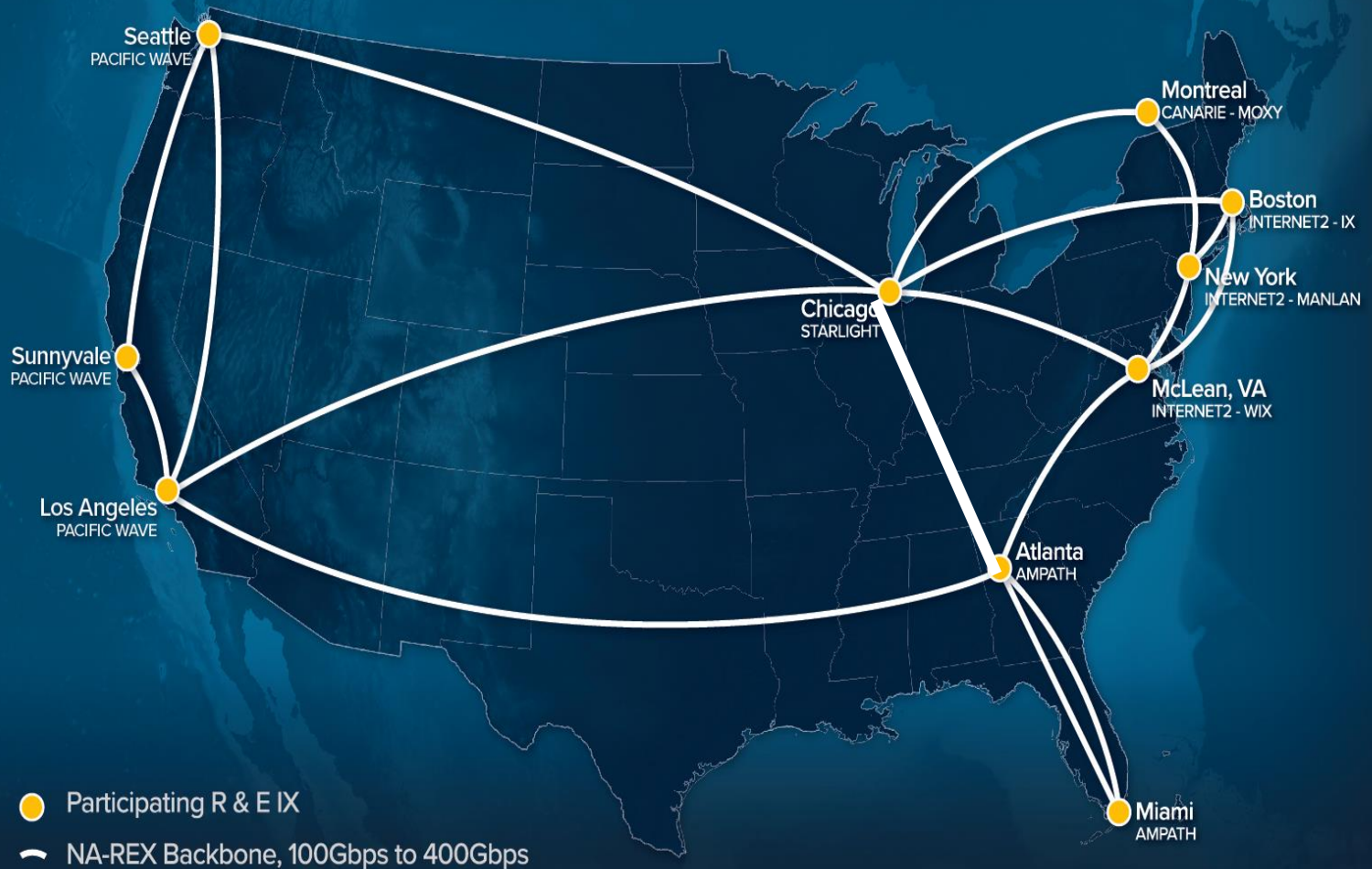
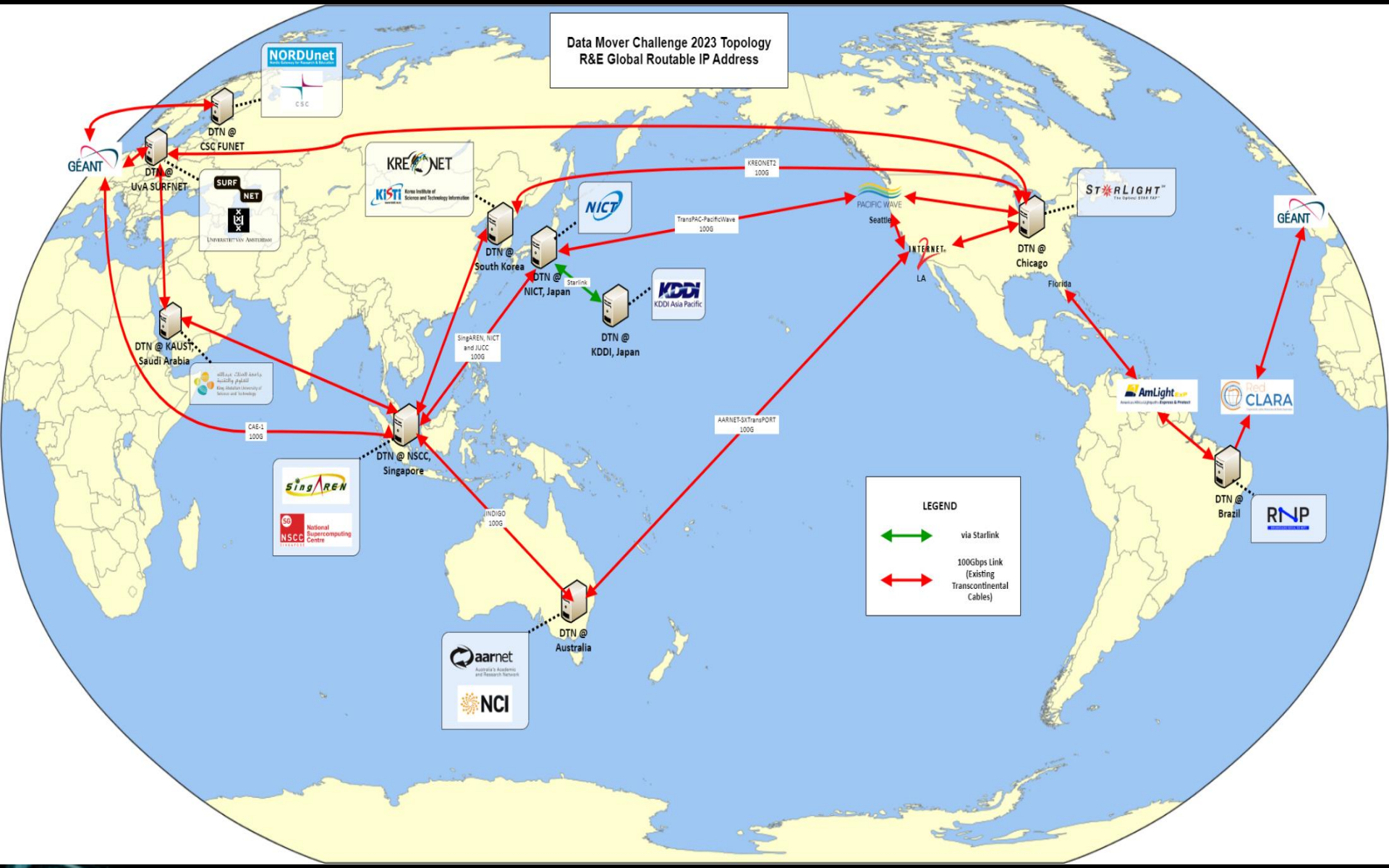
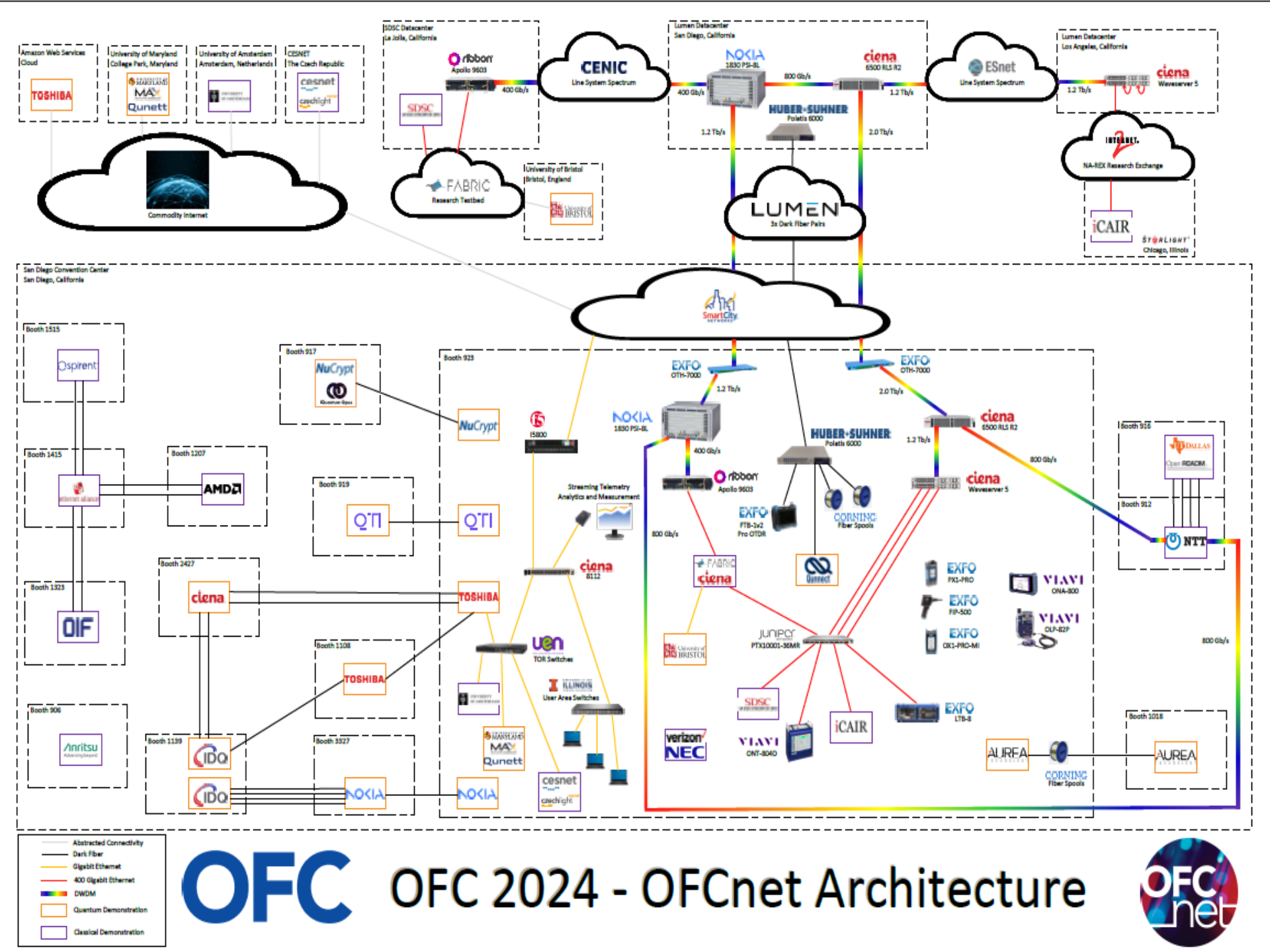
NA-REX North America Research & Education Exchange Collaboration



AMPATH PATHWAY TO THE AMERICAS
canarie
ESnet ENERGY SCIENCES NETWORK
INTERNET2
International Networks at Indiana University
STARLIGHT The Optical STAR TAP
CENIC
PACIFIC NORTHWEST GIGAPOP
PACIFIC WAVE

November 2023


Data Mover Challenge 2023 Topology
R&E Global Routable IP Address
NORDUnet
DTN @ CSC FUNET
GÉANT
DTN @ UvA SURFNET
SURFNET
KREONET
KISTI
DTN @ South Korea
NICT
DTN @ NICT, Japan
Starlink
DTN @ KDDI, Japan
KDDI Asia Pacific
KREONET2 100G
TransPAC-PacificWave 100G
PACIFIC WAVE
Seattle
INTERNET2
LA
DTN @ Chicago
STARLIGHT
Florida
GÉANT
DTN @ KAUST, Saudi Arabia
CAE-1 100G
SingAREN, NICT and JUCC 100G
DTN @ NSCC, Singapore
SingAREN
NSCC National Supercomputing Centre
INDIGO 100G
AARNET-SXTransPORT 100G
AmLight
RedCLARA
DTN @ Brazil
RNP
DTN @ Australia
aarnet
NCI
LEGEND
via Starlink
100Gbps Link (Existing Transcontinental Cables)


Amazon Web Services Cloud
TOSHIBA
University of Maryland College Park, Maryland
MAX
Qunett
University of Amsterdam Amsterdam, Netherlands
CESNET The Czech Republic
cesnet
czechlight
Commodity Internet
SDSC Datacenter La Jolla, California
ribbon Apollo 9603
400 Gb/s
SDSC
FABRIC Research Testbed
University of Bristol Bristol, England
CENIC Line System Spectrum
Lumen Datacenter San Diego, California
NOKIA 1830 PSI-8L
ciena 6500 RLS R2
800 Gb/s
400 Gb/s
1.2 Tb/s
HUBER+SUHNER Polatis 6000
2.0 Tb/s
LUMEN 3x Dark fiber Pairs
ESnet Line System Spectrum
Lumen Datacenter Los Angeles, California
ciena Waveserver 5
INTERNET2 NA-REX Research Exchange
iCAIR
STARLIGHT Chicago, Illinois
San Diego Convention Center San Diego, California
SmartCity NETWORKS
Booth 1515
Ospirent
Booth 1415
ethernet alliance
Booth 1207
AMD
Booth 1323
OIF
Booth 906
Anritsu
Booth 917
NuCrypt
Booth 919
QTI
Booth 2427
ciena
Booth 1108
TOSHIBA
Booth 1139
IDQ
Booth 3327
NOKIA
Booth 923
EXFO OTH-7000
1.2 Tb/s
2.0 Tb/s
i5800
Streaming Telemetry Analytics and Measurement
ciena 8112
TOR Switches
User Area Switches
EXFO FTB-1v2 Pro OTDR
CORNING Fiber Spools
FABRIC ciena
Qunect
EXFO FXI-PRO
EXFO FIP-500
EXFO OX1-PRO-MI
VIAVI ONA-800
VIAVI OLP-82P
JUNIPER PTX10001-36MR
EXFO LTB-8
VIAVI ONT-804D
verizon NEC
AUREA
CORNING Fiber Spools
Booth 918
DALLAS Open RDACM
Booth 912
NTT
Booth 1018
AUREA
Abstracted Connectivity
Dark Fiber
Gigabit Ethernet
400 Gigabit Ethernet
DWDM
Quantum Demonstration
Classical Demonstration
OFC
OFC 2024 - OFCnet Architecture
OFCnet

Chameleon

www.chameleoncloud.org

CHAMELEON: A LARGE SCALE, RECONFIGURABLE EXPERIMENTAL INSTRUMENT FOR COMPUTER SCIENCE

Kate Keahey

Joe Mambretti, Pierre Riteau, Paul Ruth, Dan Stanzione

THE UNIVERSITY OF CHICAGO TACC renci NORTHWESTERN UNIVERSITY NSF

DOE's Integrated Research Infrastructure (IRI) Vision:

To empower researchers to meld DOE's world-class research tools, infrastructure, and user facilities seamlessly and securely in novel ways to radically accelerate discovery and innovation

Advanced Networking

Edge Sensors

Advanced Computing

Researchers

Local Campus Computing

Computing Testbeds

Cloud Computing

Data Management

High Performance Data Facility

Data Repositories PuRE Data Assets

Software

Software and Applications

AI Tools Digital Twins

New modes of integrated science

Rapid data analysis and steering of experiments

Novel workflows using multiple user facilities

AI-enabled insight from integrating vast data sources

U.S. DEPARTMENT OF ENERGY | Office of Science

Slide from Ben Brown, DOE, at ECP IAC – Jan 2024

www.startap.net/starlight

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