Global Research Platform And BRIDGES

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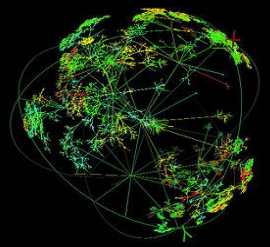
Northwestern University
Director, Metropolitan Research and Education Network (www.mren.org)
Director, StarLight International/National Communications Exchange Facility (www.startap.net/starlight),
PI: StarLight SDX, Co-PI Chameleon, PI-iGENI, PI-OMNINet

BRIDGES Meeting
June 14, 2023



iCAIR

STARLIGHT SDX

The GRP: A Platform For Global Science

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

STARLIGHT℠

Selected Applications

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

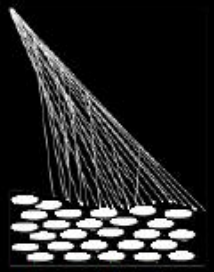
Virgo
www.virgo-gw.eu

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

SKA
www.skatelescope. org

LIGO
www.ligo.caltech. edu

USGS EROS
www.usgs.gov/ centers/eros

Blue Waters
bluewaters.ncsa. illinois.edu

PRAGMA
www.pragma-grid.net

NEON
www.neonscience. org

CENTRA
www.global centra.org

SAGE2
sage2.sagecommons. org

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

Jetstream
www.jetstream-cloud.org

Chameleon
www.chameleon cloud.org

PRP
pacificresearch platform.org

Genomic Science Program
genomicscience. energy.gov

Belle II
www.belle2.org

LBNF/DUNE/ ProtoDUNE
lbnf.fnal.gov

XENON
xenon.astro. columbia.edu

NOvA
novaexperiment. fnal.gov

SDSS
www.sdss.org

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

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

ALMA
www.alma observatory.org

IVOA
www.ivoa.net

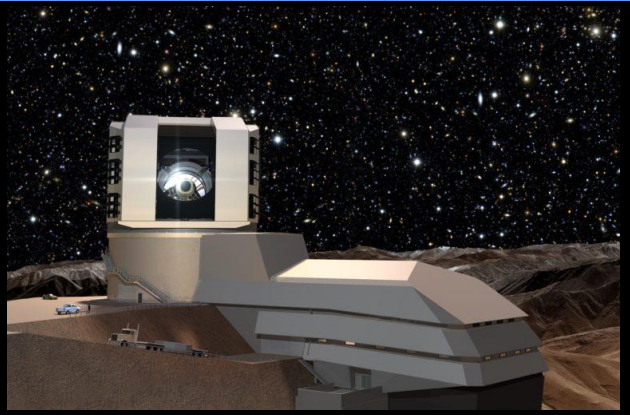
Compilation by Maxine Brown and Joe Mambretti

STARLIGHT℠

Instruments: Exebytes Of Data

High Luminosity LHC

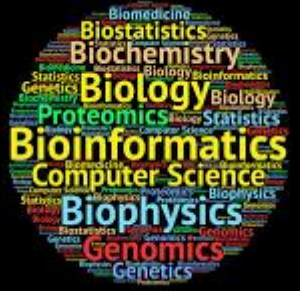
SKA Australia Telescope Facility



Vera Rubin Observatory

KSTAR Korea Superconducting Tokamak

Next Gen Advanced Photon Source

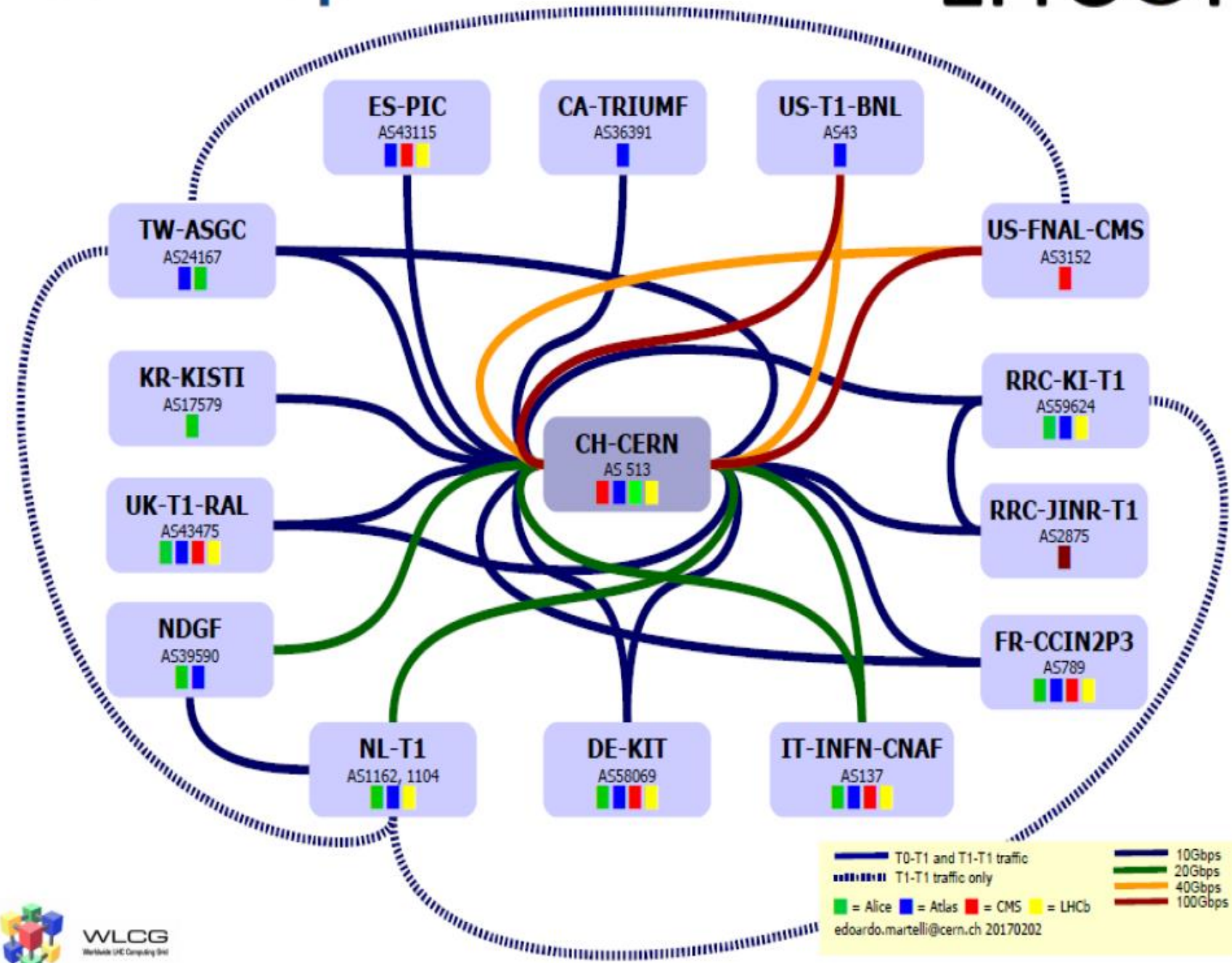


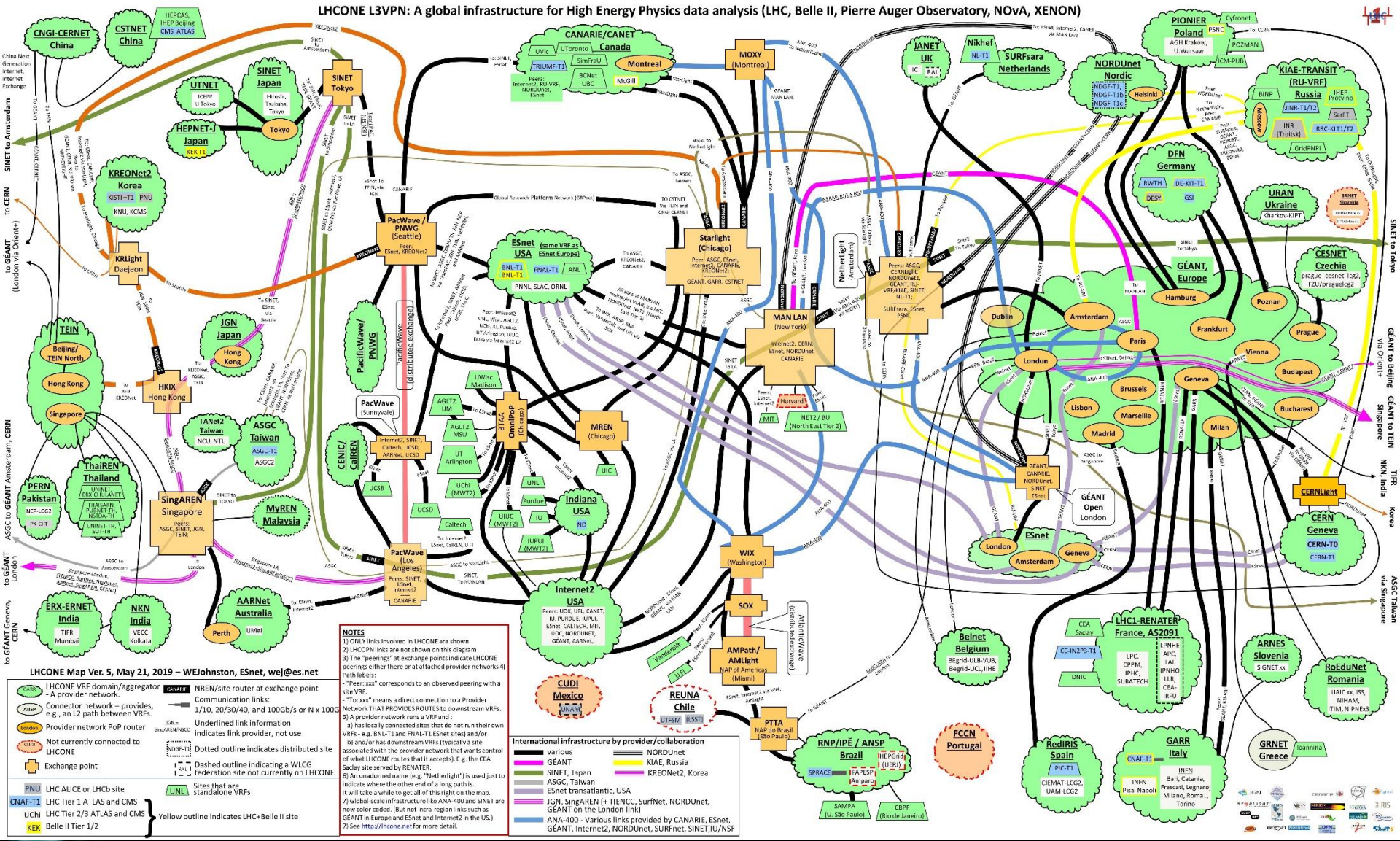
Bioinformatics/Genomics

Large Scale Global Science

- Science Domains Create Cyberinfrastructure Ecosystems, Some Distributed World Wide, Some Devoted To Domains, Some Shared Among Domains
- Minimal Opportunities For Information Sharing On Cyberinfrastructure Architecture, Implementation, Technologies and Operations Among Projects
- Such Opportunities Are Especially Useful For Cross Disciplinary Research
- Example Ecosystem: HEP - LHC

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



New Science Communities Using LHCONE

- Belle II Experiment, Particle Physics Experiment Designed To Study Properties of B Mesons (Heavy Particles Containing a Bottom Quark).
- Pierre Auger Observatory, Studying Ultra-High Energy Cosmic Rays, the Most Energetic and Rarest of Particles In the Universe.
- In August 2017 the PAO, LIGO and Virgo Collaboration Measured a Gravitational Wave Originating From a Binary Neutron Star Merger.
- The NOvA Experiment Is Designed To Answer Fundamental questions in neutrino Physics.
- The XENON Dark Matter Project Is a Global Collaboration Investing Fundamental Properties of Dark Matter, Largest Component Of The Universe.

Recent=> DUNE/ProtoDUNE – Deep Underground Nutrino Experiment

Next Generation Research Platforms

- *“a comprehensive, scalable, cyberinfrastructure that bridges diverse scientific communities and integrates high--performance computing, data, software, and facilities in a manner that brings theoretical, computational, experimental, and observational approaches together to advance the frontier” NSF*
- **Large Scale Science DMZs, Super Facilities**
- **National Research Platforms**
- **Continental Research Platforms: Orchestration Among Multiple Domains, Large Scale High Capacity WAN Transport (100, 400, 800 G 1.2 Tbps), High-Fidelity Data Flow Monitoring, Visualization, Analytics, Diagnostic Algorithms, Event Correlation AI/ML/DL International Testbeds for Data-Intensive Science**

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: Multiple 400 Gbps Paths Planning for 800 Gbps Tbps

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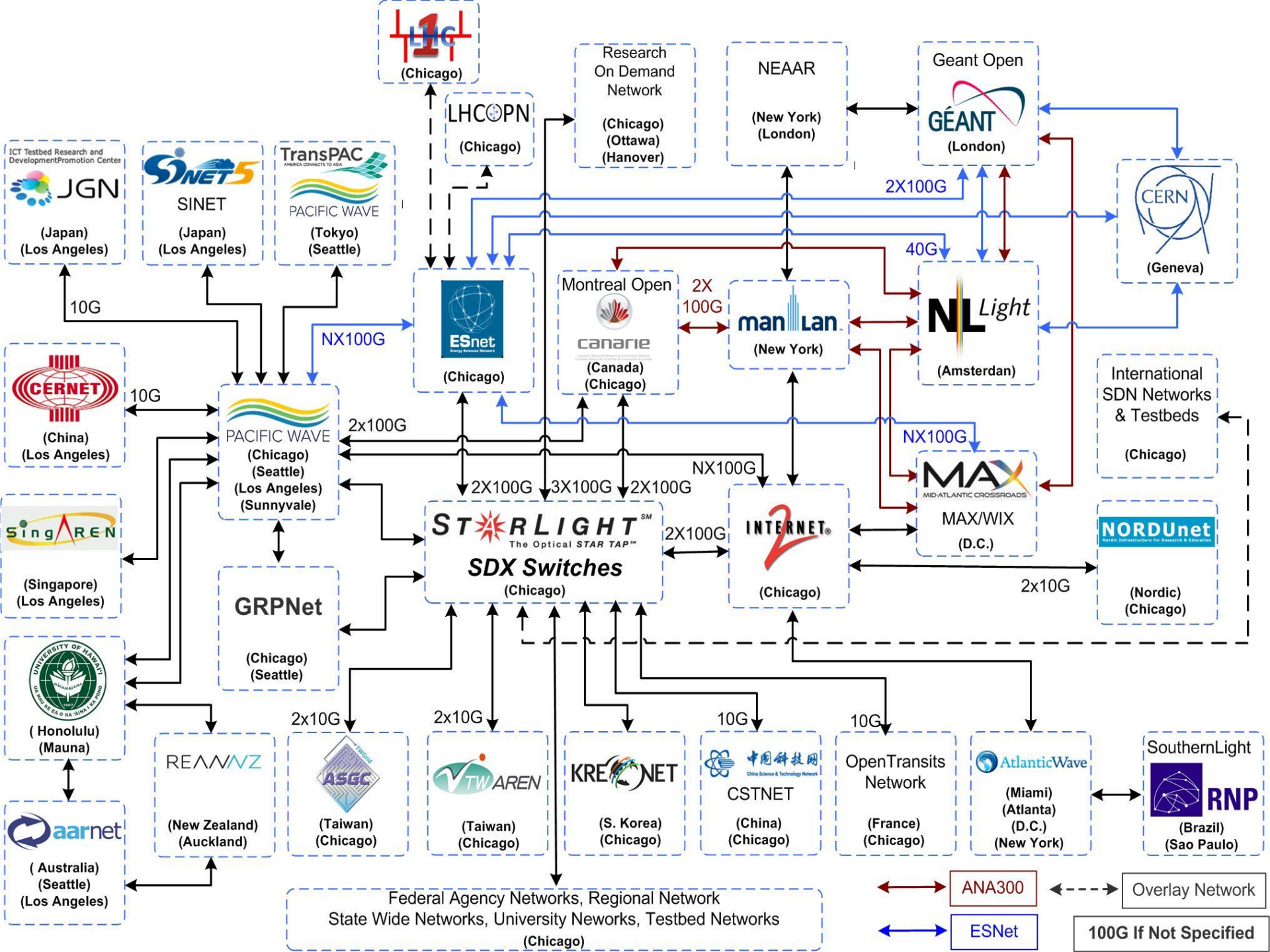
International Federated Testbeds As Instruments for Computer Science/Network Science

- The StarLight Communications Exchange Facility Supports ~ 25 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


LHC
(Chicago)
LHCOPN
(Chicago)
Research On Demand Network
(Chicago)
(Ottawa)
(Hanover)
NEAAR
(New York)
(London)
Geant Open
GÉANT
(London)
CERN
(Geneva)
2X100G
40G
ICT Testbed Research and DevelopmentPromotion Center
JGN
(Japan)
(Los Angeles)
SINET
(Japan)
(Los Angeles)
TransPAC
PACIFIC WAVE
(Tokyo)
(Seattle)
10G
NX100G
ESnet
(Chicago)
Montreal Open
canarie
(Canada)
(Chicago)
2X 100G
manLan
(New York)
NL Light
(Amsterdan)
CERNET
(China)
(Los Angeles)
10G
PACIFIC WAVE
(Chicago)
(Seattle)
(Los Angeles)
(Sunnyvale)
2x100G
International SDN Networks & Testbeds
(Chicago)
NX100G
MAX
MID-ATLANTIC CROSSROADS
MAX/WIX
(D.C.)
NX100G
2X100G
3X100G
2X100G
SingAREN
(Singapore)
(Los Angeles)
STARLIGHT
The Optical STAR TAP
SDX Switches
(Chicago)
2X100G
INTERNET2
(Chicago)
2x10G
NORDUnet
(Nordic)
(Chicago)
GRPNet
(Chicago)
(Seattle)
(Honolulu)
(Mauna)
2x10G
2x10G
10G
10G
REANNZ
(New Zealand)
(Auckland)
ASGC
(Taiwan)
(Chicago)
TWAREN
(Taiwan)
(Chicago)
KREONET
(S. Korea)
(Chicago)
CSTNET
(China)
(Chicago)
OpenTransits Network
(France)
(Chicago)
AtlanticWave
(Miami)
(Atlanta)
(D.C.)
(New York)
SouthernLight
RNP
(Brazil)
(Sao Paulo)
aarnet
(Australia)
(Seattle)
(Los Angeles)
Federal Agency Networks, Regional Network
State Wide Networks, University Neworks, Testbed Networks
(Chicago)
ANA300
ESNet
Overlay Network
100G If Not Specified

AutoGOLE Open R&E Exchanges

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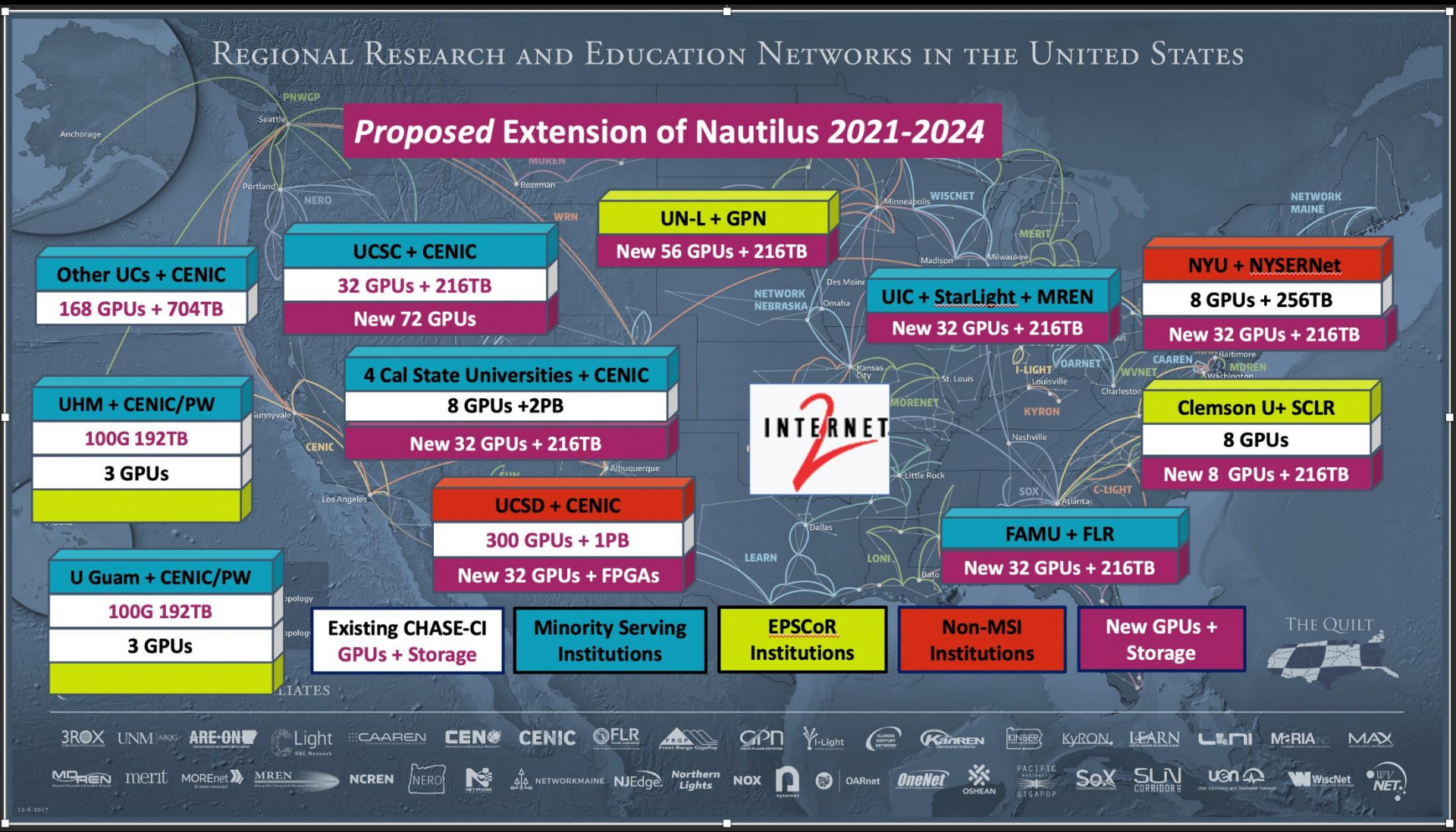
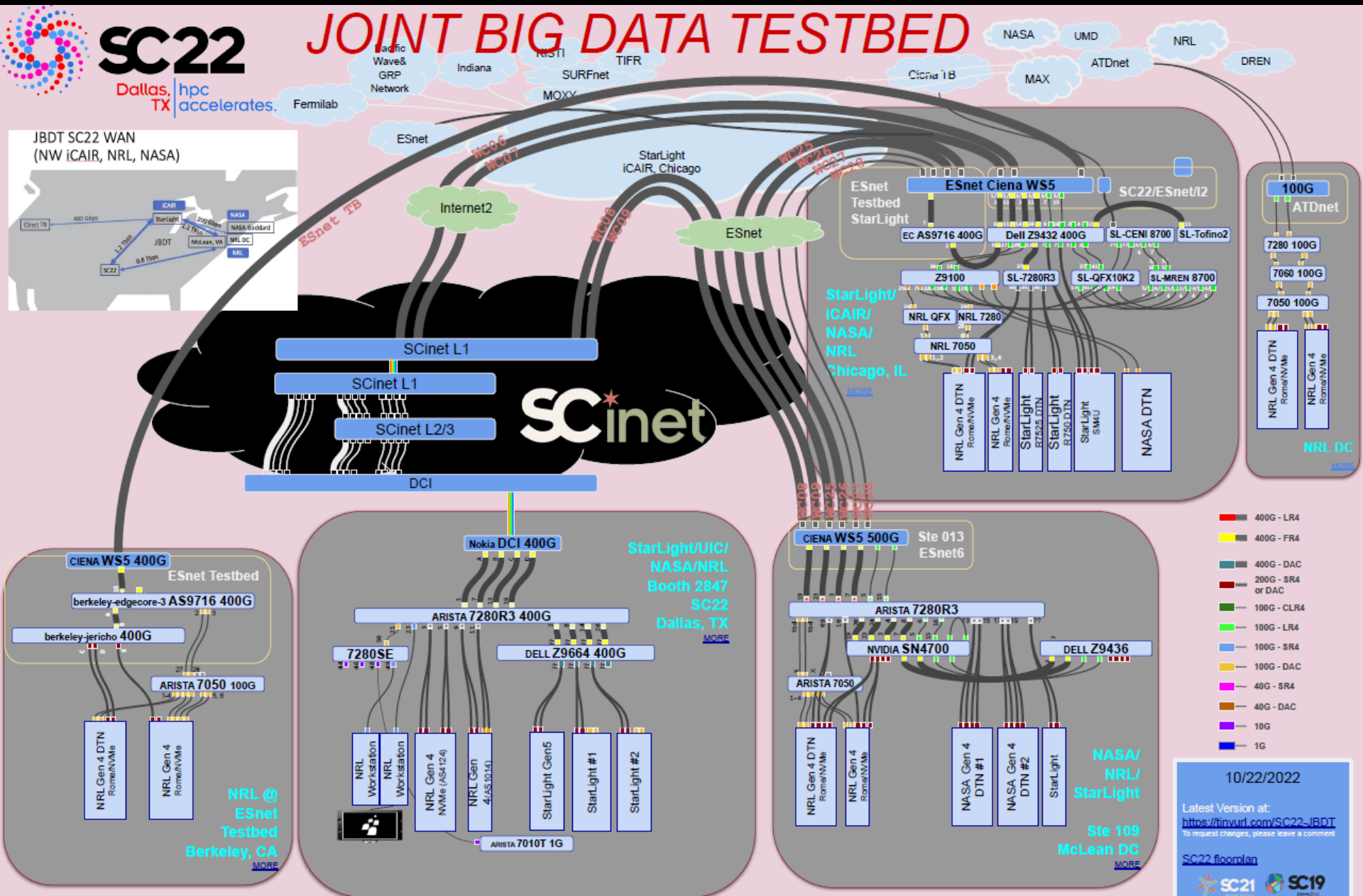

Regional Research and Education Networks in the United States
Proposed Extension of Nautilus 2021-2024
Other UCs + CENIC
168 GPUs + 704TB
UCSC + CENIC
32 GPUs + 216TB
New 72 GPUs
UN-L + GPN
New 56 GPUs + 216TB
UIC + StarLight + MREN
New 32 GPUs + 216TB
NYU + NYSERNet
8 GPUs + 256TB
New 32 GPUs + 216TB
UHM + CENIC/PW
100G 192TB
3 GPUs
4 Cal State Universities + CENIC
8 GPUs +2PB
New 32 GPUs + 216TB
INTERNET2
Clemson U+ SCLR
8 GPUs
New 8 GPUs + 216TB
UCSD + CENIC
300 GPUs + 1PB
New 32 GPUs + FPGAs
FAMU + FLR
New 32 GPUs + 216TB
U Guam + CENIC/PW
100G 192TB
3 GPUs
Existing CHASE-CI GPUs + Storage
Minority Serving Institutions
EPSCoR Institutions
Non-MSI Institutions
New GPUs + Storage
THE QUILT
PNWGP
Seattle
Anchorage
Portland
Bozeman
NERO
WRN
MREN
Minneapolis
WISCNET
MERIT
NETWORK MAINE
Madison
Milwaukee
NETWORK NEBRASKA
Omaha
Des Moine
Kansas City
St. Louis
I-LIGHT
OARNET
CAAREN
MDREN
Baltimore
Washington
WVNET
Louisville
Charleston
MOREnet
KYRON
Nashville
Sunnyvale
CENIC
Albuquerque
Los Angeles
Little Rock
SOX
C-LIGHT
Atlanta
Dallas
LEARN
LONI
Bato
3ROX
UNM
ABQG
ARE-ON
Light
CAAREN
CENIC
FLR
GPN
I-Light
KanREN
KINBER
KyRON
LEARN
LONI
MCRIA
MAX
MDREN
merit
MOREnet
MREN
NCREN
NERO
NETWORKMAINE
NJEdge
Northern Lights
NOX
OARnet
OneNet
OSHEAN
PACIFIC NORTHWEST GIGAPOP
SoX
SUN CORRIDOR
uen
WiscNet
WVNET

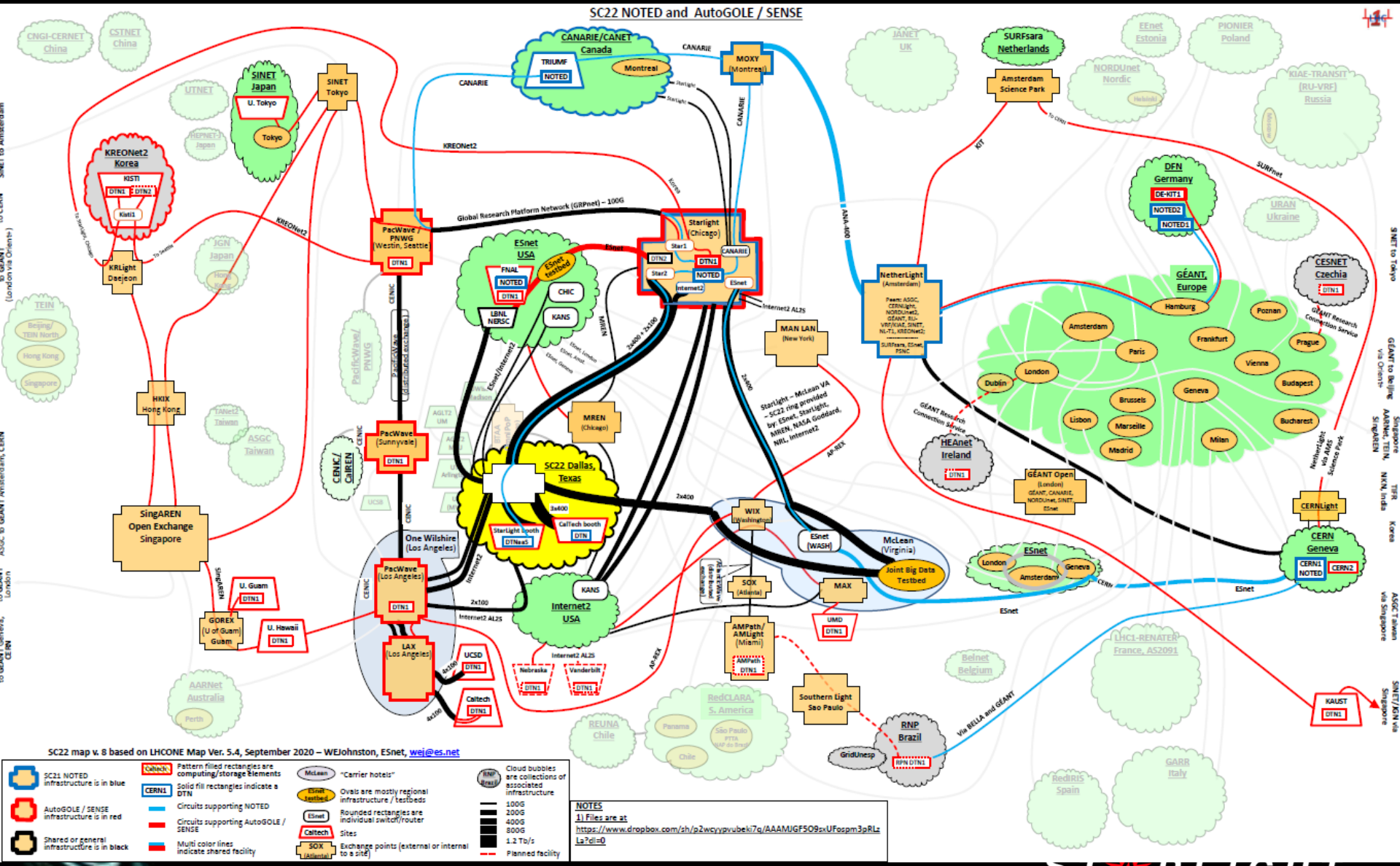
SC22 SCinet National WAN Testbed

- As In Previous Years, iCAIR Supports SCinet In Designing and Implementing a National WAN Testbed
- A Key Focus Is 400, 800, and 1.2 Tbps Path Services and Interconnections, Including Direct Connections To Edge Nodes, Primarily High Performance DTNs
- The SC22 National WAN Testbed Was Designed and Implemented To Support Demonstrations and Experiments Of Innovations Related To Data Intensive Science

Persistent Communication Services For Petascale Sciences: Demonstrations At IEEE/ACM Supercomputing Conference – SC22, Dallas Texas



Network Optimized Transport for Experimental Data (NOTED) – AI/ML Driven WAN Network Orchestration



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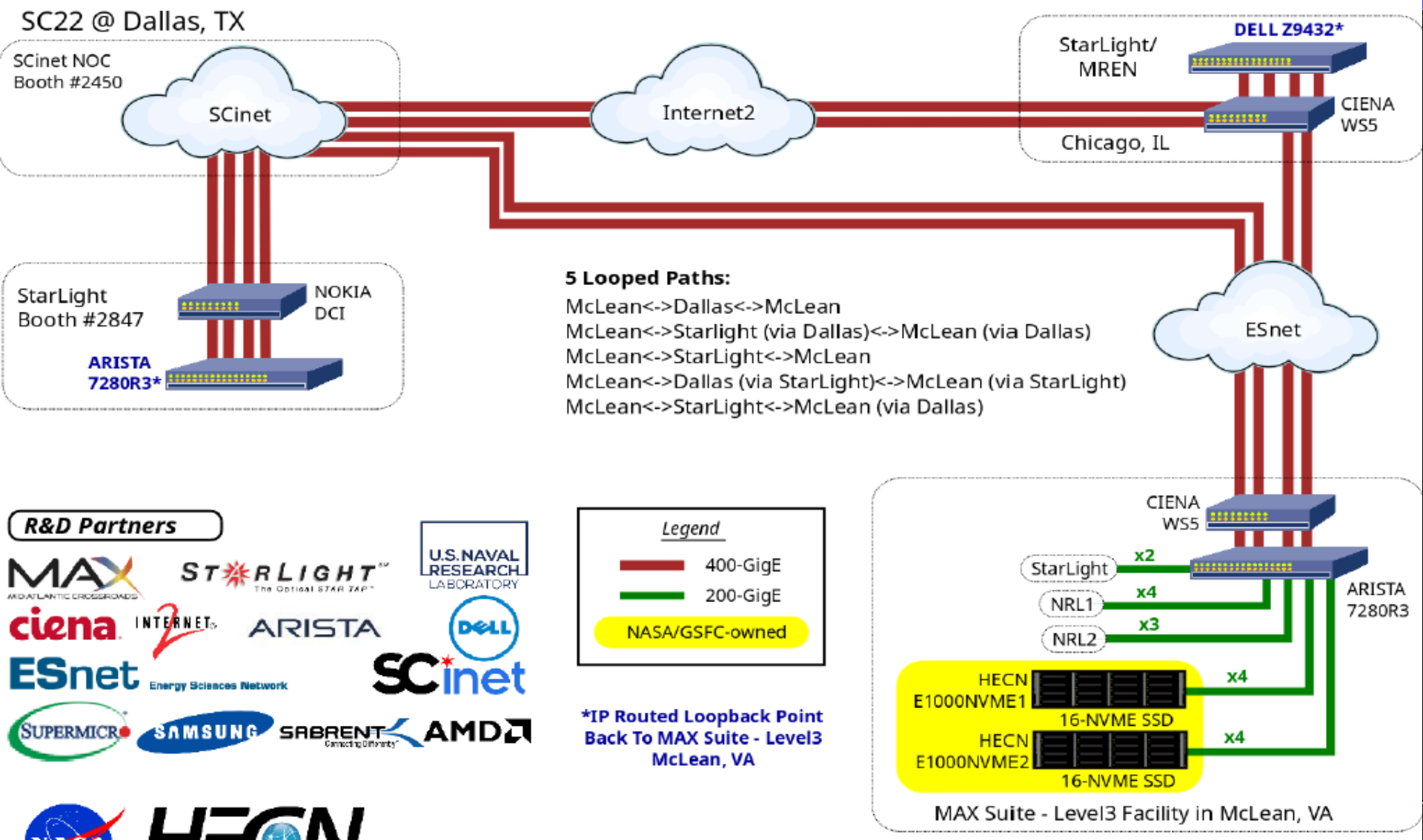
SC22
Joint Big Data Testbed

Demonstrations of 400 Gbps Disk-to-Disk WAN File Transfers using NVMe-oF/TCP

An SC22 Collaborative Initiative Among NASA and Several Partners



R&D Partners

MAX MID-ATLANTIC CROSSROADS · STARLIGHT The Optical STAR TAP · U.S. NAVAL RESEARCH LABORATORY · ciena · INTERNET2 · ARISTA · DELL · ESnet Energy Sciences Network · SCinet · SUPERMICRO · SAMSUNG · SABRENT · AMD

Legend

400-GigE

200-GigE

NASA/GSFC-owned

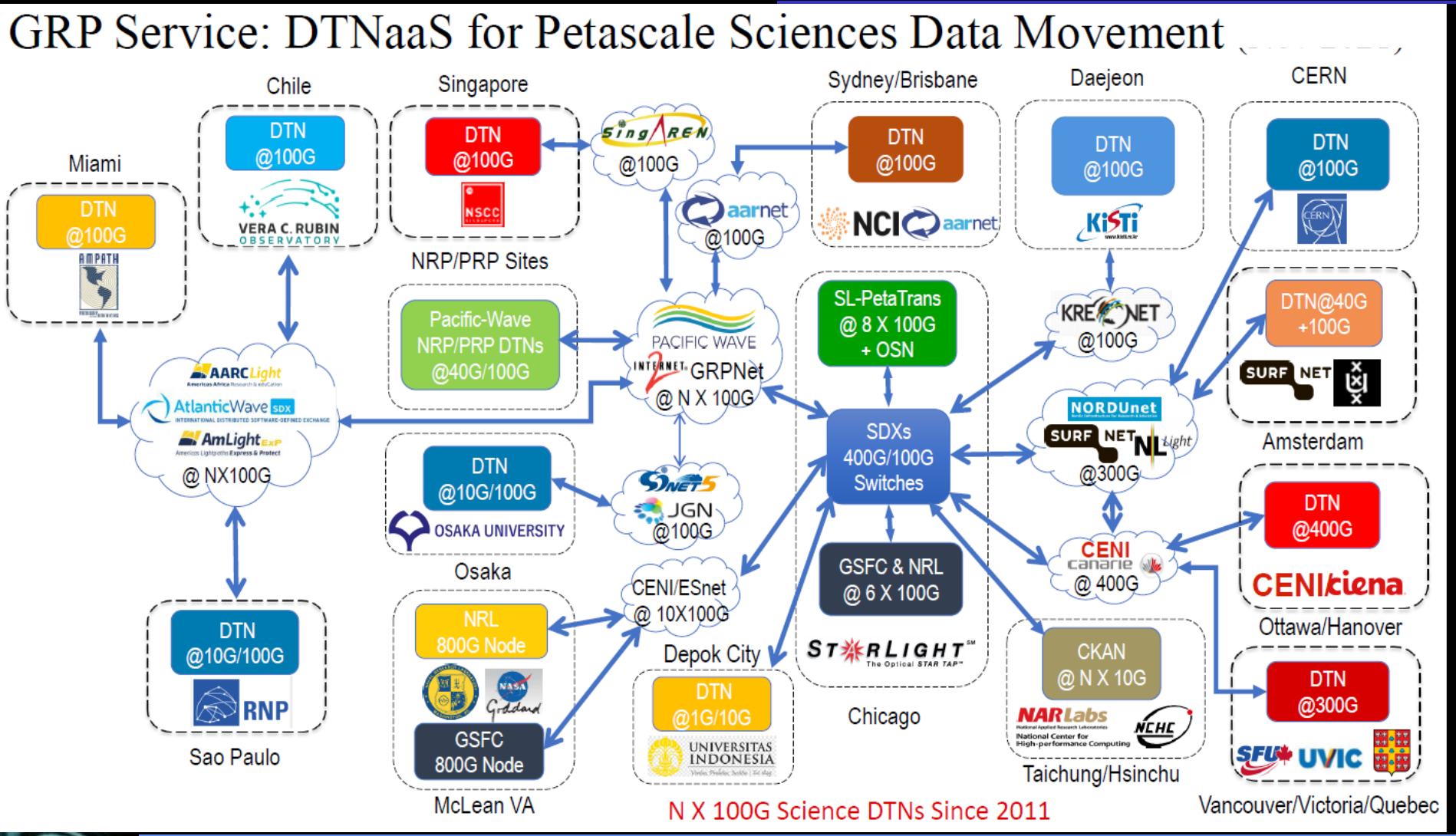
***IP Routed Loopback Point Back To MAX Suite - Level3 McLean, VA**

NASA · HECN High End Computer Networking

In memory of Paul Lang and Pat Gary

NASA/GSFC High End Computer Networking (HECN) Team
Diagram by Bill Fink - 10/20/2022

GRP DTNaaS For Petascale Science



DTN-as-a-Service

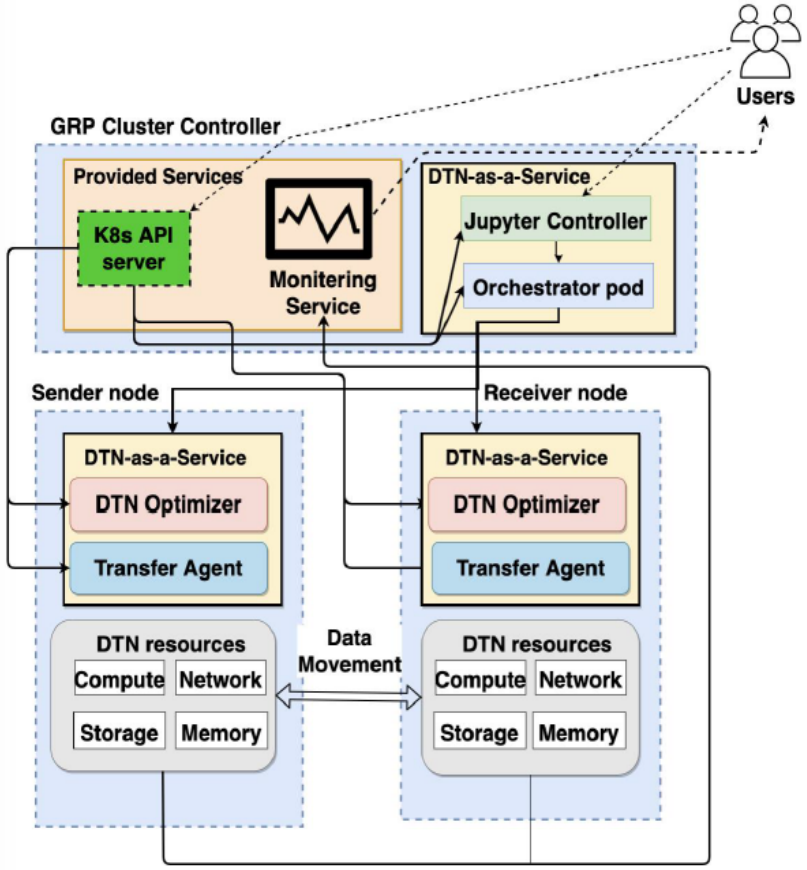
GRP Cluster with DTN-as-a-Service

DTN-as-a-Service(DTNaaS) provides a data movement workflow in GRP k8s cluster:

1. Deploy DTNaaS workloads via k8s API server
2. Use Jupyter to optimize and run transfers
3. Observe performance from monitoring service

GRP DTNaaS Components:

- Orchestrator: controller of DTNaaS to manage agent and optimizer pods via REST API.
- Transfer Agent: run transfer jobs
- DTN Optimizer: optimize the DTN resources for workflow
- Jupyter: web interface to run DTNaaS interactively



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STARLIGHT SDX

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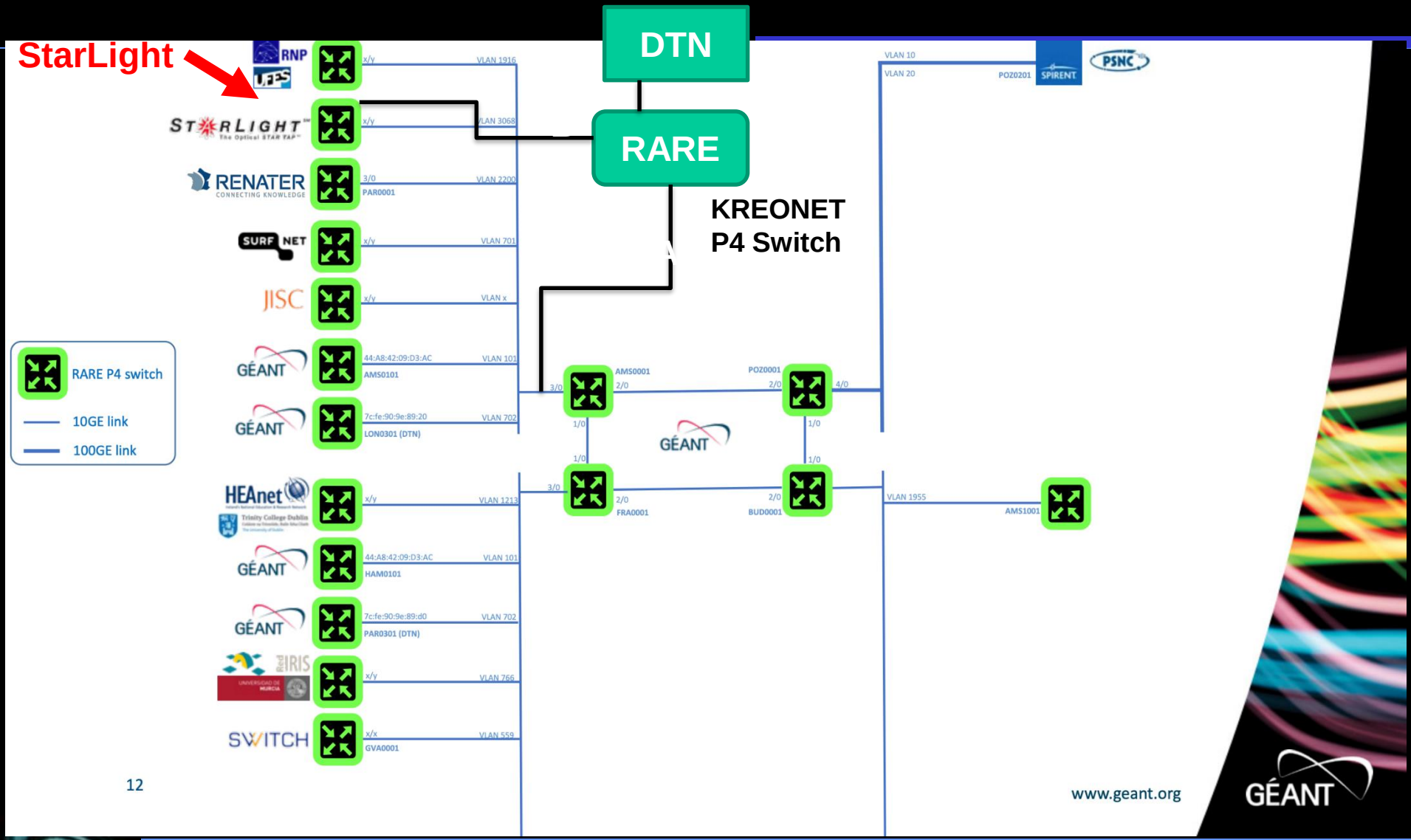
Integration With GEANT P4 Testbed



Chameleon

www.chameleoncloud.org

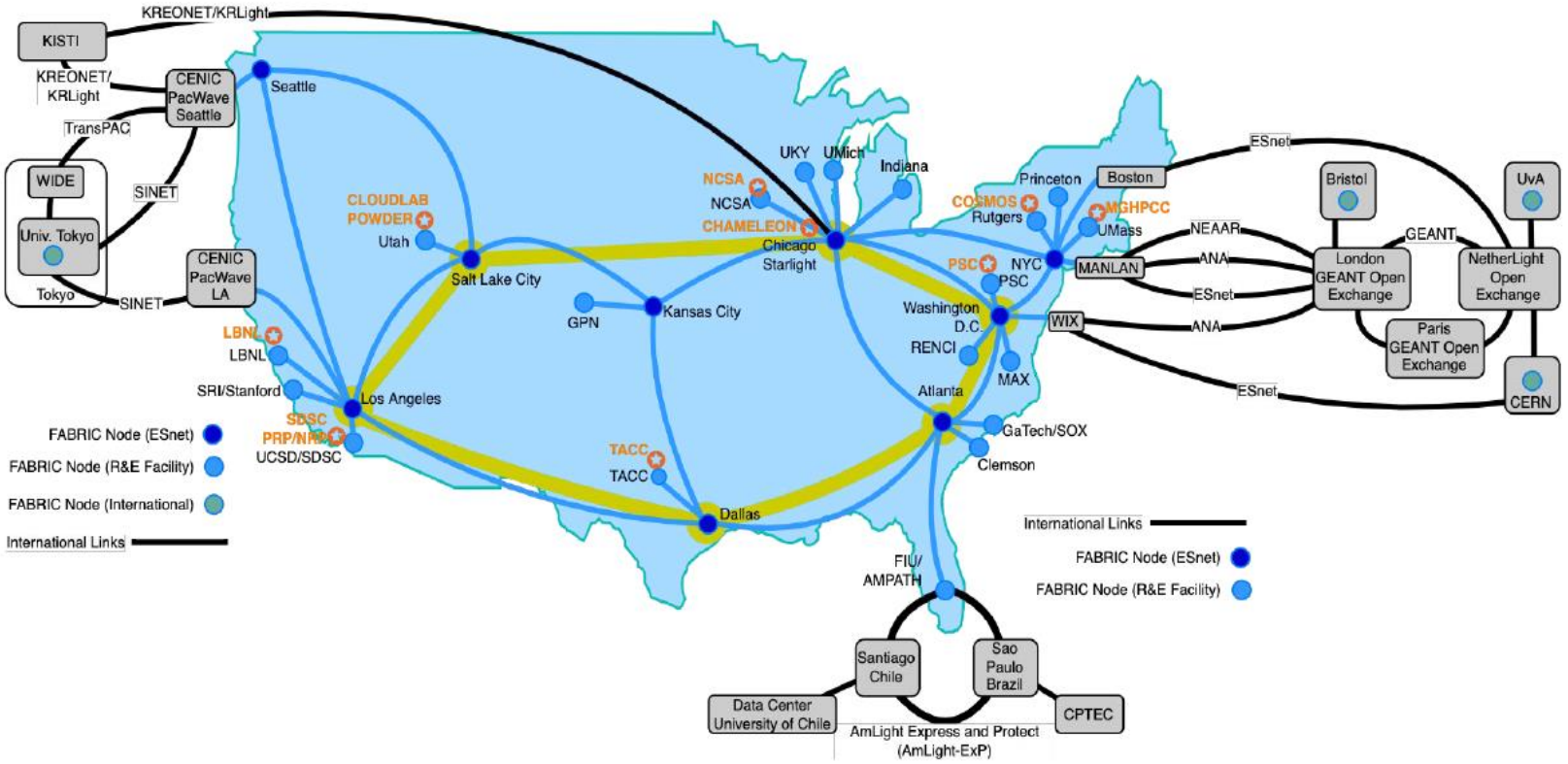
CHAMELEON: A LARGE SCALE, RECONFIGURABLE EXPERIMENTAL INSTRUMENT FOR COMPUTER SCIENCE

Kate Keahey

Joe Mambretti, Pierre Riteau, Paul Ruth, Dan Stanzione

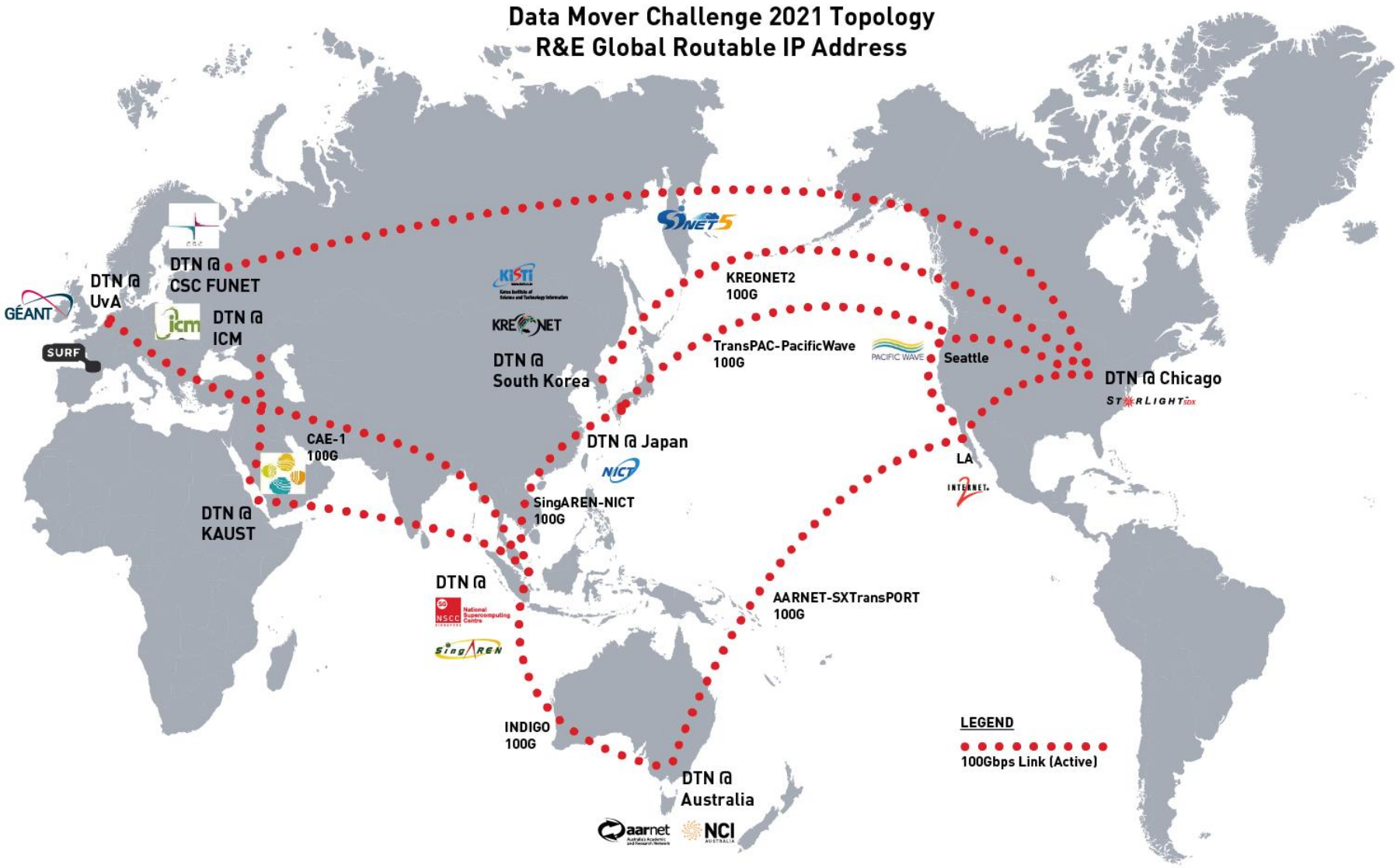
THE UNIVERSITY OF CHICAGO TACC renci NORTHWESTERN UNIVERSITY NSF

FABRIC Testbed (+FAB)



FABRIC Topology - with FAB Sites

StarLight: Founding Partner Of Supercomputing Asia DMC International Testbed



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

'23 eScience

CALLS PROGRAM TRAV

'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

www.startap.net/starlight

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

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