ESnet International Peering

FRIB SRO Workshop, 2026

ESnet by the Numbers

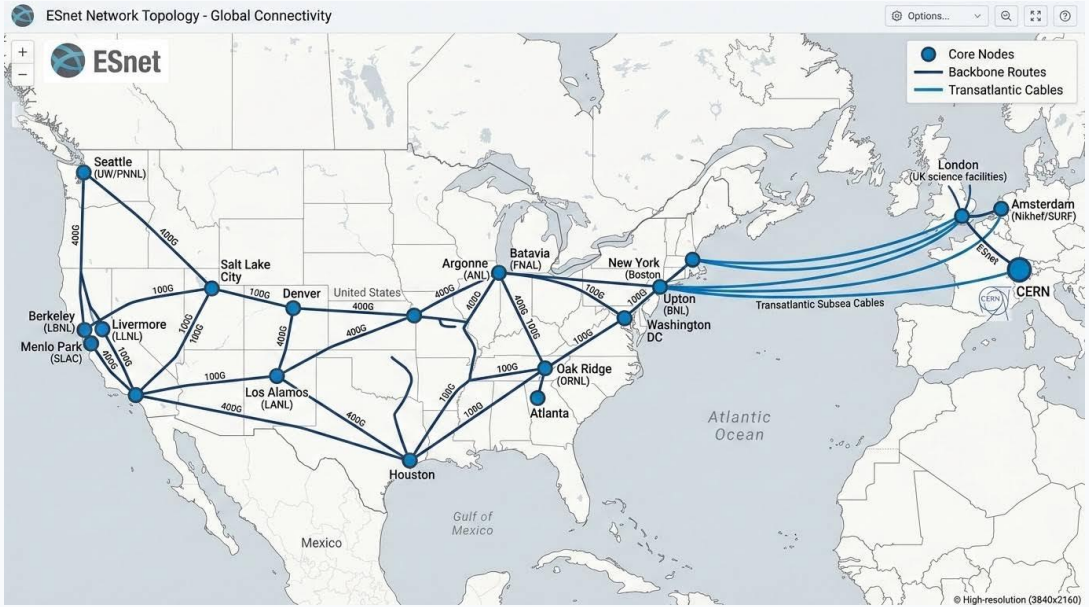
ESnet Connects

50,000+
Interconnected Users

140+
Research Institutions

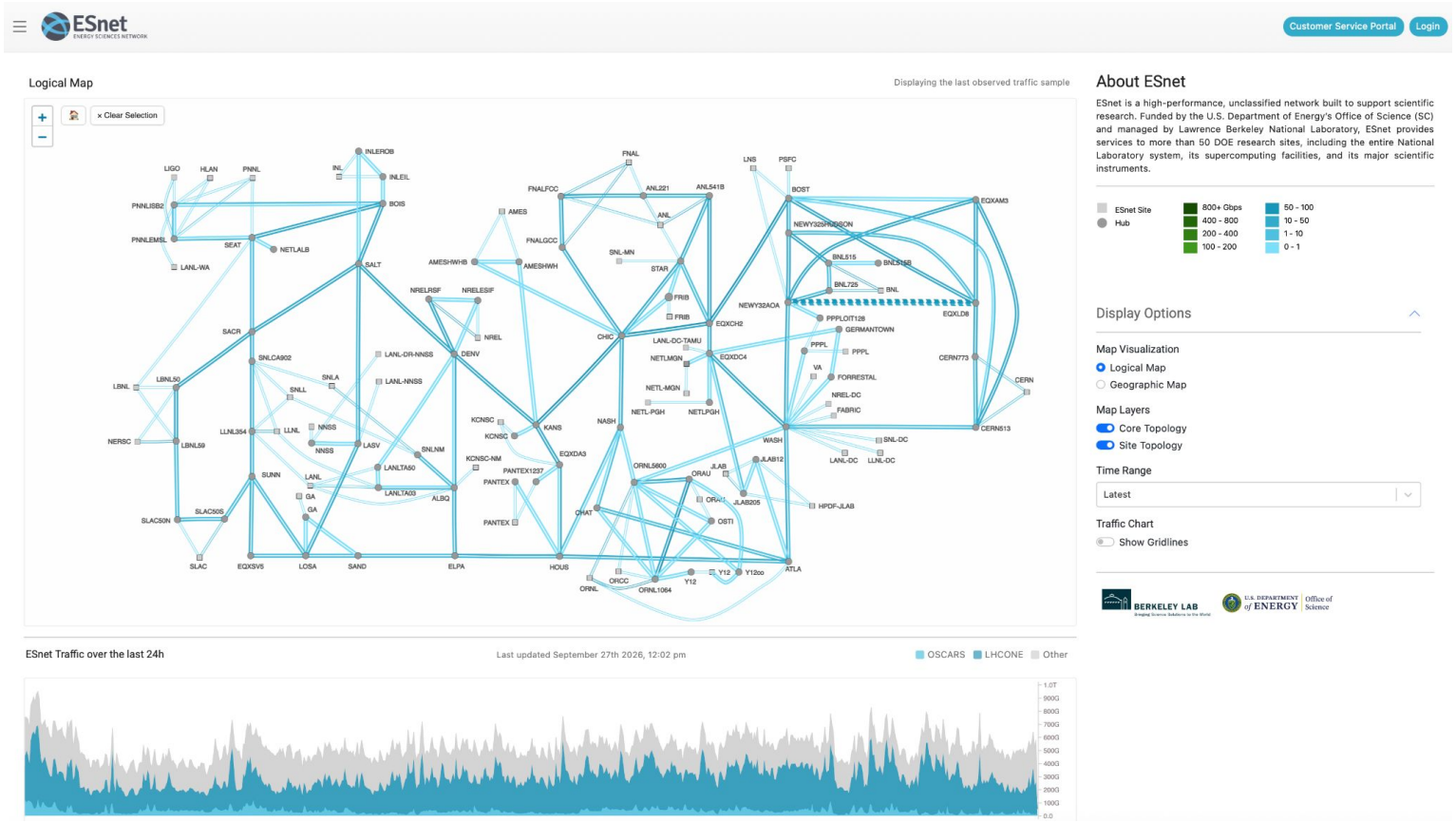
40+
DOE Sites & Facilities

200+
Global Peerings



*In U.S. | **As of Oct. 15, 2024. ESnet is measured and expected to provide 99.9% site uptime. The network regularly exceeds that standard.
**From the 2024 ESnet Site Coordinators Committee survey.

my.es.net Provides Live Visualization of Our Network



ESnet: Mission & Funding Overview

Core Mission & Purpose

Primary Mission: Deliver an unparalleled high-speed network infrastructure to enable and accelerate scientific discovery across the DOE complex.

Vision: Ensure scientific progress is completely unconstrained by the physical location of instruments, people, computational resources, or data.

Key Role: Serves as the national "data circulatory system," linking national laboratories, user facilities, supercomputers, and global collaborators.

Force Multiplier: Designed specifically for big-data science ("elephant flows"), optimizing data acquisition, placement, mobility, and sharing.

Funding & Management

Sponsorship: Funded directly by the **U.S. Department of Energy (DOE)** Office of Science.

Annual Budget: Approx $97M per year

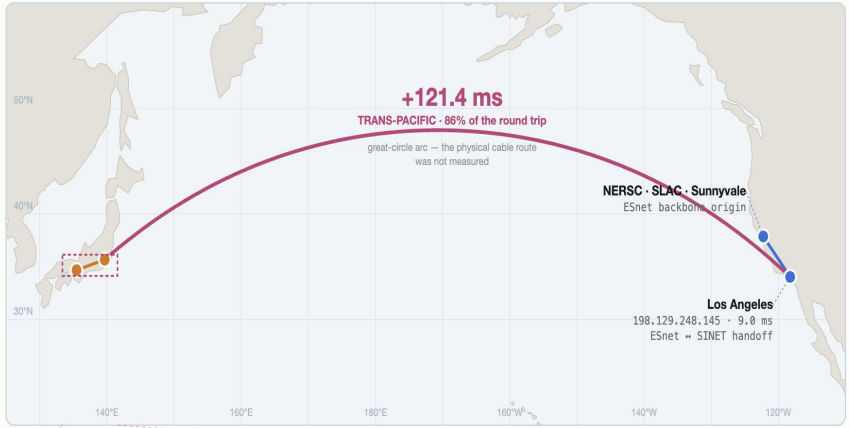
Program Office: Stewarded under the **Advanced Scientific Computing Research (ASCR)** program.

Management: Managed and operated by the Scientific Networking Division at **Lawrence Berkeley National Laboratory (LBNL)**.

Facility Model: Operated as a national **DOE HPN Scientific User Facility**, providing open-access high-performance infrastructure for basic research.

NERSC → Japan: where the R&E paths actually go

tracepath from Perlmutter login09 · 2026-09-27 · ESnet hands to SINET in Los Angeles; everything after that is domestic



Coastlines: Natural Earth (public domain) — 1:110m overview, 1:10m inset. Great-circle arc drawn between the measured endpoints; the submarine cable route was not measured. Marker positions a
Measured with tracepath -4 (UDP) from Perlmutter login09. Per-hop AS from Team Cymru; AS path confirmed against RIPE RIS.

Institution	Host	Site	Notes
RIKEN	`www.riken.jp`	Wako	Main site; may be CDN
RIKEN	`www.r-ccs.riken.jp`	Kobe	R-CCS (Fugaku)
RIKEN Harima	`www.spring8.or.jp`	Harima	SPring-8 (JASRI)
Osaka U	`www.osaka-u.ac.jp`	Suita	Main site; may be CDN
Osaka U	`www.cmc.osaka-u.ac.jp`	Suita	Cybermedia Center
Osaka U	`www.hpc.cmc.osaka-u.ac.jp`	Suita	HPC portal
U Tokyo	`www.u-tokyo.ac.jp`	Hongo	Main site; may be CDN
U Tokyo	`www.itc.u-tokyo.ac.jp`	Hongo/ Kashiwa	IT Center (UTnet)
U Tokyo	`www.icrr.u-tokyo.ac.jp`	Kashiwa	ICRR; alt. campus path

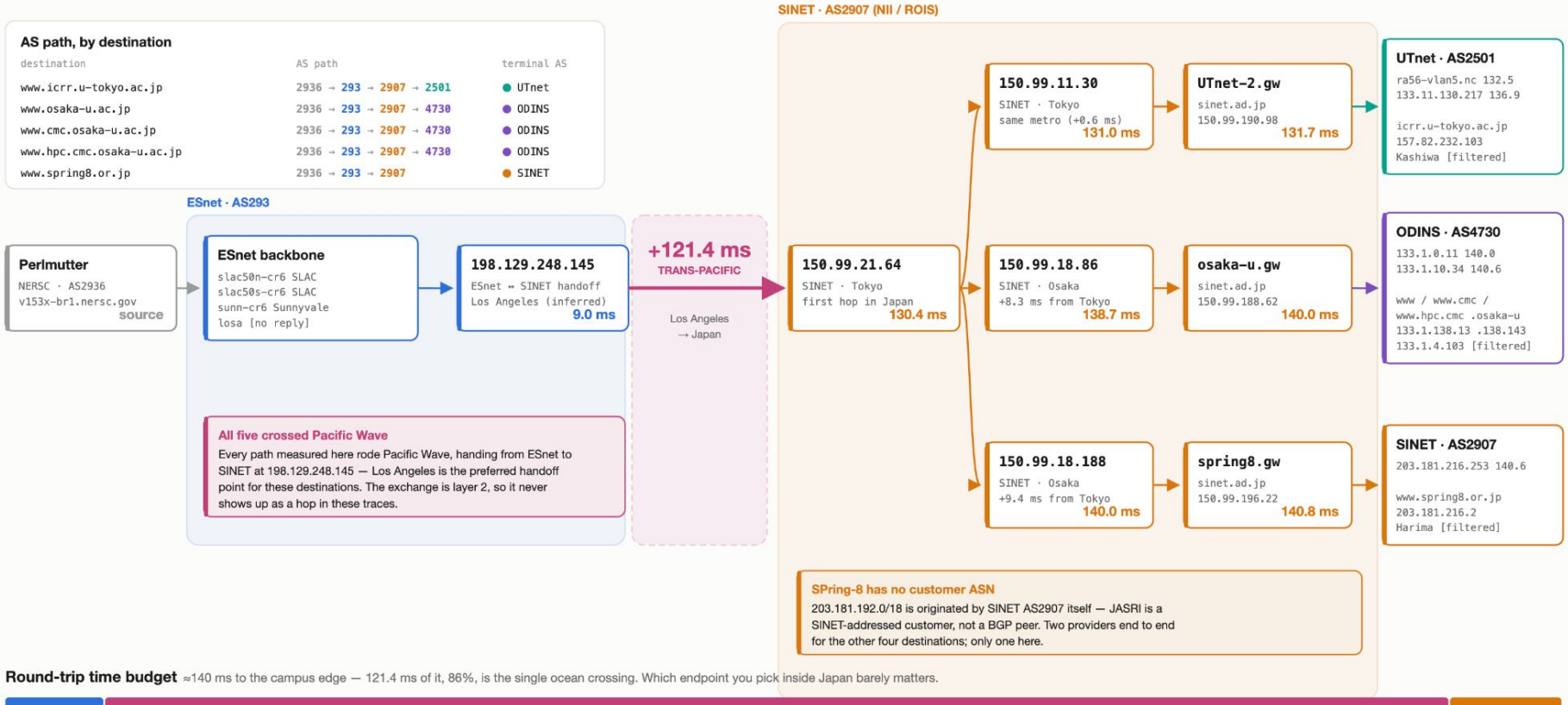
How NERSC reaches Japan's R&E networks

tracepath from Perlmutter login09 to five R&E destinations · 2026-09-27 · round-trip times in ms

ESnet AS293 · SINET AS2907 · UTnet AS2501 · ODINS AS4730

AS path, by destination

destination	AS path	terminal AS
www.icrr.u-tokyo.ac.jp	2936 → 293 → 2907 → 2501	UTnet
www.osaka-u.ac.jp	2936 → 293 → 2907 → 4730	ODINS
www.cmc.osaka-u.ac.jp	2936 → 293 → 2907 → 4730	ODINS
www.hpc.cmc.osaka-u.ac.jp	2936 → 293 → 2907 → 4730	ODINS
www.spring8.or.jp	2936 → 293 → 2907	SINET



Round-trip time budget ≈140 ms to the campus edge — 121.4 ms of it, 86%, is the single ocean crossing. Which endpoint you pick inside Japan barely matters.

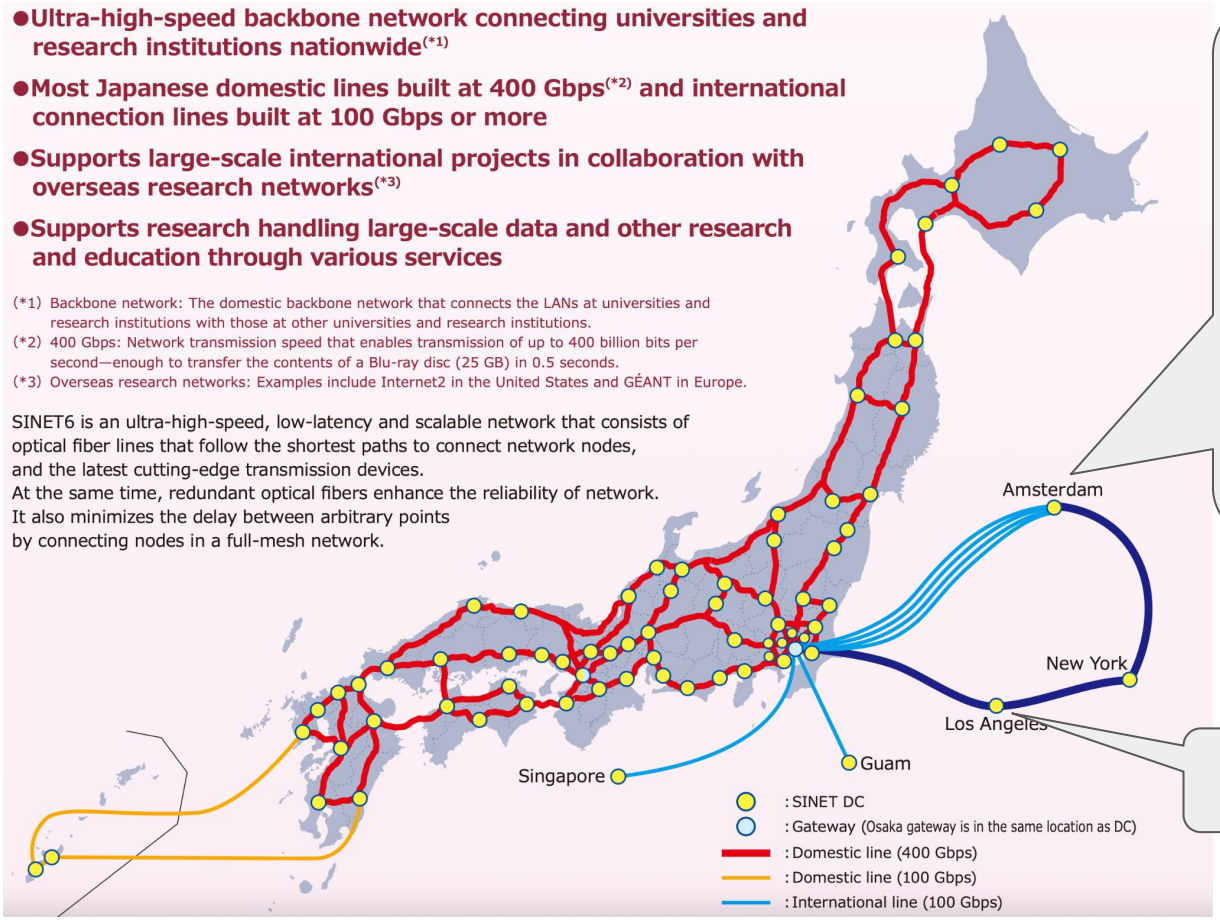


Measured with tracepath -4 (UDP); traceroute and mtr are not installed on Perlmutter login nodes. Hosts marked [filtered] drop the probes — the last responding hop shown is inside the destination campus. Per-hop AS from Team Cymru; AS path confirmed against RIPE RIS.

- **Ultra-high-speed backbone network connecting universities and research institutions nationwide(*1)**
- **Most Japanese domestic lines built at 400 Gbps(*2) and international connection lines built at 100 Gbps or more**
- **Supports large-scale international projects in collaboration with overseas research networks(*3)**
- **Supports research handling large-scale data and other research and education through various services**

(*1) Backbone network: The domestic backbone network that connects the LANs at universities and research institutions with those at other universities and research institutions.
(*2) 400 Gbps: Network transmission speed that enables transmission of up to 400 billion bits per second—enough to transfer the contents of a Blu-ray disc (25 GB) in 0.5 seconds.
(*3) Overseas research networks: Examples include Internet2 in the United States and GÉANT in Europe.

SINET6 is an ultra-high-speed, low-latency and scalable network that consists of optical fiber lines that follow the shortest paths to connect network nodes, and the latest cutting-edge transmission devices.
At the same time, redundant optical fibers enhance the reliability of network.
It also minimizes the delay between arbitrary points by connecting nodes in a full-mesh network.



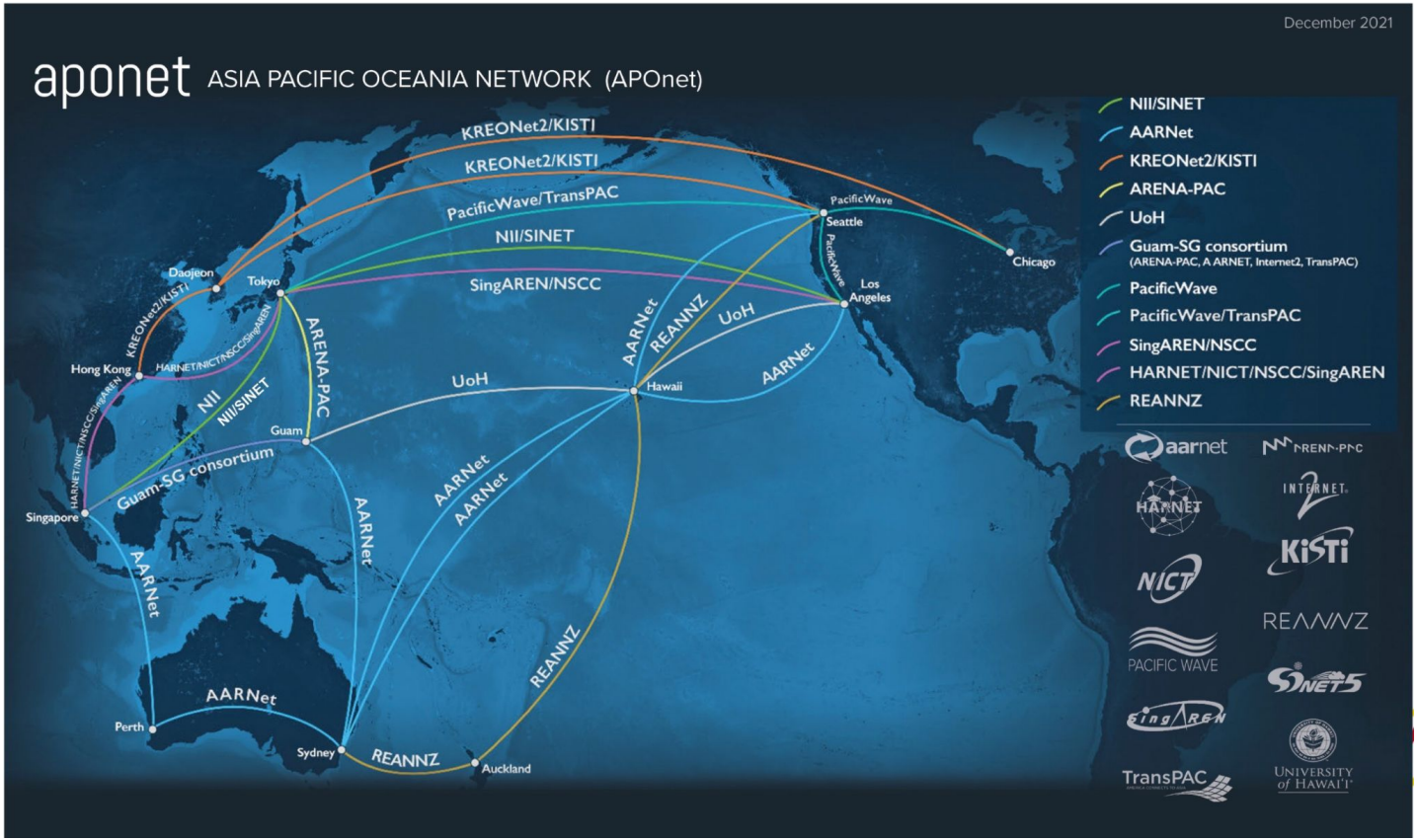
Why does Sinet have this extremely long connection directly to Europe ?

Ans: ESnet and most other networks will not provide FREE transit. Some will cost share. ESnet simply does not.

They carry traffic for their sites FRIB included

ESnet and other networks peer here

Resilience : Many Networks Share Failover Paths

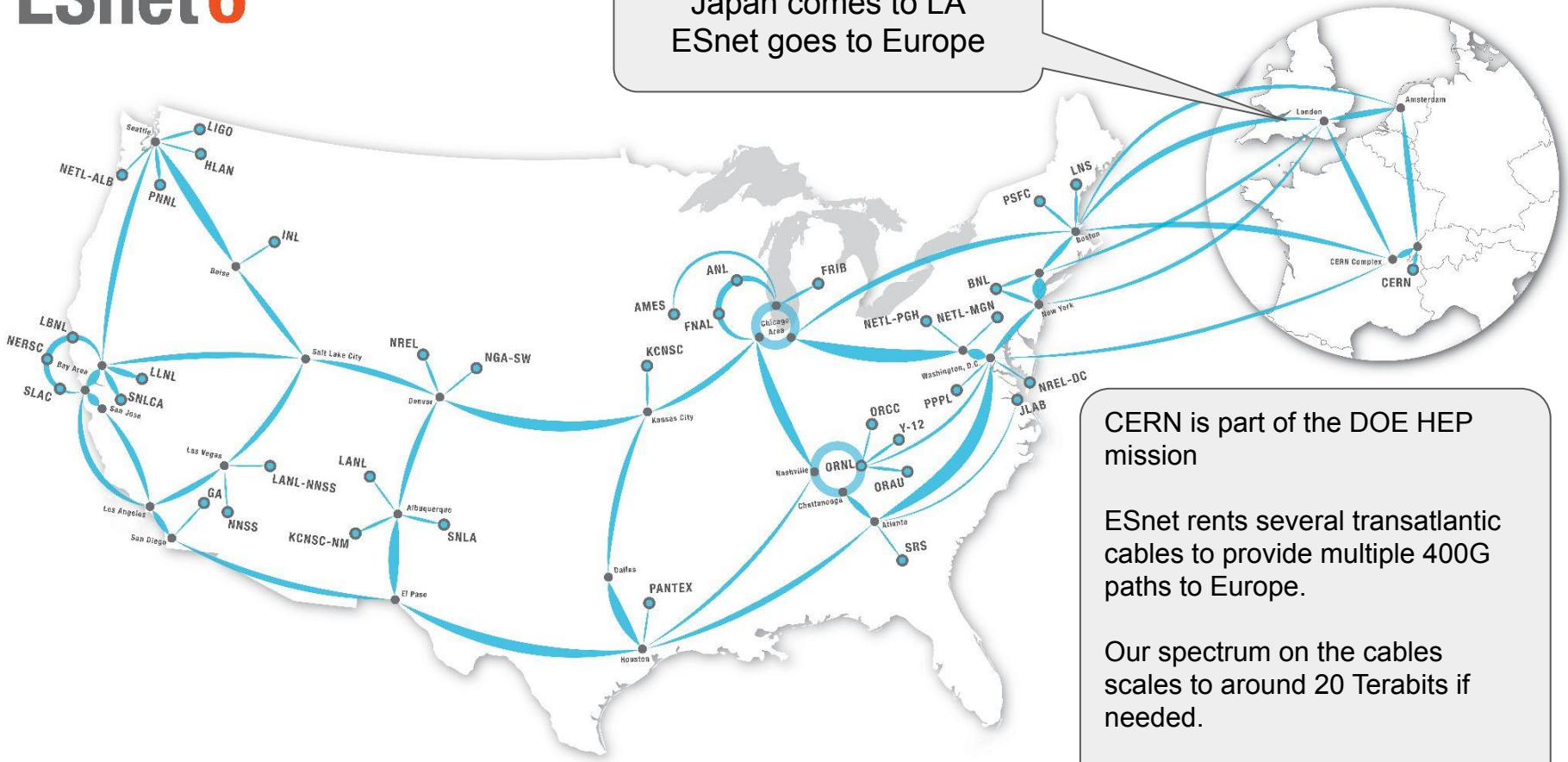


Expect better than 95% up time, even if individual cables go down more frequently.

Slightly dated map from 2021

ESnet6

Japan comes to LA
ESnet goes to Europe



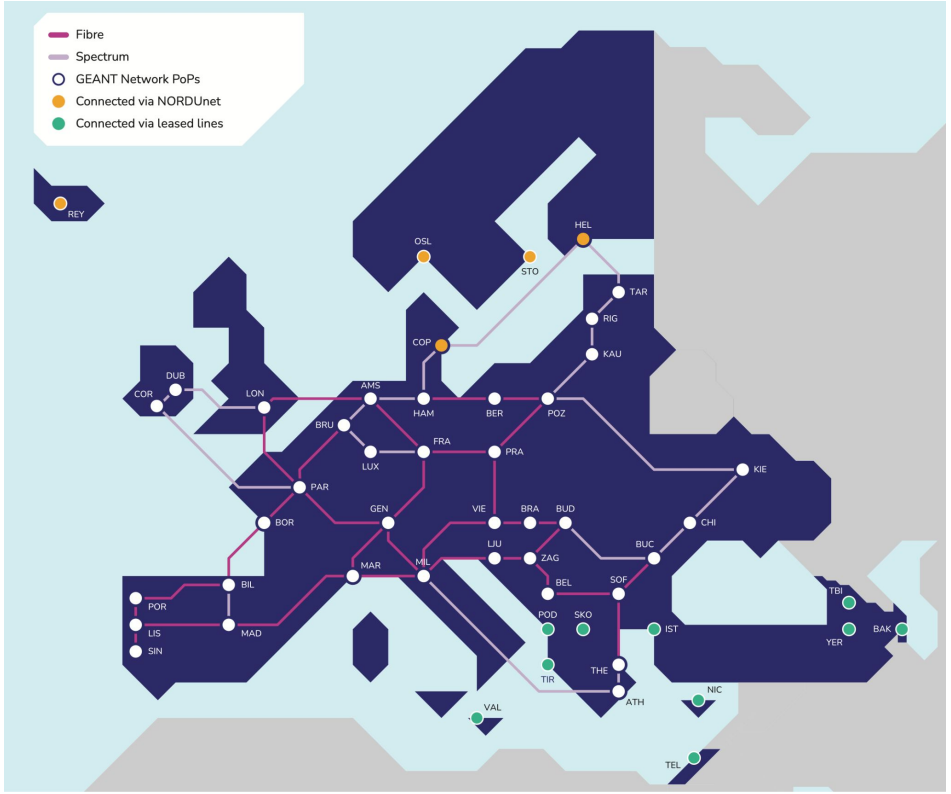
CERN is part of the DOE HEP mission

ESnet rents several transatlantic cables to provide multiple 400G paths to Europe.

Our spectrum on the cables scales to around 20 Terabits if needed.

London / Amsterdam / CERN

Geant



Within Europe, Geant provides connectivity to every research institution and university.

ESnet peers with Geant

As well Geant + ESnet provide shared protection and cost sharing across their independent transatlantic fibers

Asia Pacific networks like Sinet, AARNET, Singaren all have independent peerings with Geant in Europe as well

Conclusion:

400G networks are available throughout the world

The R&E networks are largely settlement free. There is no charge to use them, except your local fees to connect your campus to the global network.

You do not need to call anyone, or request anything.

Run : traceroute < anywhere in the world >

See what comes back…

If it is a DOE site, you will find ESnet on the path.

Epilogue - EJFAT

Budget: ESnet spends between 1% and 2% of its budget to support EJFAT.

Vision: Deep network integration is essential for real use of the network for scientific discovery.

Current EJFAT Engagements

Light Sources & Accel.

- LBNL / ALS
- SLAC / LCLS
- ANL / APS
- BNL / EIC

Nuclear & Particle Phys.

- JLAB / CEBAF
- JLAB / HPDF
- FRIB / FRIB
- CERN / LHCb
- SLAC / SCDF

HPC & Compute Facilities

- LBNL / NERSC
- ORNL / OLCF
- BNL / Alexi Compute
- ORNL+ / AMSC + ESnet

Technology Integration

FPGA

- Artix A7 & Cyclone IV
- Kria & Alveo U2xx
- AMANEQ
- CEBAF DAQ

Software

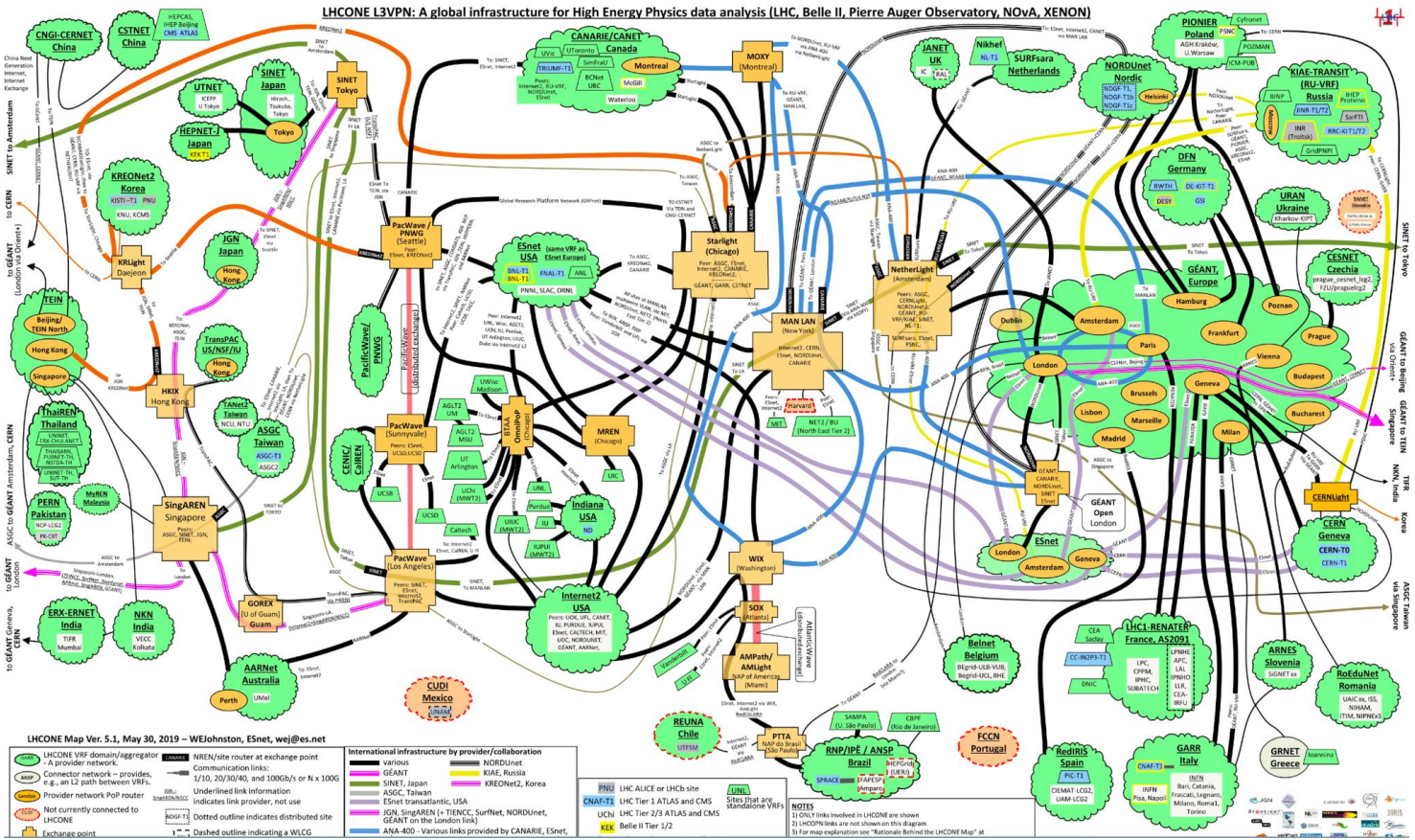
EPICS pvaPy
LCLstream - LCLSII
COSMIC ptychography
Jlab multiple use cases
EIC testbed
BNL various demos
GNUradio

Highlights

- Full DAQ to event identification from JLab to perlmutter at 100Gbps (Supercomputing 2026)
- EJFAT integration into first Genesis supercomputer (Lux at OLCF)
- First production workflow (LCLS crystallography) beam time measurement to analysis
- New EJFAT features being designed for :
  - reliable delivery
  - bidirectional communications

Backup

LHCONE : Only one of these will ever exist



A small Internet built like the Internet

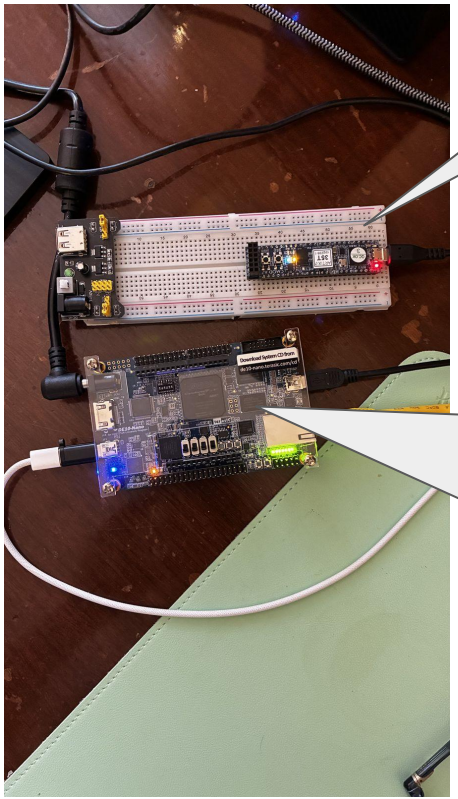
L3VPN
BGP peerings between AS

Controlled ingress and egress from the walled garden

Woven by an army of tibetan monks

Designed to entertain physicists during the long dark winters

Toys..



Digilent
Cmod a7
EJFAT on
UART

Altera
DE10 Nano

Cyclone IV +
Arm

1G EJFAT

Alveo U55/250/280
100G development
Emulate missing front
end DAQ.

At scale EJFAT testing
100G EJFAT



Kria
Ultrascale+
Arm cores + Ubuntu
SFP+

Goal: port AMANEQ
to this platform for
development and
testing. Lacks
AMANEQ headers,
so build test stubs for
what's missing.
10G EJFAT

