ESnet Updates

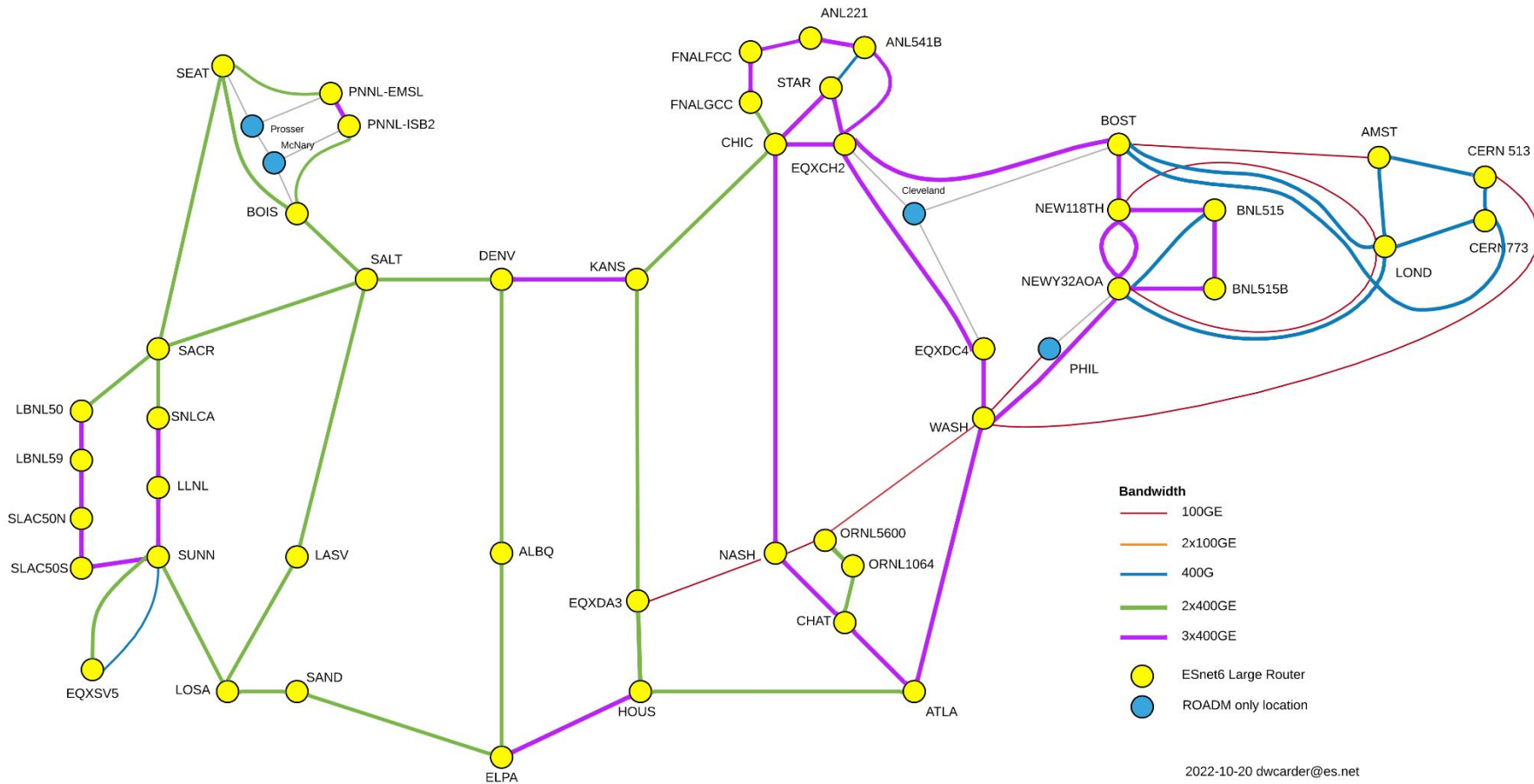**Eli Dart for many others at ESnet**

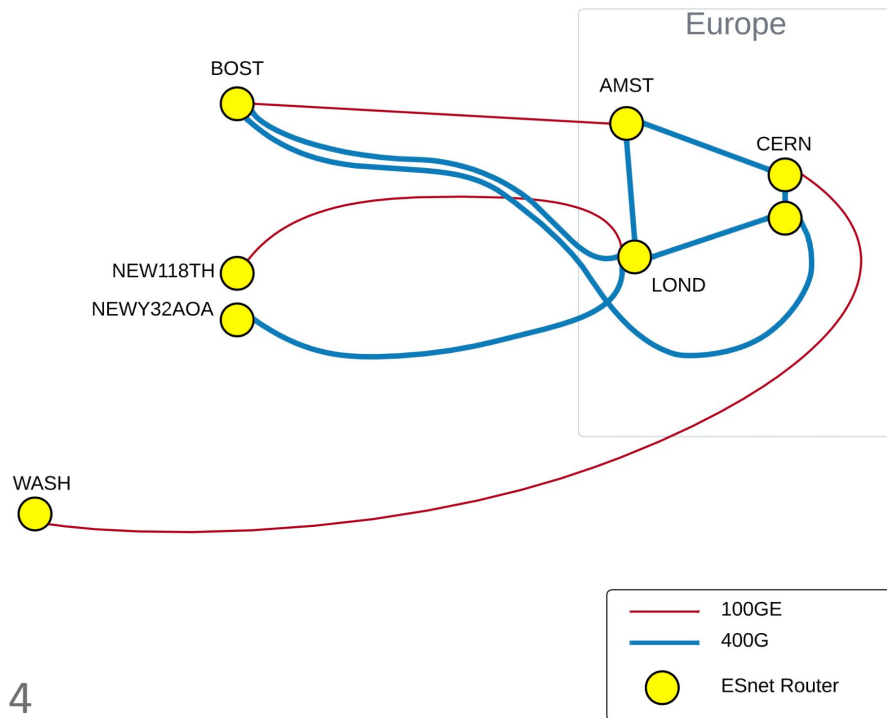LHCOPN/LHCONE #50
FZU, Prague CZ
18-19 April 2023

Agenda

- Note well - this presentation contains the work of many people

- ESnet Backbone Planning
- Trans-Atlantic Networking Plans
- Tier1 and Tier2 connectivity
- perfSONAR plans for LHCONE
- Statistics for DC24

ESnet Backbone planning - Q3 2023

Bandwidth
- 100GE
- 2x100GE
- 400G
- 2x400GE
- 3x400GE

ESnet6 Large Router

ROADM only location

2022-10-20 dwcarder@es.net

Trans-Atlantic & EU ring upgrades

- **Now In Production:**
  - 400G New York - London
- Currently underway:
  - 400G Boston - London (late fall)
  - 400G Boston - CERN (late fall)
  - 400G Europe Ring (late fall)

- Trans-Atlantic capacity targets
  - 1.5T in advance of DC24
  - ...
  - **3.2T* in 2027**, well in advance of Run 4

Europe

BOST
AMST
CERN
NEW118TH
NEWY32AOA
LOND
WASH

100GE
400G
ESnet Router

*Assuming funding continues as expected

ESnet

Transatlantic Cable Landing

Terrestrial cable

Subsea cable with outer armor removed

Copper power conductor

Loose tube fiber

Dielectric

Inner steel strength members

Routing Changes for Load Balancing

- We will have a mix of transatlantic link speeds for a while
- Routing protocols are not capacity-aware or load-aware
- Network Services (Michael Sinatra and others) have been working on a solution
  - ECMP across segment-routed LSPs
  - Put more LSPs on the 400G circuits
  - Initial results are positive
- Consequences:
  - Different flows between host pairs may take different paths with different latencies
    - Load balancing is per-flow, *not* per-packet, so we don't anticipate re-ordering or related problems
  - Traceroute may look odd (again)

ESnet

ESnet Cloud connectivity today

ESnet6 built physical network into major commercial facilities

- via private fiber interconnects
    - 5x100G to Google (one more pending)
    - 6x100G to Oracle
- via fabrics
    - 5x100G to Microsoft
    - 5x100G to Amazon

Private Cloud Interconnects to nearly any provider

- 5 locations (each 2x100G) to PacketFabric
    - OSCARS connectivity across ESnet
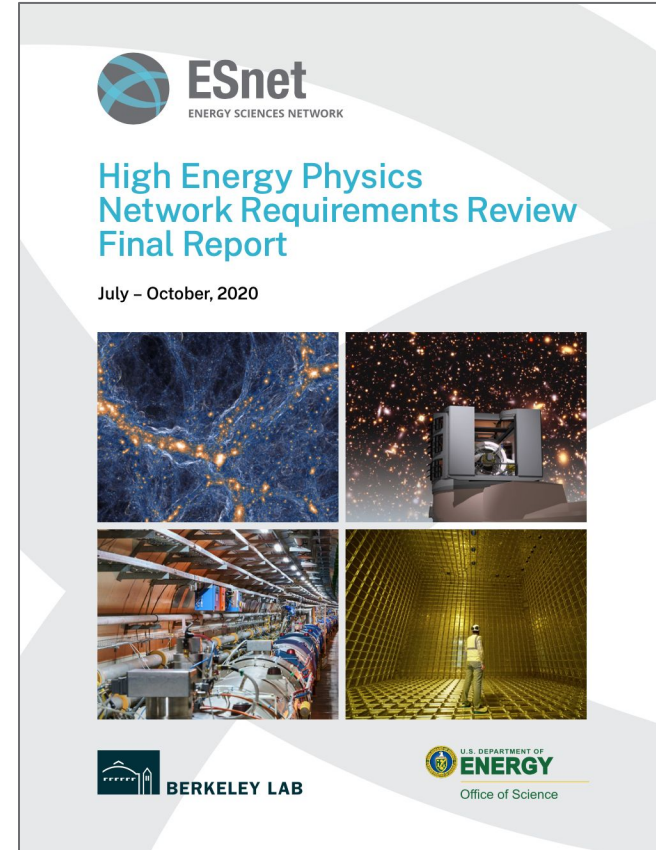   - possibility for API-based provisioning end-to-end

ESnet

DOE Site Connectivity

- ESnet6 installed routers collocated at our sites
- Most are connected to our optical system at 1.2Tbit + redundancy
- We are now ready to accommodate upgrades as sites are able
  - BNL - US ATLAS Tier 1
    - Current: 300G (2 x 100G + 1 x 100G)
    - Near Future: 800G (1 x 400G + 1 x 400G)
  - FNAL - US CMS Tier 1
    - Current: 400G (2 x 100G + 2 x 100G)
    - Near Future: 800G (1 x 400G + 1 x 400G)
  - NERSC
    - Current: **1T** (2 x 400G + 2 x 100)

ESnet

US Tier 2 Site Connectivity

- Report identified connectivity needs for T2 Sites
- Projections codified into data challenges
- Data Challenges (full software stack)
  - 1: 10% of the target 2021   # Successful
  - 2: 25% in 2024   # On Track
  - Interested in understanding what happens after DC24
- Continuing engagement with US Tier2 sites and the network paths to get to them

ESnet
ENERGY SCIENCES NETWORK

High Energy Physics Network Requirements Review Final Report

July – October, 2020

BERKELEY LAB

U.S. DEPARTMENT OF ENERGY
Office of Science

https://doi.org/10.2172/1804717

ESnet

US Tier 2 Site Connectivity

- ESnet making the rounds talking to *every* US T2 site
- Gathering and helping synchronize plans from
  - Individual PI's
  - Departmental Support Staff
  - Campus IT & CIO
  - Regional Networks
  - R&E Exchange points
- Plans assessed:
  - Vanderbilt, SoX, CalTech, UCSD, CENIC, Nebraska, GPN, Purdue, Wisconsin, OmniPoP, New NET2, UMASSNET, MIT, NoX , LEARN, AGLT2
- Todo:
  - MWT2, UTA

LHCONE Connectivity Upgrades

- In progress
  - Direct Connection to CENIC in Los Angeles
    - CalTech, UCSD
  - PACWAVE connectivity in Los Angeles
    - International connectivity
  - GPN 400G
    - Nebraska
  - NOX 100G in Boston
    - Supporting New NET2

ESnet

perfSONAR

- ESnet perfSONAR fleet is nearing completion
  - Lots of supply chain and related logistics problems
  - Tuning challenges (different hosts than we originally specified)
- Problem: little LHCONE presence
  - Previously there were only a few LHCONE hosts in ESnet
  - Desire to avoid additional hardware deployments for LHCONE
- Solution: LHCONE interfaces on ESnet perfSONAR hosts
  - Nearing completion of IPv6 LHCONE interfaces on many/all hosts
  - Intent is to enable richer test and measurement on LHCONE than was previously available
  - Target availability: May 2023

perfSONAR version 5

- perfSONAR Version 5 is out!
- Packages for major distros coming soon
- ESnet will upgrade its systems shortly
- We need to have a discussion about community tags in perfSONAR (can we claim 'LHCONE' in the lookup service?)
- We are looking forward to working with the community on testing Tier2 paths

ESnet

Statistics for DC24

- Something to think about for tomorrow's discussion
- ESnet's statistics systems can tell us some things about network data
- What do we need to do in preparation for DC24?
- Sites provide statistics - what do we need from the network in the middle?

14
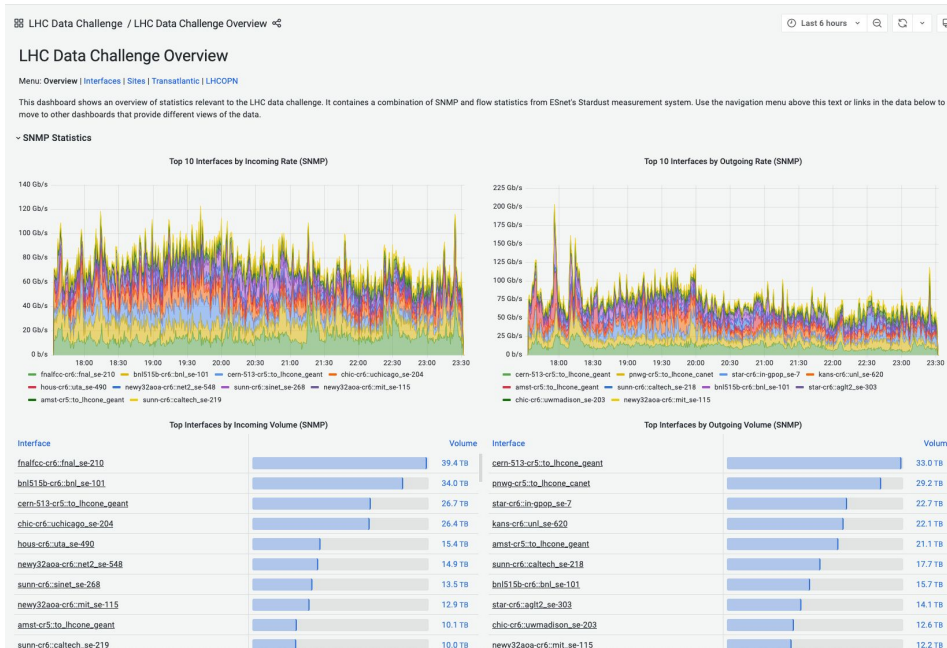
Moving Forward Together

- I'm presenting the work of many other people
- Several things are in motion now
    - Transatlantic and backbone upgrades
    - perfSONAR
    - Exchange point and related connectivity for Tier2s
- With the knowledge that resources are finite, what else needs to be done?

ESnet

Thanks!

dart@es.net

Energy Sciences Network (ESnet)

Lawrence Berkeley National Laboratory

http://my.es.net/

http://www.es.net/

http://fasterdata.es.net/

ESnet