



ESnet

ENERGY SCIENCES NETWORK

ESnet Networking Initiatives

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AmRP Working Group Meeting

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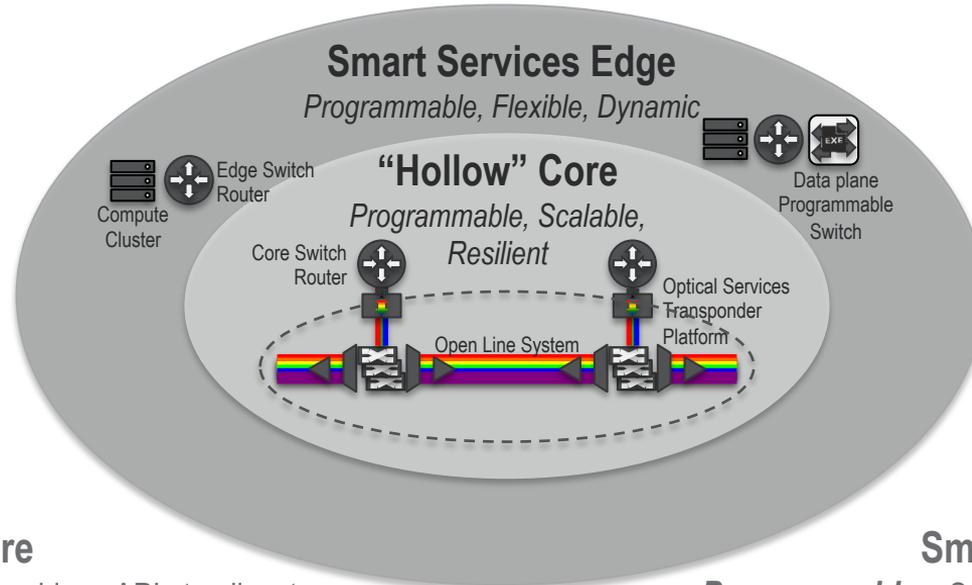


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ESnet6 (“Hollow-Core”) Architecture Overview



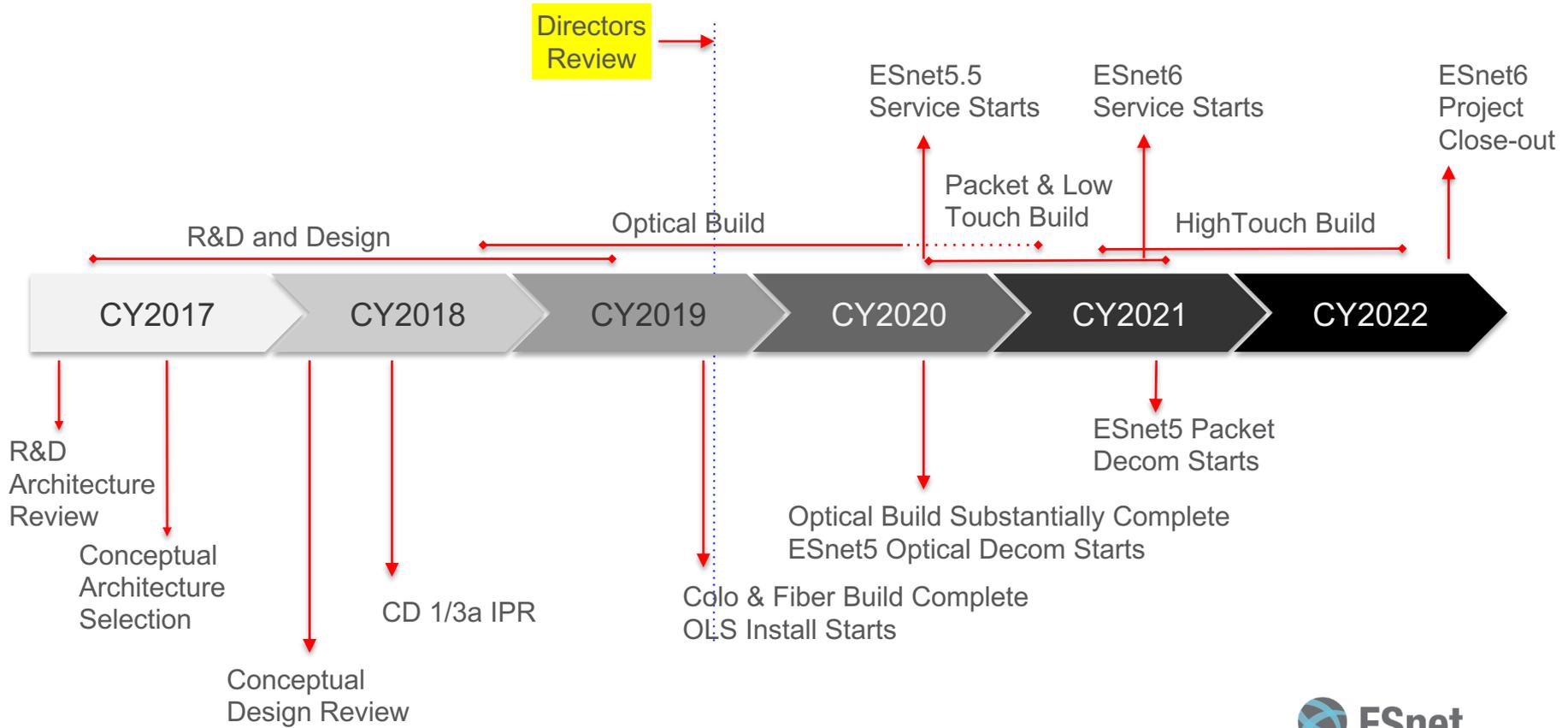
“Hollow” Core

- **Programmable** – Software driven APIs to allocate core bandwidth as needed, and monitor status and performance.
- **Scalable** – Increased capacity scale and flexibility by leveraging latest technology (e.g. FlexGrid spectral partitioning, tunable wave modulation).
- **Resilient** – Protection and restoration functions using next generation Traffic Engineering (TE) protocols (e.g. Segment Routing (SR)).

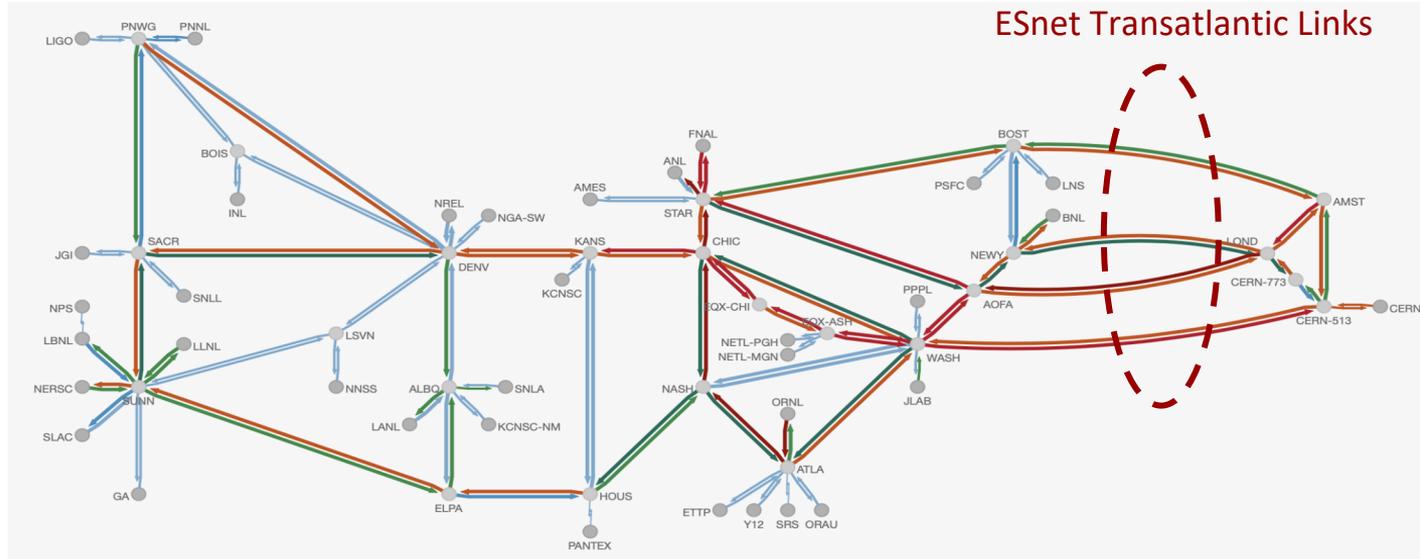
Smart Services Edge

- **Programmable** – Software driven APIs to manage edge router/switch and retrieve telemetry information.
- **Flexible** - Data plane programmable switches (e.g. FPGA, NPU) in conjunction with compute resources to prototype new services (driven by Software Defined Networks (SDN)).
- **Dynamic** – Dynamic instantiation of services using SDN paradigms (e.g. Network Function Virtualization (NFV), Virtual Network Functions (VNF), service chaining).

ESnet6 Project Implementation Timeline



ESnet has 4+1 Transatlantic links



ESnet operates the following Transatlantic links as of August 2019:

- | | | |
|---------------|-----------------|------------------------------------|
| 1. 100 Gbit/s | Boston | Amsterdam |
| 2. 100 Gbit/s | New York (newy) | London |
| 3. 100 Gbit/s | New York (aofa) | London |
| 4. 100 Gbit/s | Washington | CERN |
| 5. 50 Gbit/s | New York (aofa) | London (NEAR) - <i>shared link</i> |



LHCOPN vs LHCONE

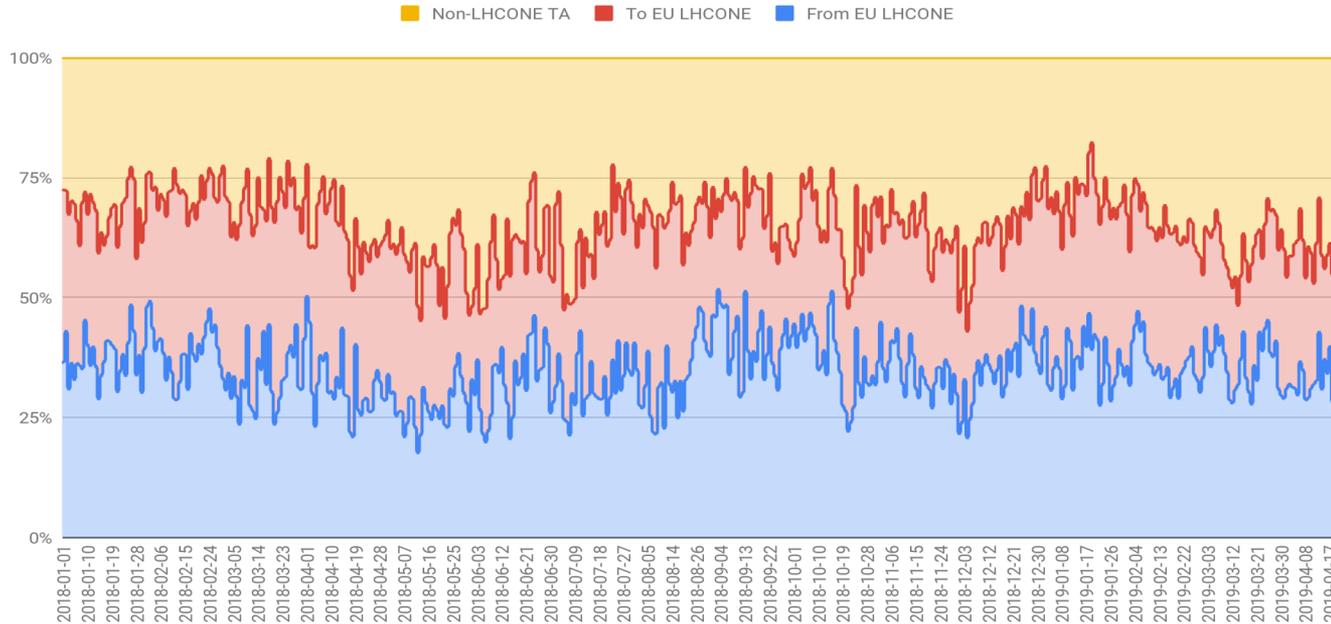
- LHCOPN - dedicated ESnet circuits to carry CERN T0 to T1 traffic:
 - FNAL circuit - average utilization 15 Gbit/s, peaks of 75 Gbit/s
 - BNL circuit - average utilization 5 Gbit/s, peaks of 40 Gbit/s
 - Traffic utilization is symmetrical (both directions are used)
- LHCONE - LHC Open Network Environment (Tier 1/2/3 network)
 - Serves an expanding global community
 - Originally designed to distribute traffic in a hierarchical fashion
 - ESnet serves US ATLAS and CMS HEP sites (both universities and labs)
- Both LHCOPN and LHCONE share the same transatlantic links

LHCOPN statistics: <https://netstat.cern.ch>



Transatlantic links - who is using them?

ESnet TA Traffic Distribution LHCONE vs Other Traffic



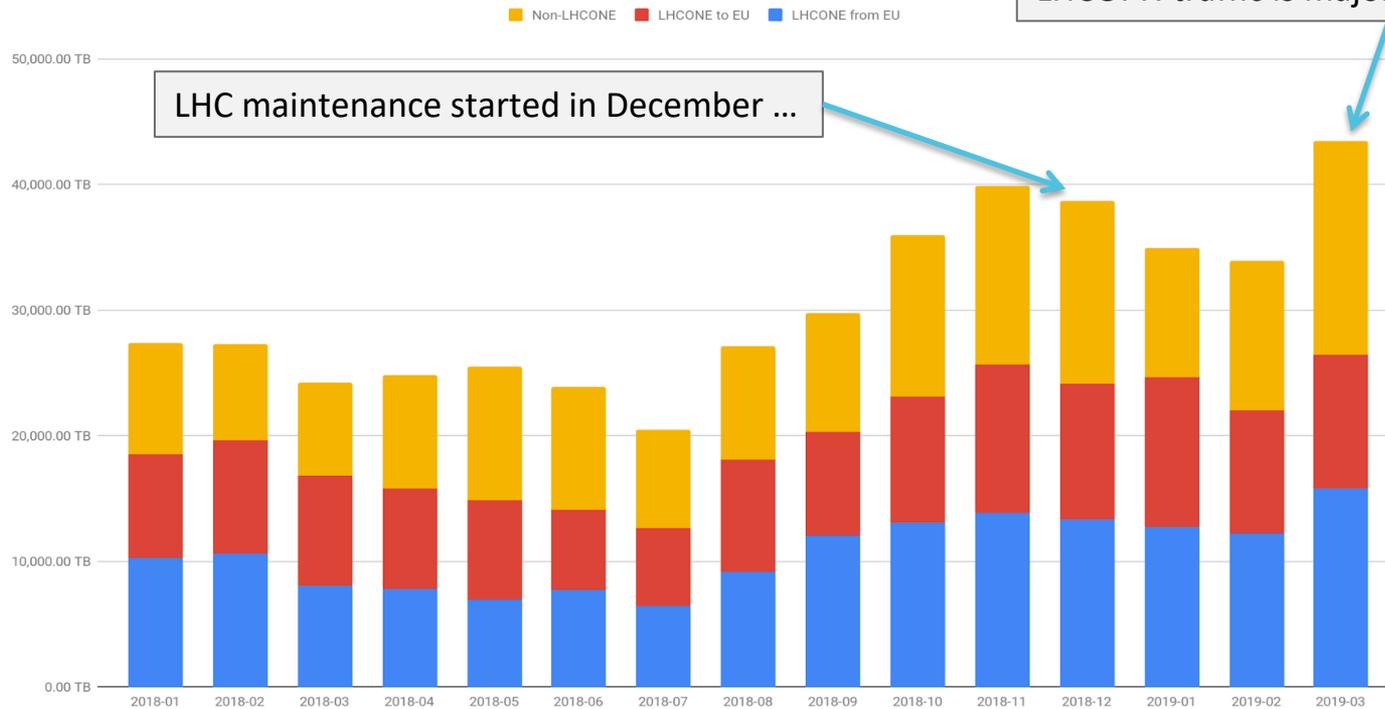
Observation: most of our TA traffic is **LHCONE** - 60% on average.

LHCOPN is ~25% of all TA traffic (part of “Non-LHCONE” on the plot).

LHCONE + LHCOPN = 85% of ESnet’s TA utilization.

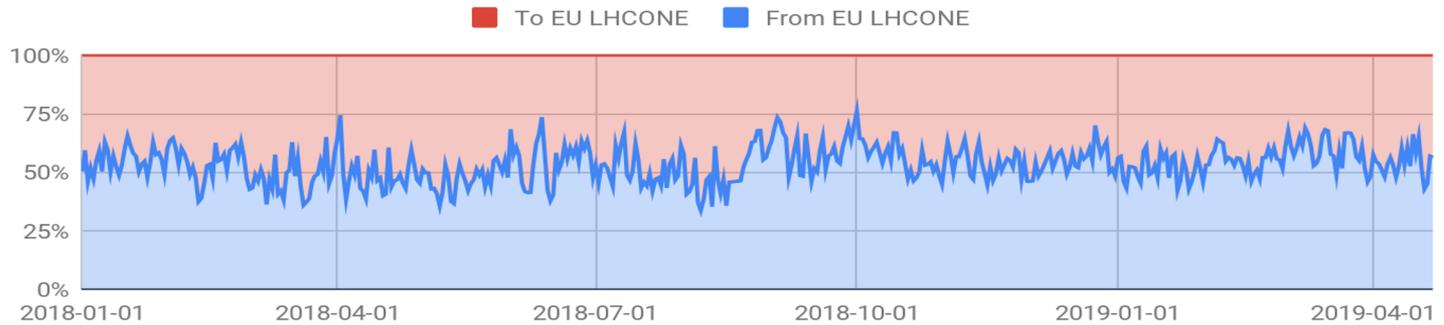
Transatlantic Volume - by Month

Total Volume on ESnet TA Links by Month



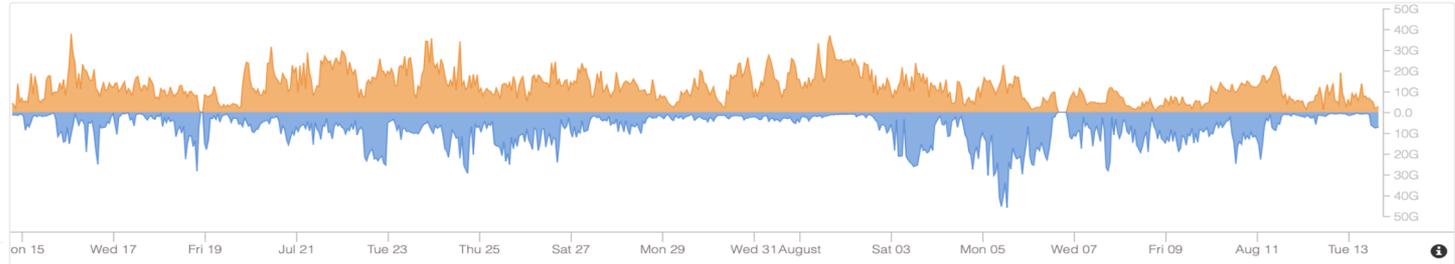
Transatlantic - Direction Analysis

LHCONE



LHCOPN

FNAL Primary LHCOPN

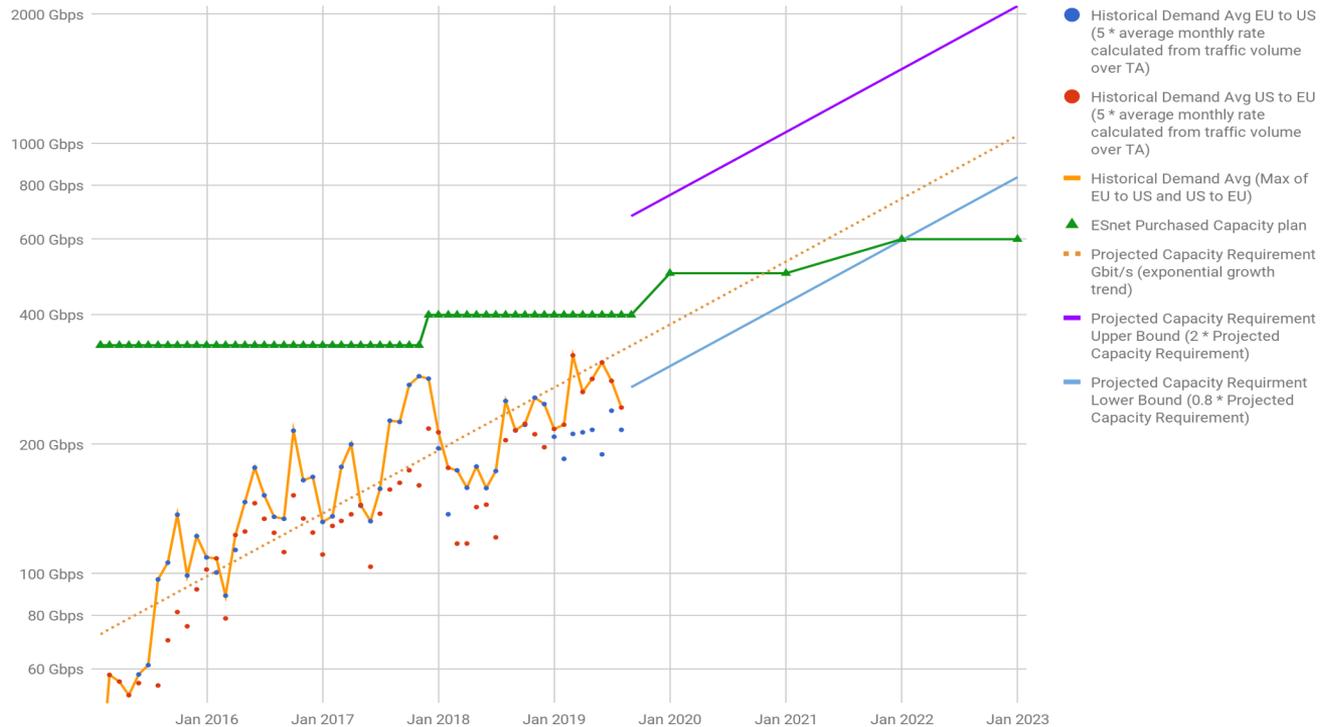


Observation: EU->US is only slightly higher than US->EU.
Traffic direction is generally balanced on both LHCONE and LHCOPN.



Transatlantic Forecasting

European Demand and Capacity Forecasts (updated Sept 2019)



Transatlantic Forecasting - Observations

- ESnet's TA usage continues to grow - LHCONE traffic is the main contributor on TA. Approximating exponential growth on TA:
 - up to ~50% increase yearly - based on 2018-2019
 - up to ~40% increase yearly - based on last 3 years
- Traffic growth changes continuously
 - we have seen a general slowdown at ESnet in traffic growth during the last 5 years - however LHC traffic did not follow it
 - Run 4 of LHC will increase data rates from 2020, with HL-LHC (5-10 times more resources according to CERN)
 - Expansion of the LHCONE network and new HEP experiments utilizing LHCONE will also increase traffic



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Thank you!

ESnet6 slides provided by Chin Guok.

Transatlantic forecasting slides
provided by Richard Cziva.



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