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ENERGY SCIENCES NETWORK

ESnet's Transatlantic Traffic: Analysis and Forecasting

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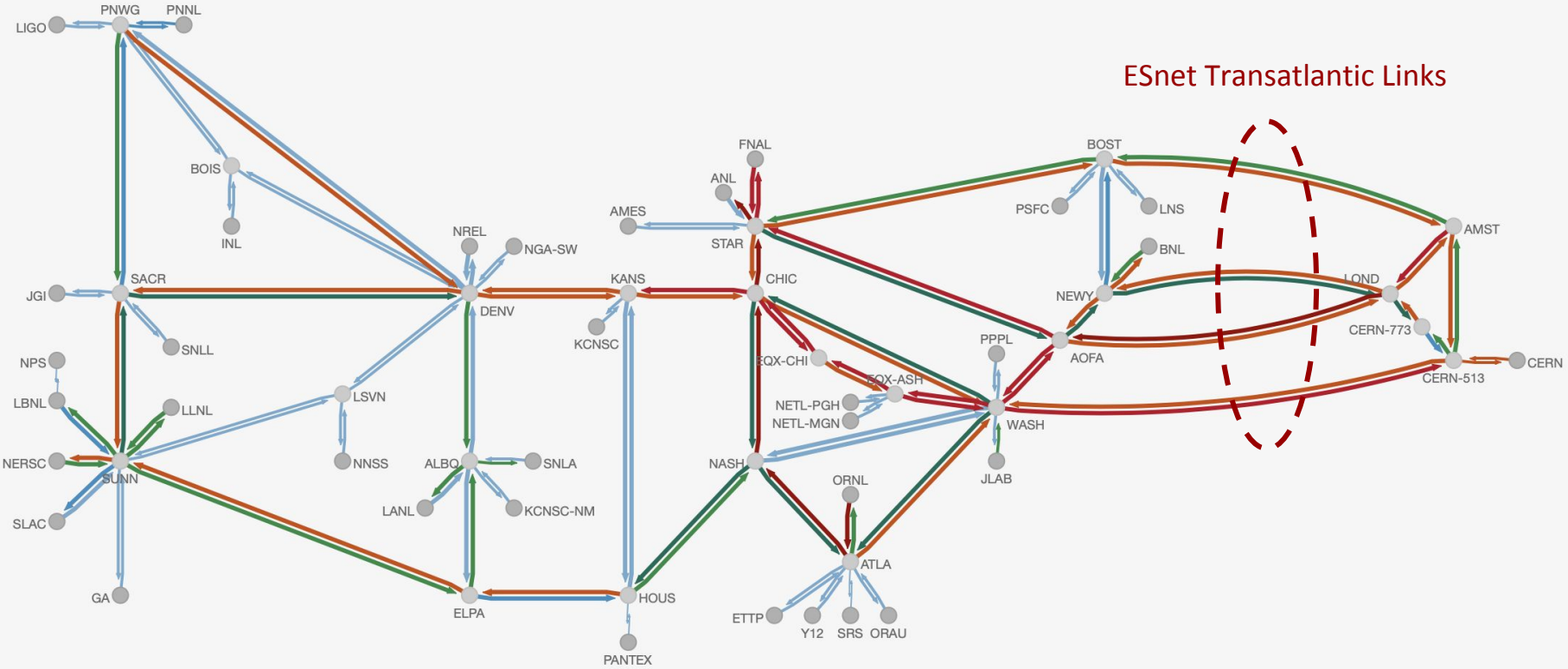
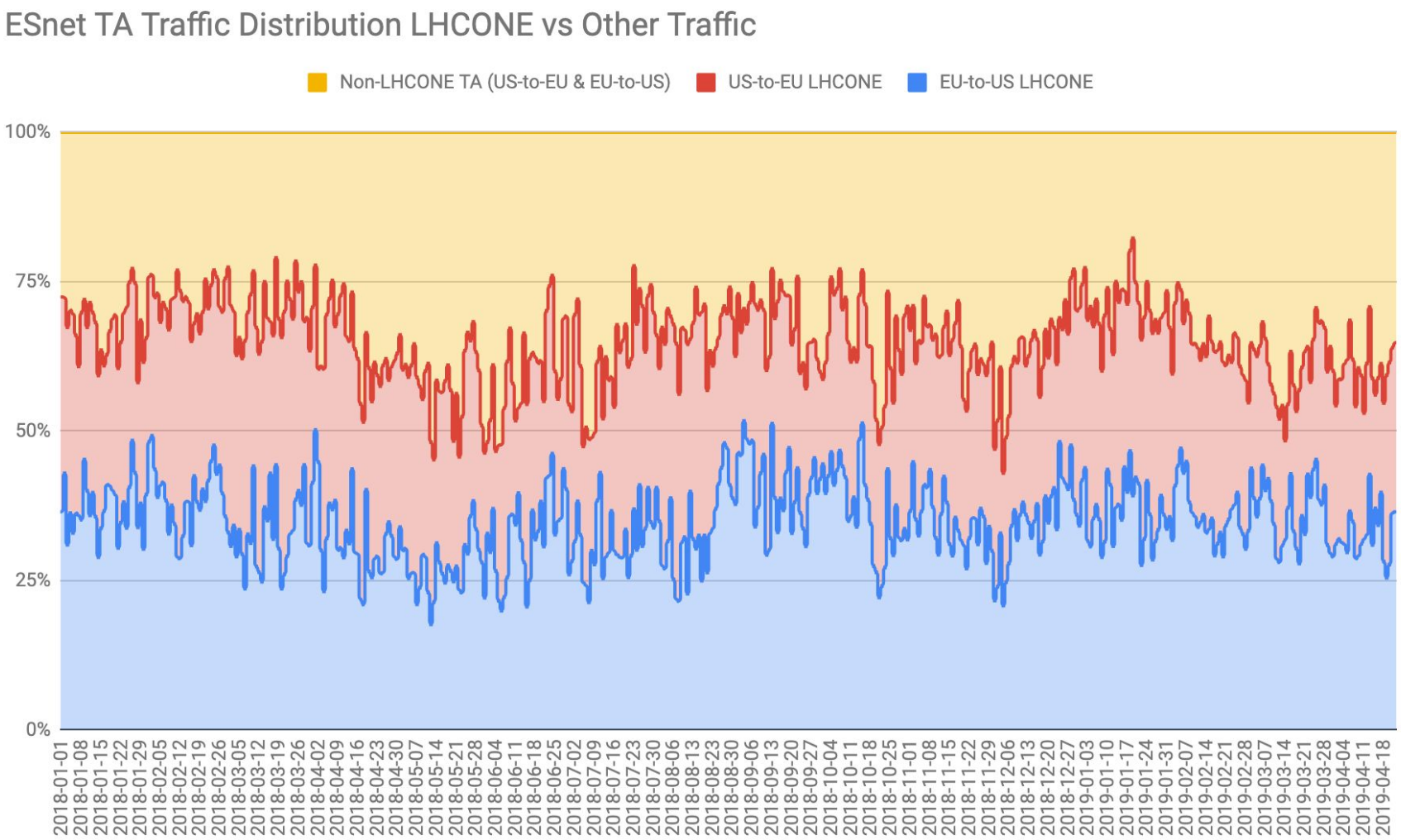
ESnet has 4+1 Transatlantic links



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 (NEAAR) - *shared link*

Transatlantic links - who is using them?



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.

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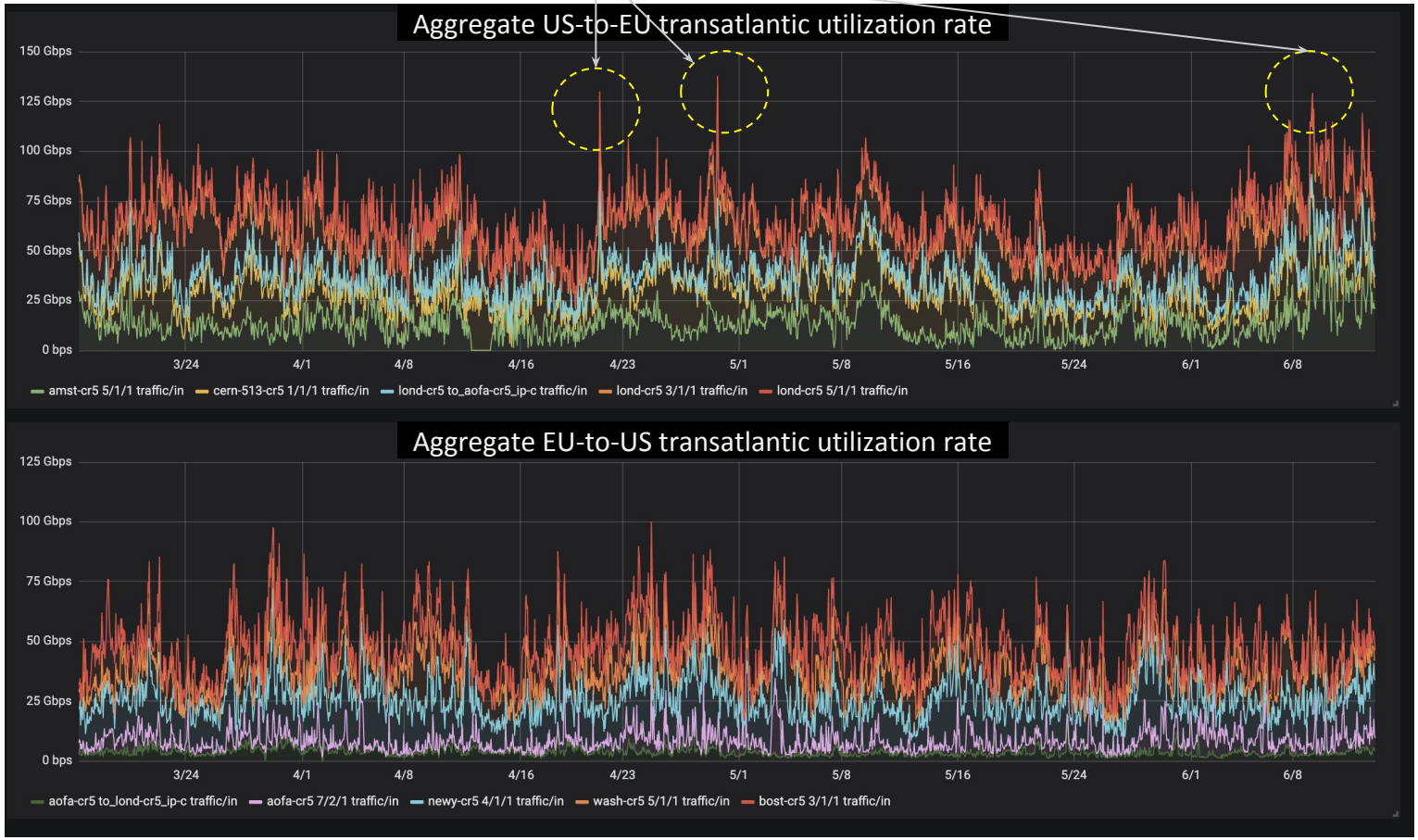
Peaks of around 130 Gb/s (up to 160 Gb/s)*

Utilization peaks of 130 Gb/s are common US-to-EU...



Aggregate utilization of all TA links.

Example timeframe: March 16 2019 - June 13 2019

Source: ESnet Grafana dashboard

**NB: Average over 30 sec intervals*

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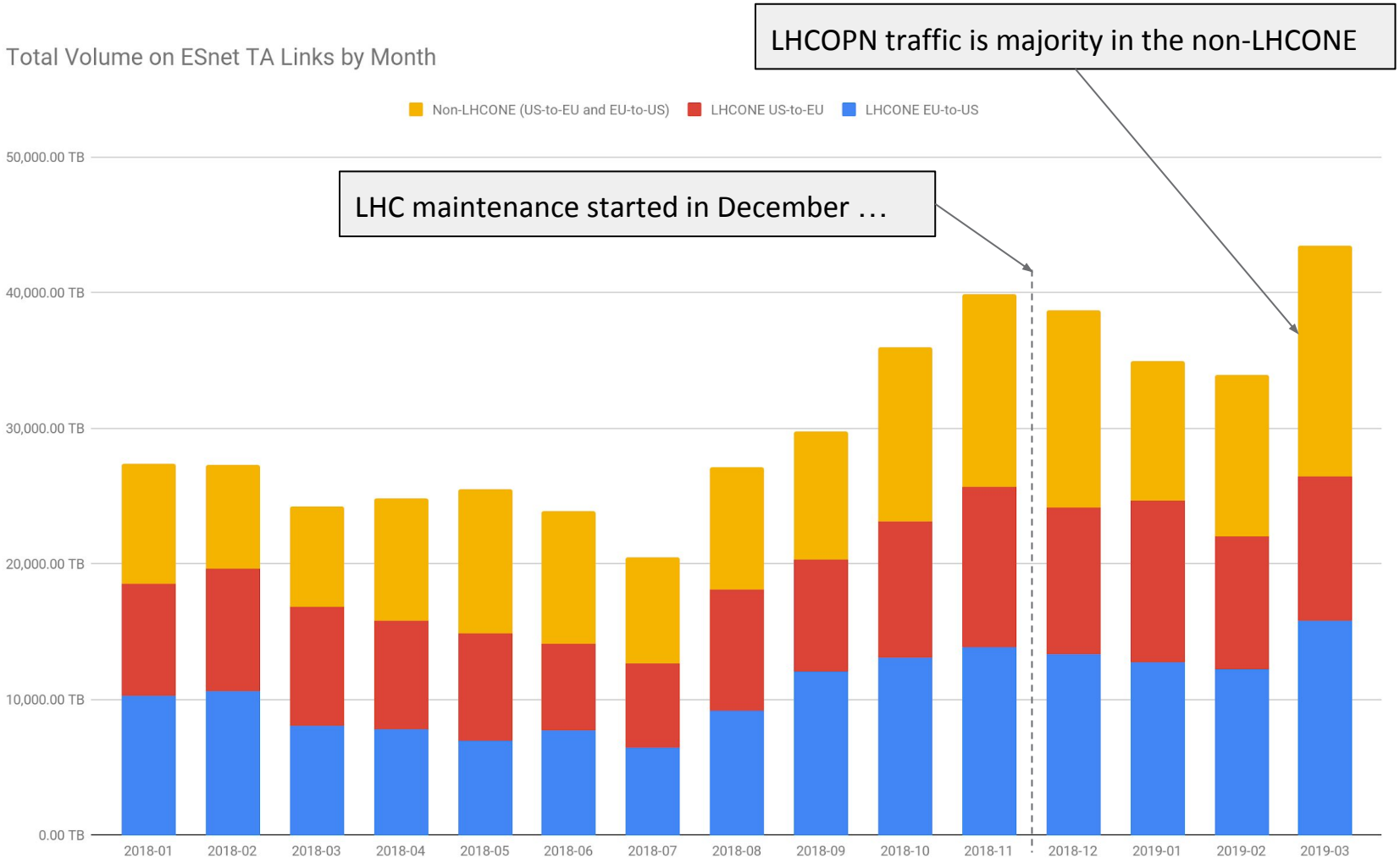
Transatlantic Volume - by Month



Observation: LHC maintenance did only have a slight effect on the data growth.

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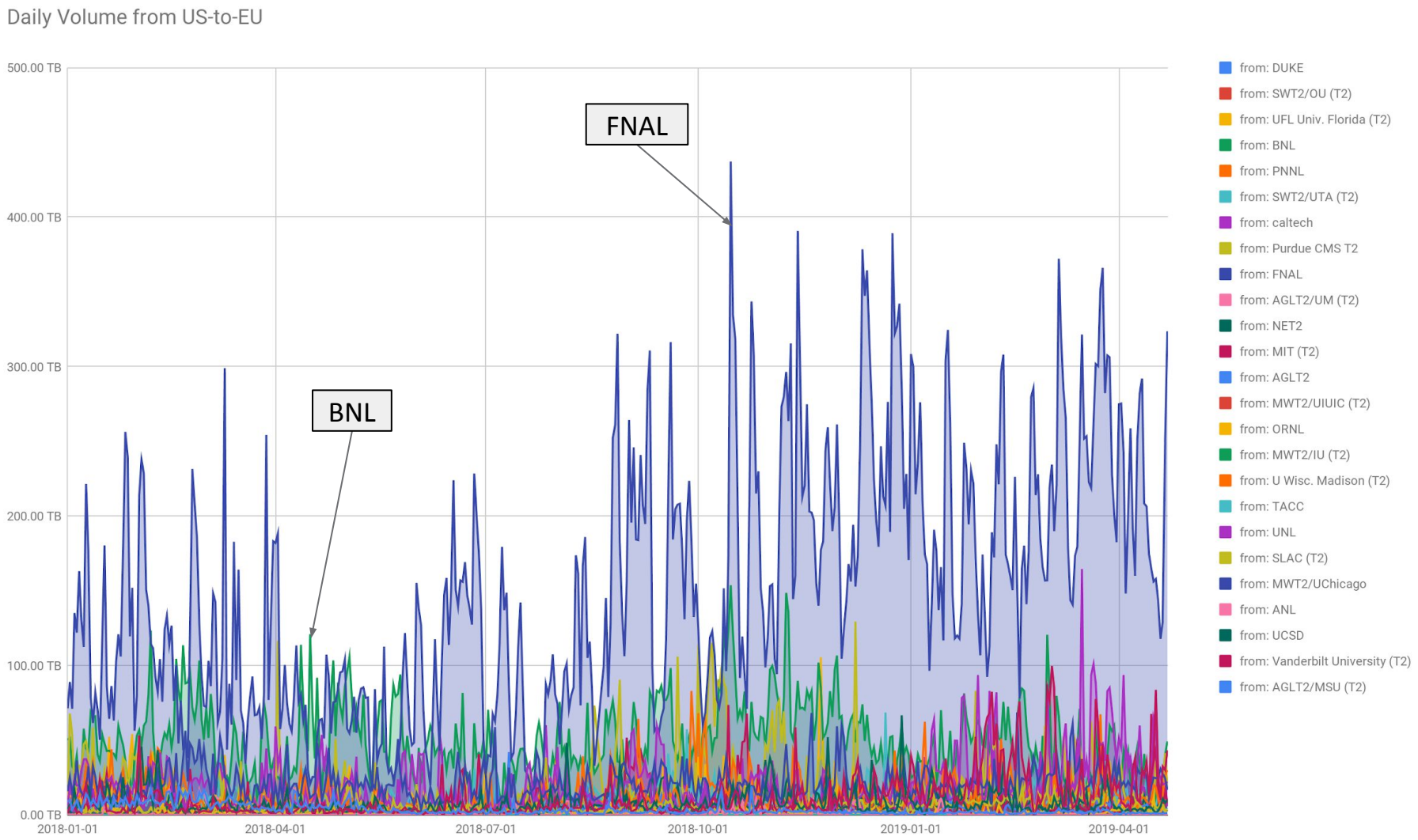
Transatlantic - from US to EU by LHCONE site



Fermilab and BNL are the top data sources for TA bandwidth from US to EU.

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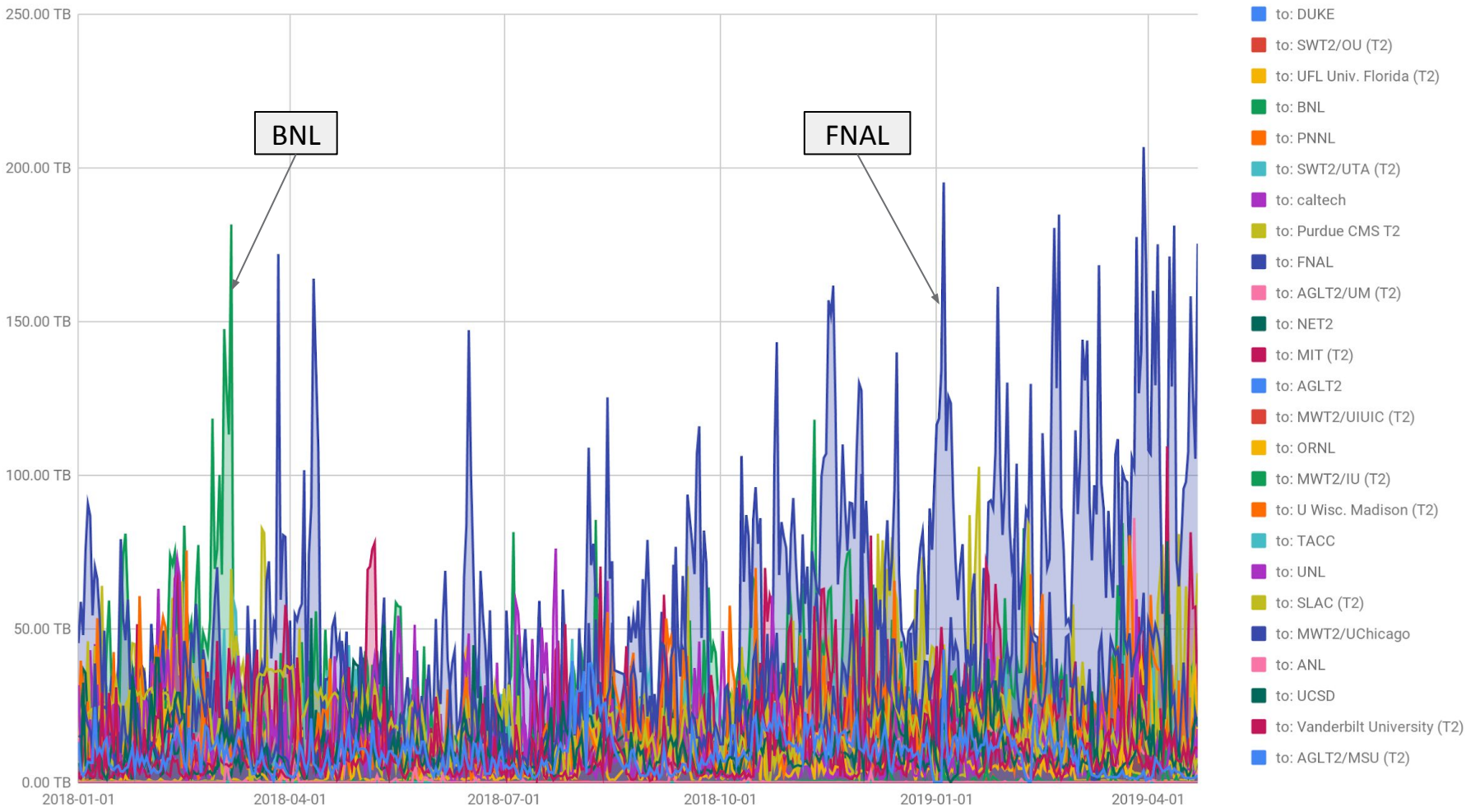
Transatlantic - from EU to US by LHCONE site



Fermilab is by far the top consumers of TA bandwidth from EU to US.

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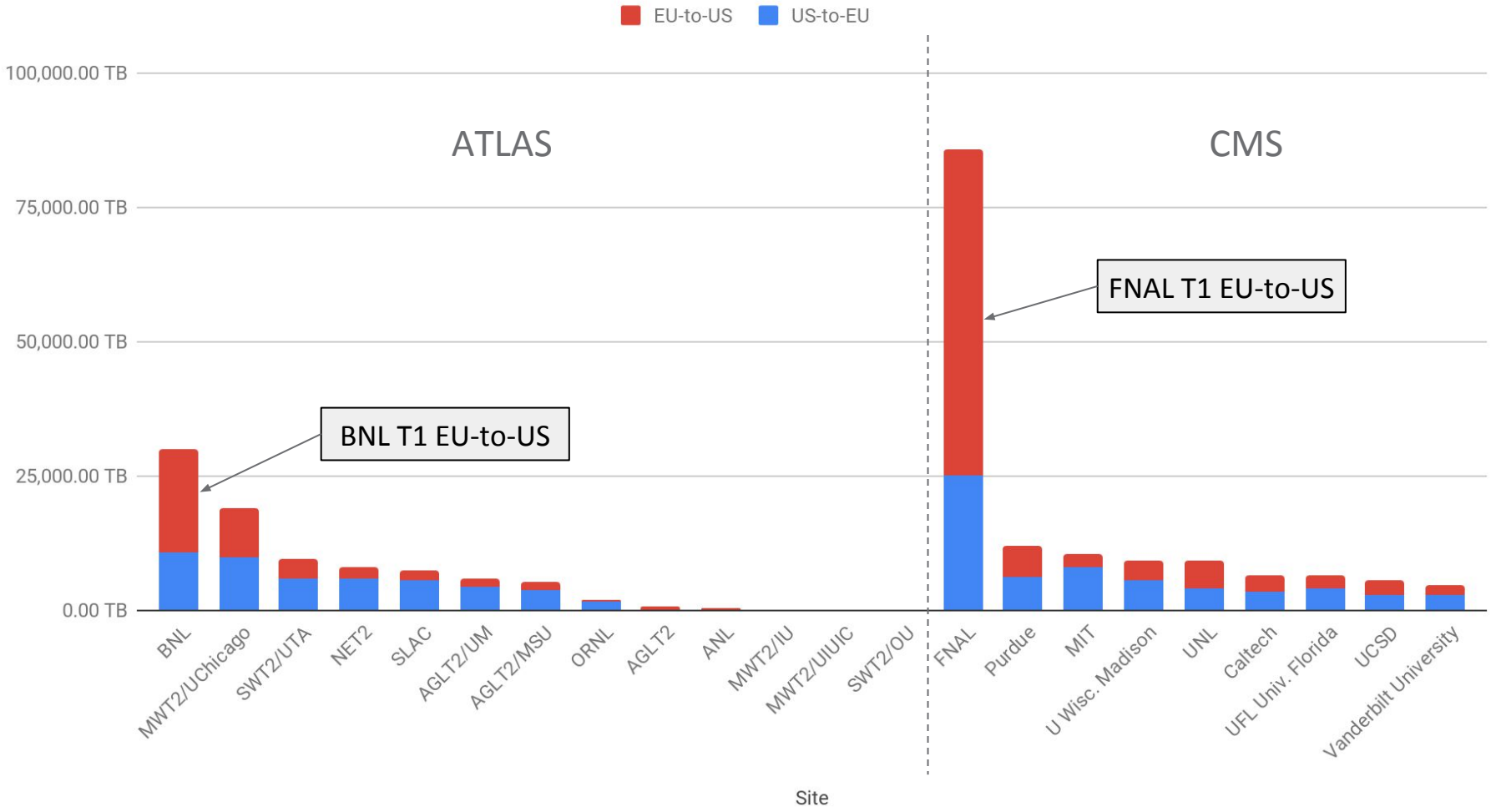
Transatlantic - LHCONE Site Usage

US-to-EU and EU-to-US (volume trasferred between Jan 2018 - April 2019)



Tier model in operation: most traffic from EU comes to BNL and FNAL.

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Projected Capacity Requirement

- We define the projected capacity requirement for each month as **5 times the average monthly utilization of all TA links,** where average utilization is calculated from total number of bytes transferred over any of the TA links.

- The following factors were taken into account for the multiplier of 5:
  - Our TA traffic is bursty - peaks with 2.2-3 times the average utilization are measured on TA (reaching over 160 Gbit/s)
  - We add overhead to allow for long TA provisioning times and sudden increases of LHC traffic - anticipated after the maintenance is over and when HL-LHC starts. From July 2018 to Aug 2018, LHC traffic volume has grown by 150% in one month.
  - ESnet's TA links can experience very low availability - e.g., Boston - Amsterdam had 96.8% availability in Dec 2018. One link going down means 22% loss of capacity.

- Lower bound of this: 0.8 * Projected Capacity Requirement
- Upper bound of this: 2 * Projected Capacity Requirement

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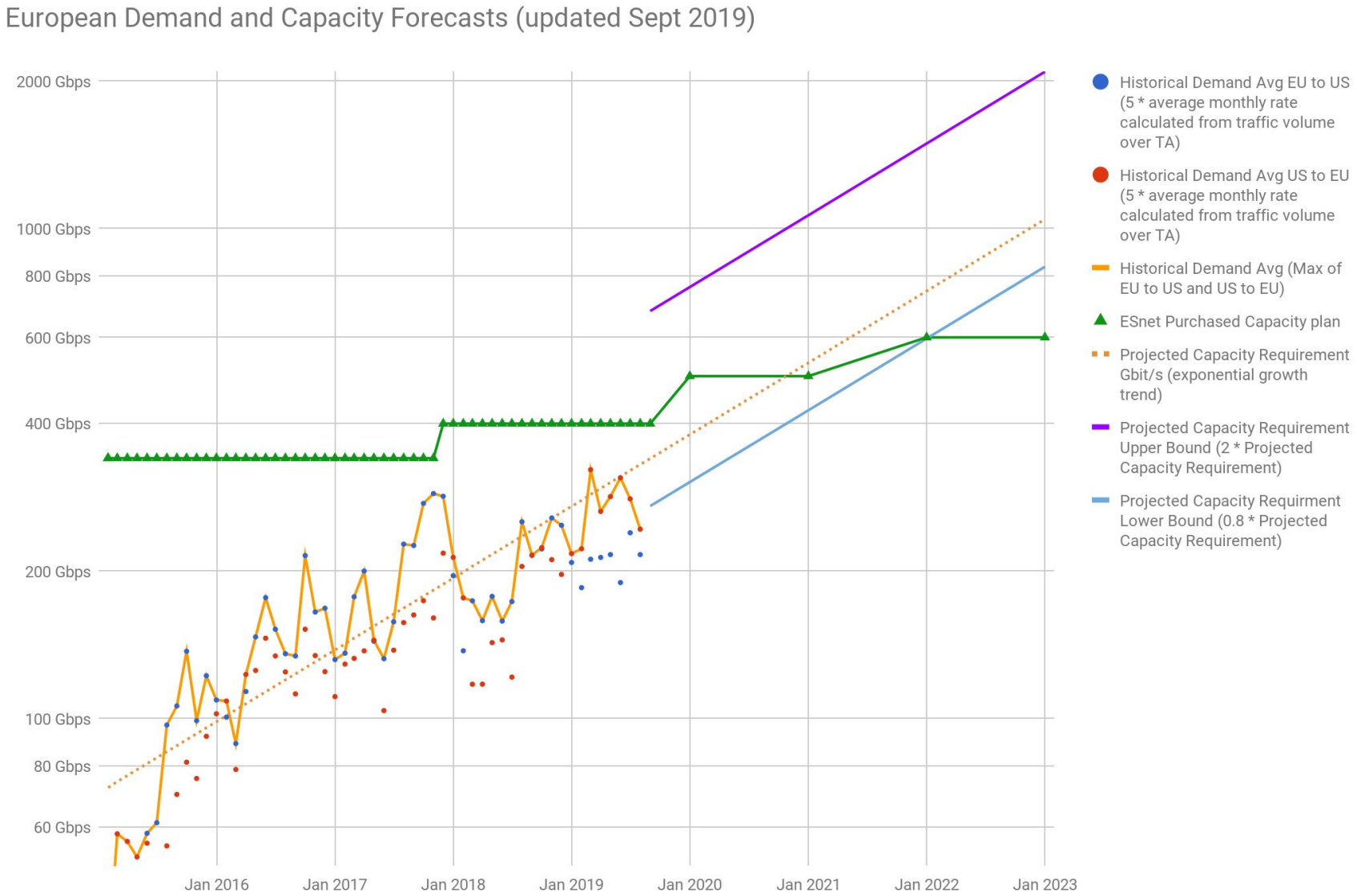
Transatlantic Forecasting



Note: Projected Capacity Requirement is calculated as 5 times the average utilization (notes presented on a separate slide).

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 ~40% increase yearly - based on last 3 years
  - up to ~50% increase yearly - based on 2018-2019
- **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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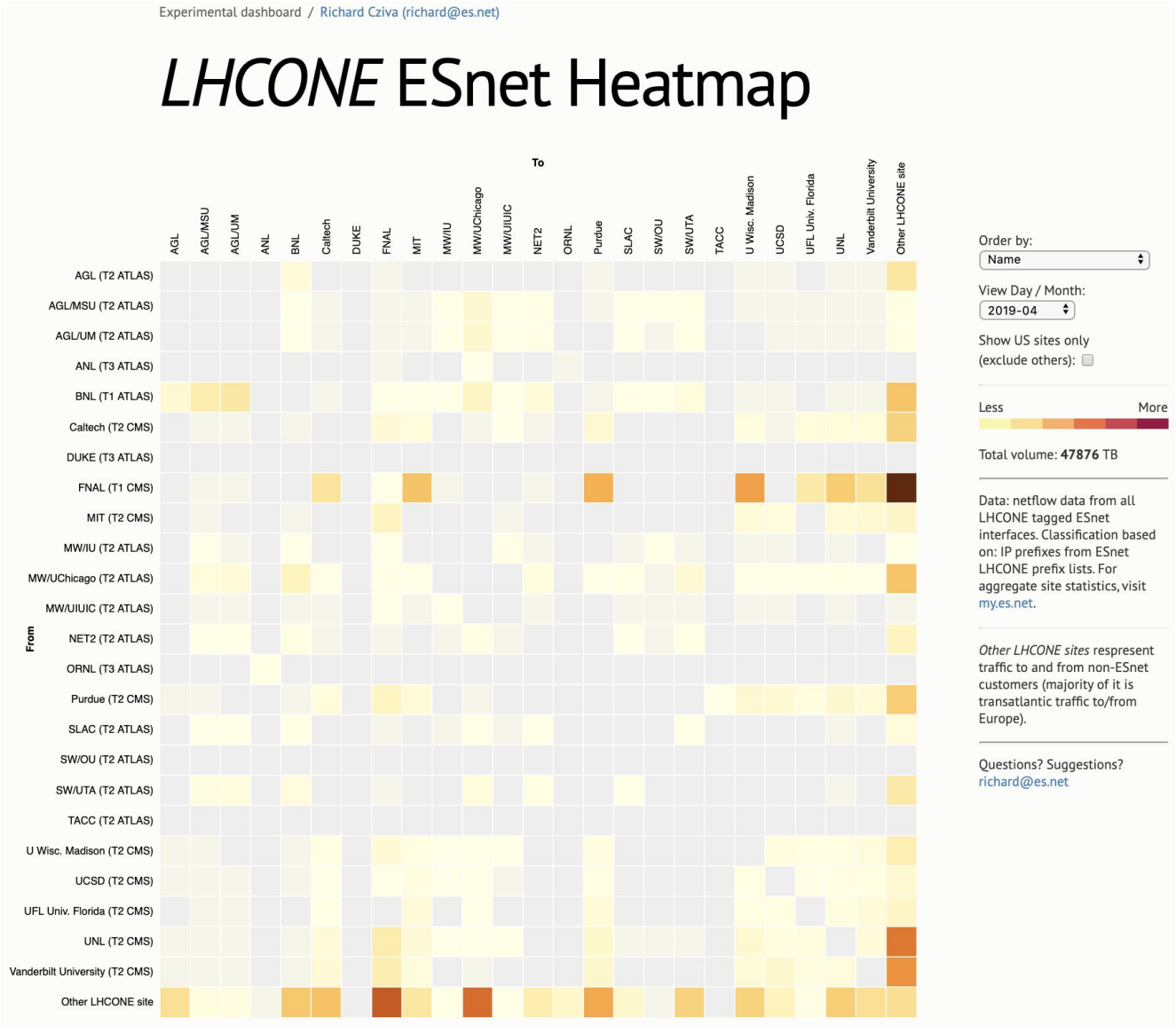
Interactive ESnet LHCONE Traffic (Experimental) Dashboard <https://downloads.es.net/public/richard/>



Questions...

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