Efficiently Transferring Petabytes at ~70Gbps

ESCC meeting LBNL,

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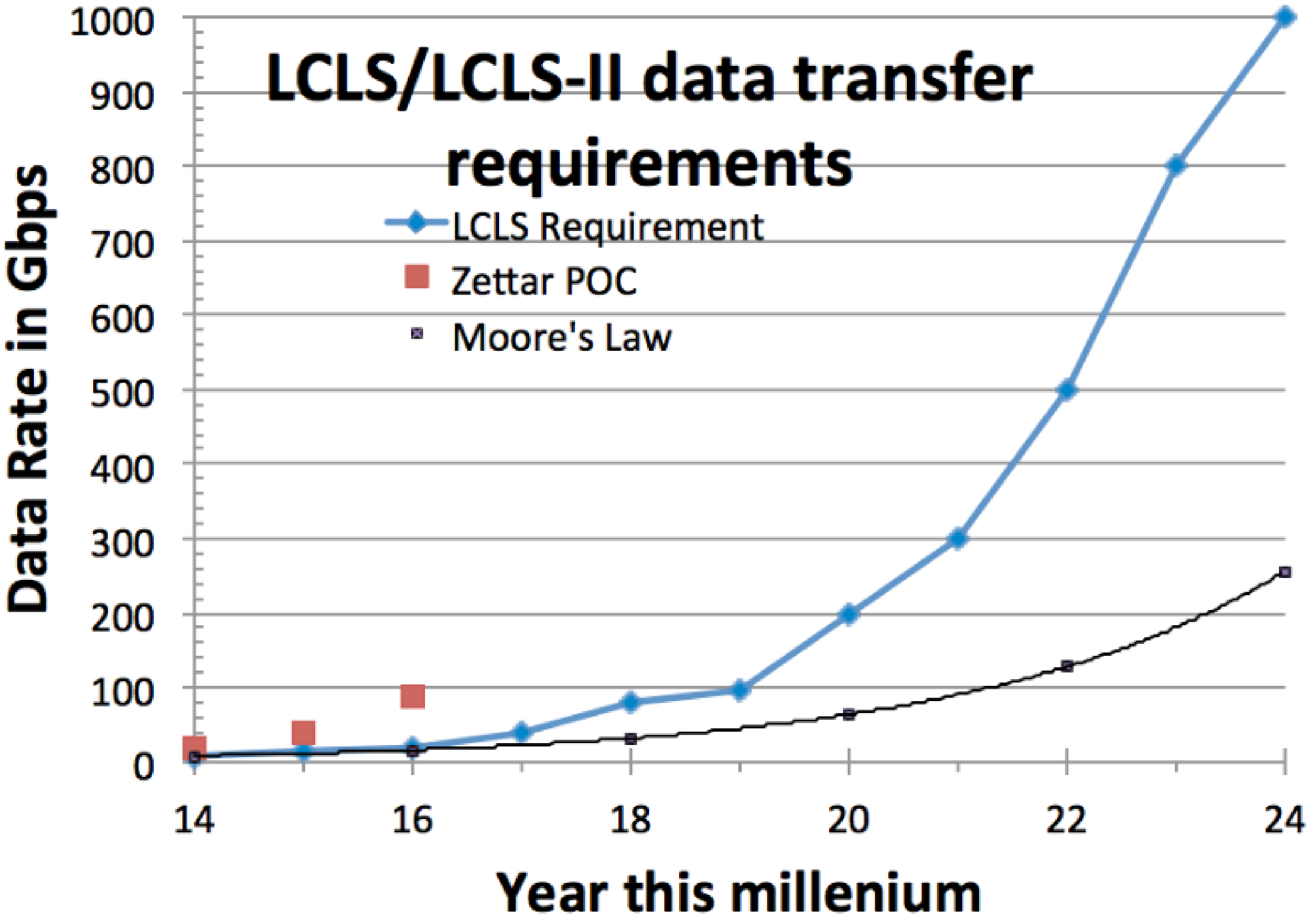
U.S. DEPARTMENT OF ENERGY

Office of Science

SLAC NATIONAL ACCELERATOR LABORATORY

Requirements for LCLS-II

- Beam Pulse rate 120HZ=> 1 MHz
- Data rate increase by factor 1000 to Tbps by 2024



Plus

- LHC/ATLAS
- LSST
- The rest

Overview

- Transfer files over the 5000-mile OSCARS SLAC link
- **Shared** in the SLAC production 100Gbps border network
  - Need to keep ~ 20Gbps for other production traffic
- 0.1PB in 3.4 hours at ~70Gbps, **1PB in 34 hours**
- Using the following testbed:
  - Two 2 x1U storage tiers with 8 x Intel DC P3700 U.2 1.6TB NVMe SSDs (each 1U server has 4 x NVMe SSDs)
  - Connected by InfiniBand
  - Two 2-1U DTN clusters (one sending, one receiving), running Zettar zx.
  - Each DTN has 4x10G Ethernet ports, , i.e. 2 x 4 x 10Gbps = **80Gbp**s
- All ports are connected to 2 x Arista 7280SE-68 10/100G switches.
- One of the Aristas connects to the SLAC Cisco 100GBps border router & thence to ESnet
- Note that due to the testbed hardware configuration, **the max speed the testbed can attain is ~ 80Gbps.**

The test bed collocated at SLAC

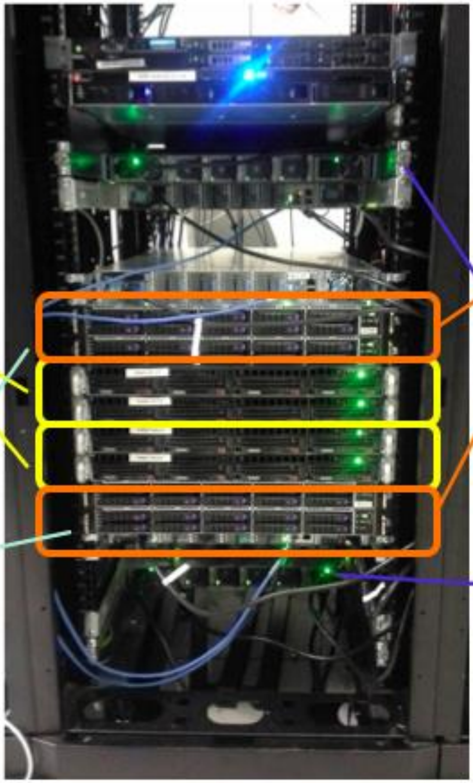
The Test-bed

DTNs

2 x Yahoo! C73E/ 64/960 1U servers/ cluster

4x10G/server

2 x Mellanox SB7700 InfiniBand EDR switches

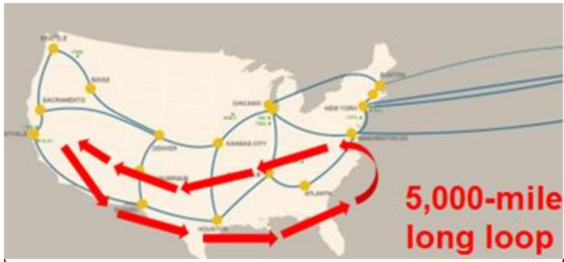


Storage tiers

2 x HPC all-NVMe storage tiers (2 x 1U AIC SB122A-PH 10Bay servers/tier)

- 20GB/s read/tier
- 12GB/s write/tier

2 x Arista 7280SE-68 10/100G switches



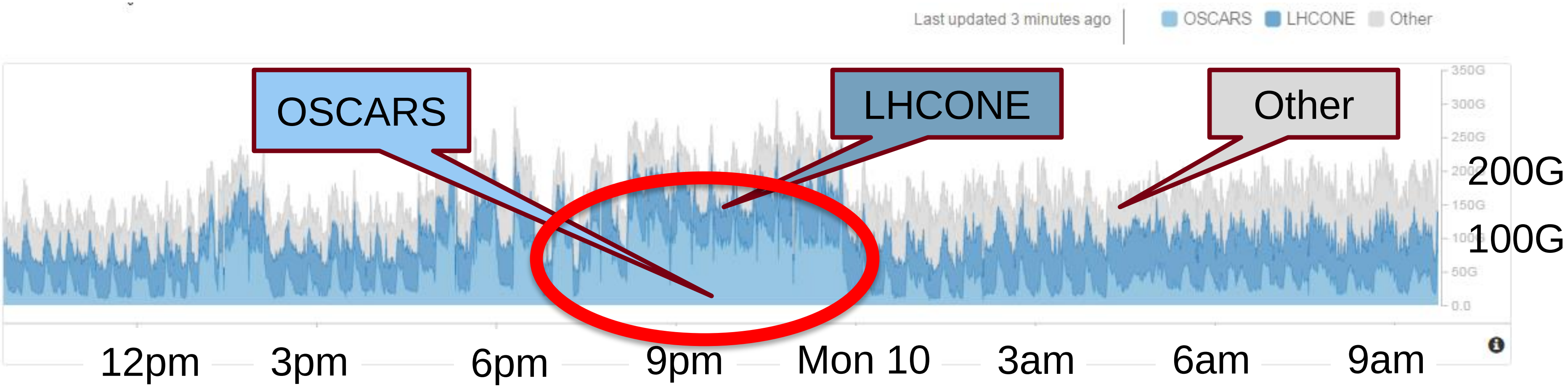
OSCARS

ESnet
ENERGY SCIENCES NETWORK

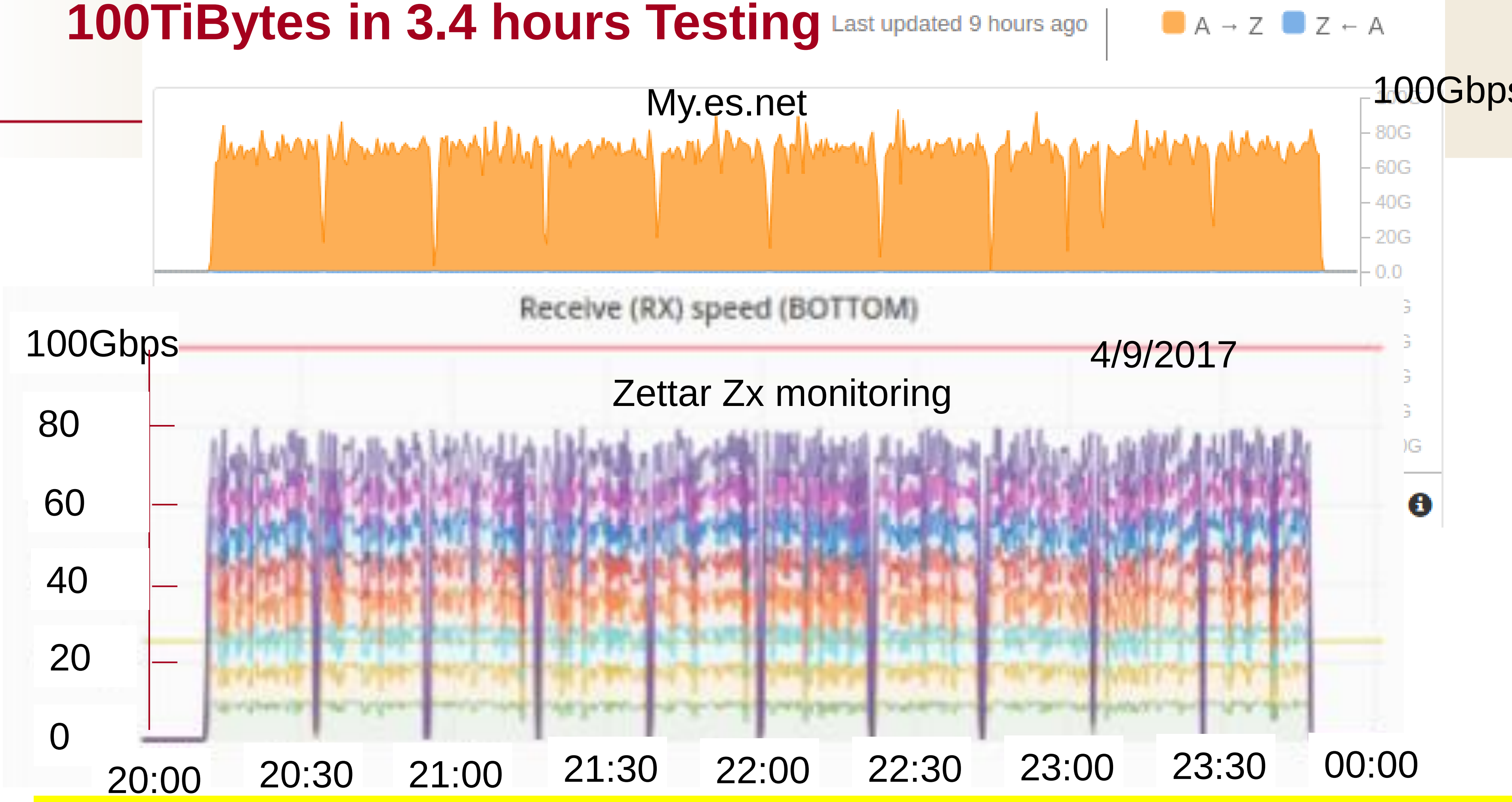
Other cluster or High speed Internet

Impact on all ESnet traffic

When running data transfer contributes ~ 1/3 of total ESnet traffic

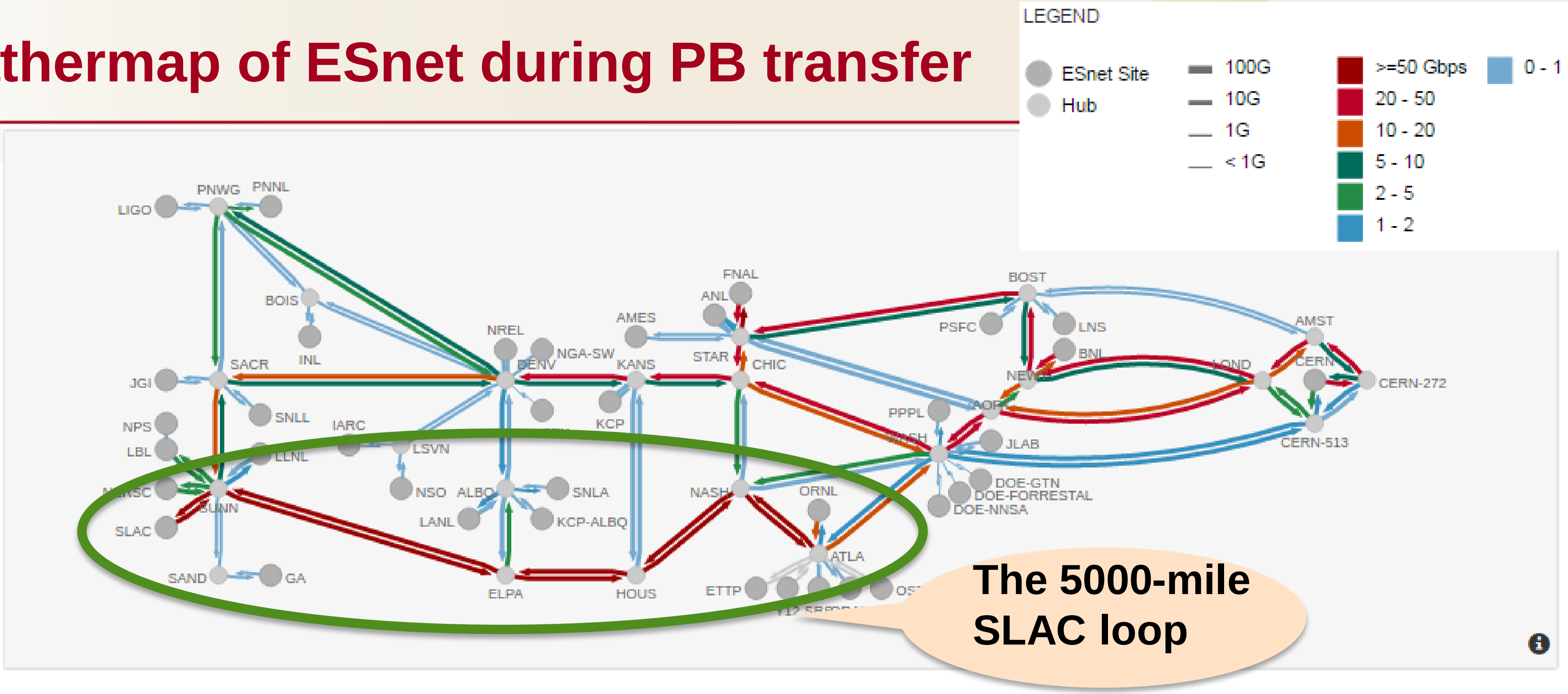


100TiBytes in 3.4 hours Testing



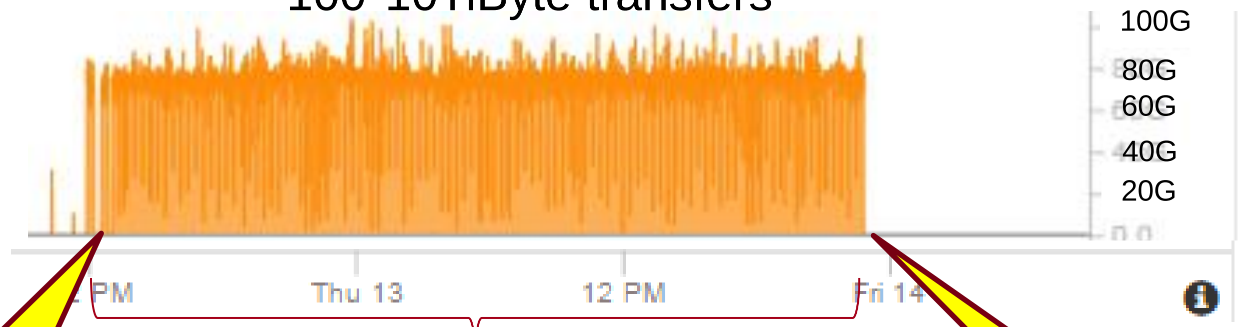
- 10 runs of 10 TiB each = 100TiB took 3.4 hours
- ~ 1PiB in 34 hours
- LCLS-II need to transfer 20PB SLAC => NERSC takes 680 hours with our testbed

Weathermap of ESnet during PB transfer



The 5000-mile SLAC loop

100*10TiByte transfers

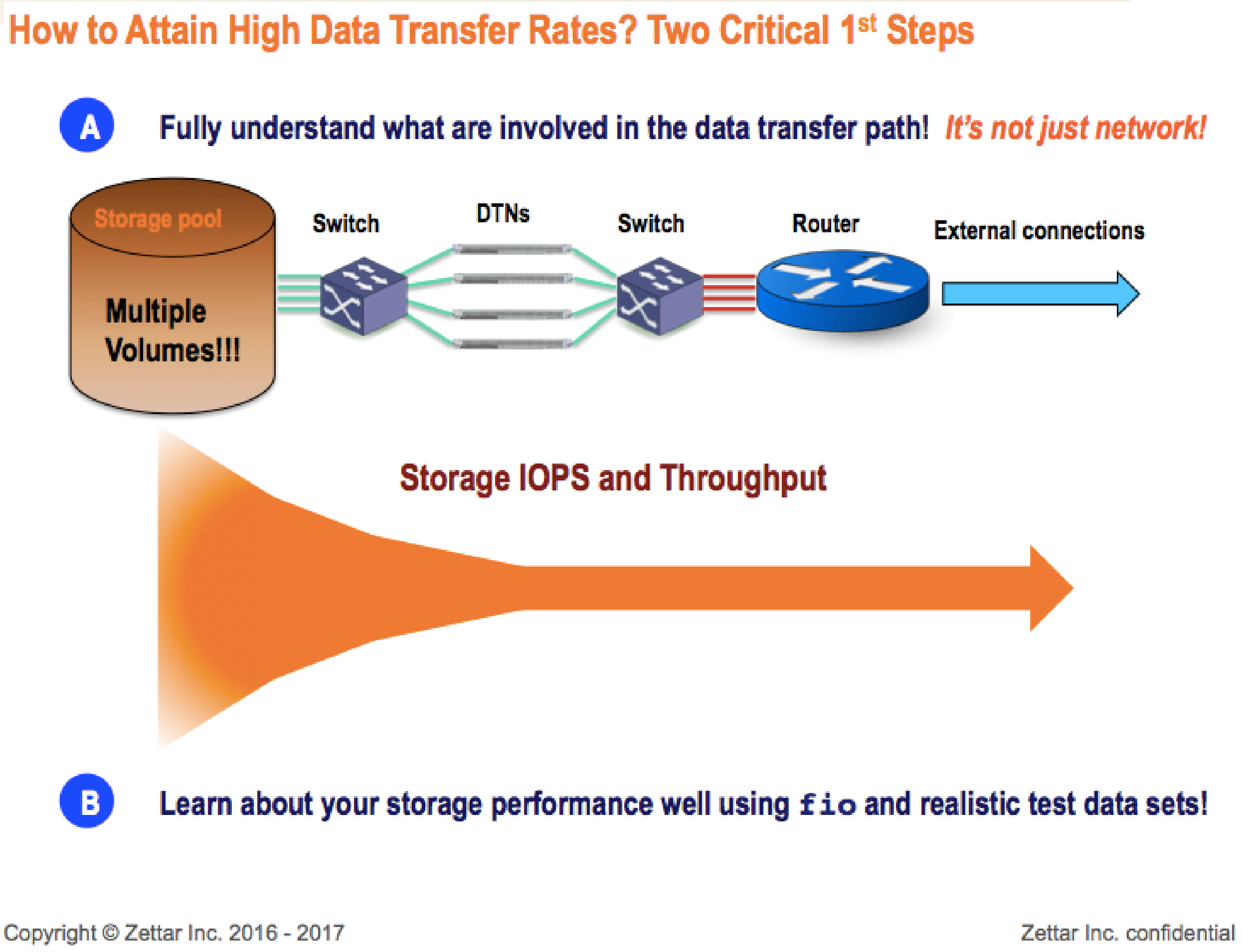


4/12/2017
12:12:33

1 PebiByte in < 1.5days
34hrs 16 mins 51 seconds

4/13/2017
22:29:24

Not just the network



How to Attain High Data Transfer Rates? Two Critical 1st Steps

A Fully understand what are involved in the data transfer path! *It's not just network!*

B Learn about your storage performance well using `fio` and realistic test data sets!

Bottle neck today is the IOPS needed for write

Conclusions

- Demonstrated **sustained 70Gbps over long distances**.
- **Today's challenge is writing** the data to the files (IOPS)
  - Network not a problem **using standard TCP**
- We have been beating the 16 Intel DC P3700 NVMe SSDs since 2015 much harder and longer than most people in the world. But **Intel DC P3700 NVMe SSD performance has been consistent**
- The four AIC SB122A-PH 10Bay NVMe 1U **storage servers have proven to be highly cost-effective choices** as well. Do not need to spend big $$$ on the proprietary all-flash storage systems from NetApp, Dell/EMC, Hitachi etc.
- **InfiniBand just works.** The use of a Mellanox EDR (100Gbps) in each of the AIC SB122A-PH 10Bay NVMe 1U storage server, and a Mellanox FDR (56Gbps) HCA in each of the Yahoo! 1U C73E/64/960 DTN, together with the two Mellanox SB7700 IB switches has proven to be a quite cost-effective and reliable combination.

Future

Thinking about using test data sets with different file size distribution patterns, also even bigger test data sets (> 10TiB each, e.g. 50TiB each would be good)

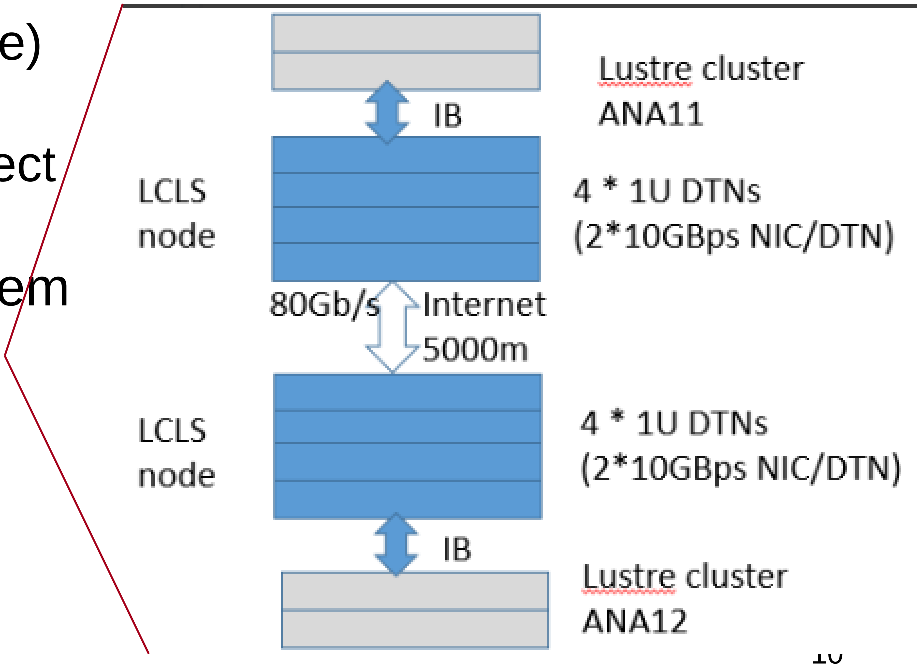
Upgrade 200Gbps border at SLAC to two *100Gbps

Discuss with Intel about testing different CPU models.

- On the LCLS side, the modern (Broadwell) but low-end Intel E5-2620v4 8 core @ 2.1 Ghz CPU is used on all five LCLS DTNs
- NERSC DTNs use the older (Ivy Bridge) E5-2680 v2 20 cores @ 2.80GHz
- How do the CPU choices on DTNs affect the transfer performance,

Look at **impact of LCLS Lustre** file system on performance

Then onto NERSC



Summary

What is special:

- ***Scalable. Add more NICs, more DTNs, more storage servers, links as needed/available…***
- ***Power & space efficient; low cost***
- ***HA tolerant to loss of components***
- ***Storage tiering friendly***
- ***Reference designs***
- ***Easy to use software available commercially***

Proposed Future PetaByte Club

A member of the Petabyte Club MUST be an organization that is capable of using a shared production point-to-point WAN link to attain a production data transfer rate >= 150PiB-mile/hour

Other information, questions

Who needs it

- **LCLS Exascale requirements**, Thayer and Perazzo, Tbit/s 2014
  - https://confluence.slac.stanford.edu/download/attachments/178521813/ExascaleRequirementsLCLSCaseStudy.docx
- **Focus more on data migration when moving to the cloud,**
  - http://www.ciodive.com/news/focus-more-on-data-migration-when-moving-to-the-cloud-expert-says/439871/
- **Amazon**, ship a PByte **in a week** (168hours). They manually ship appliances around to get the data from A to B.

Progress

- **186 Gbps Data Transfer Sets New Record, 2011**
  - **SC11 Seattle <> U Victoria, 97Gbps/direction, 2 racks at SC11**
  - http://www.huffingtonpost.com/2011/12/16/worlds-fastest-internet_n_1154065.html
- **LCLS SLAC->NERSC 2013, 116TB in 5 days**
  - http://es.net/science-engagement/case-studies/multi-facility-workflow-case-study/
- **The Petascale project,** Eli Dart, ESCC Winter 2016
  - **Goal Pbyte/week using Cosmology data**
- **Moving a Petabyte of data** June 13, 2015, identifies why it is difficult.
  - http://inside.igneous.io/moving-a-petabyte-of-data,