ESnet

ENERGY SCIENCES NETWORK

Science DMZ Implementation at the Advanced Photon Source

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GlobusWorld 2016

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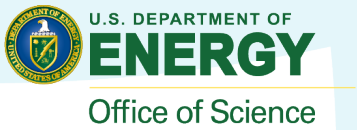

Outline

- Preliminaries
- The Science
- The Project
- The Results

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The Science DMZ in 1 Slide

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Science DMZ now recognized as a global best practice.

NSF is investing ~$130M to promote adoption by US universities (among other CI goals). Fourth funding round underway.

>120 universities in the US have deployed or are considerign this DOE architecture.

In addition: USDA, NIH – with NASA, NOAA investigating.

Australian, Canadian universities following suit.

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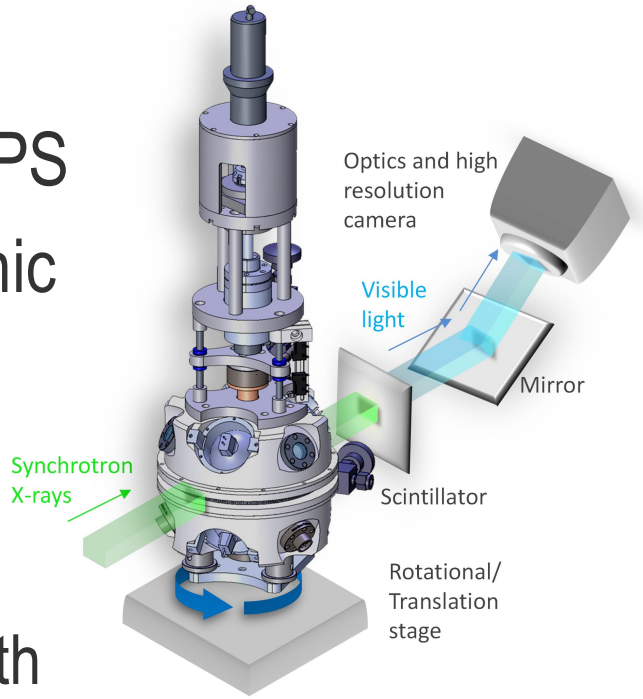
GM/CA

- General Medical Sciences and Cancer Institutes Structural Biology Facility @ APS
  - Focused on the study of crystallographic structure determination of biological macromolecules by X-ray diffraction
- Typical User:
  - Visits and spends some allocated time with samples and the beamline machinery
  - Mails samples, controls device remotely
  - In either case – data has to go 'somewhere'



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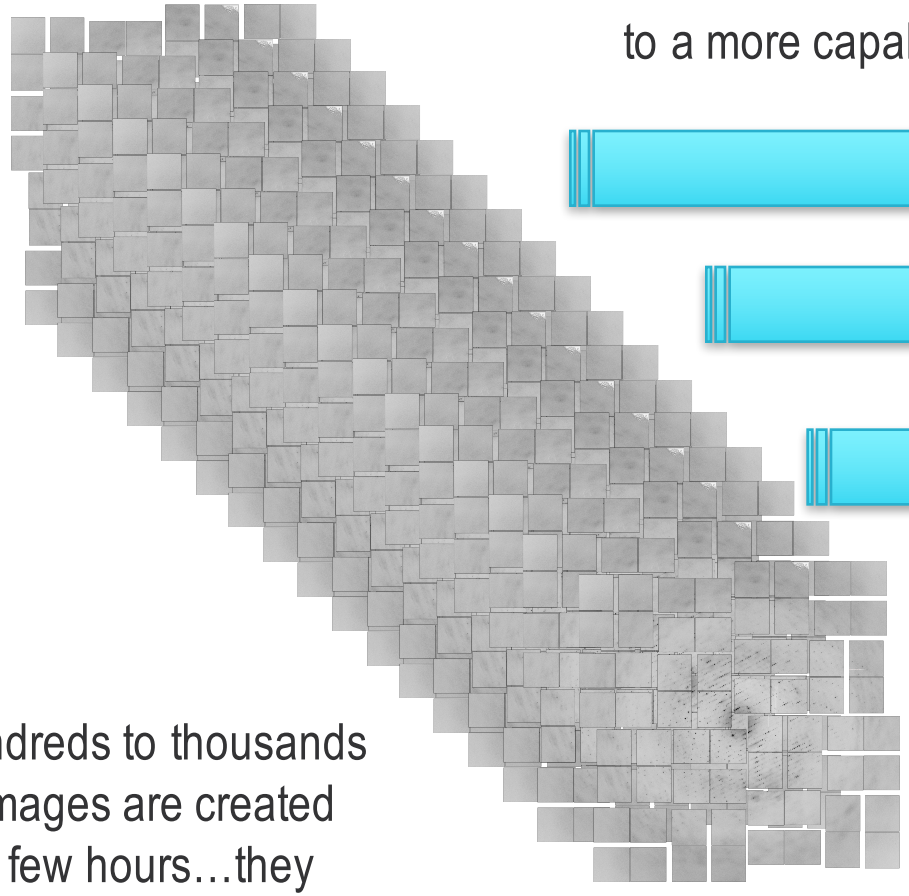
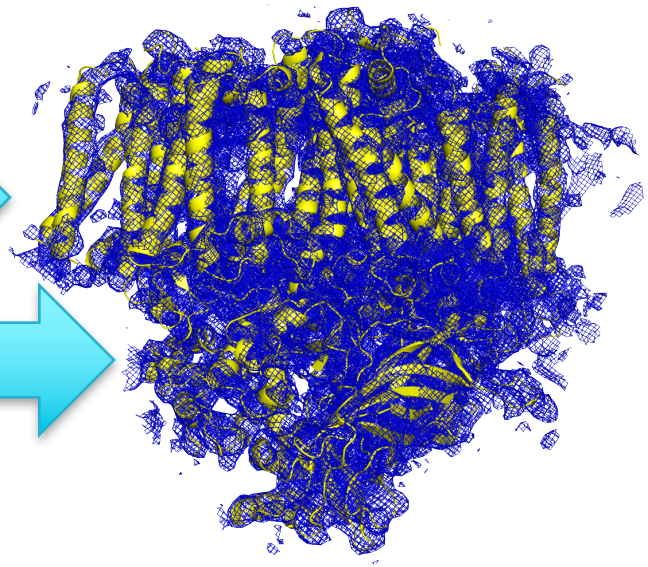
E Pluribus Unum

Processing on this order of magnitude can't be done locally – we need to send (over a network) to a more capable facility





Hundreds to thousands of images are created in a few hours…they can range in size from MB to TB

After processing on a supercomputer, models are created.

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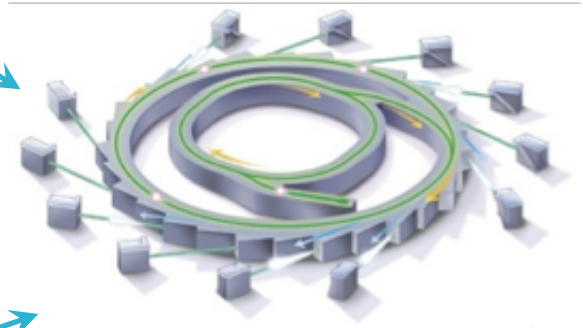
Superfacility instances multiply.

By 2025, DOE light sources will be transformed by high-resolution detectors, advanced mathematical analysis techniques, robotics, software automation, programmable networks.

Integration of experimental and computational facilities in real time, using programmable networks.

Detectors capable of generating terabit data streams.

Computational tools for analysis, data reduction, feature extraction *in situ*, using advanced algorithms and specialized hardware.



Data management and sharing, with federated identity management and flexible access control.

Post-processing: reconstruction, inter-comparison, simulation, visualization.

Increased scientific throughput from robotics and automation software.

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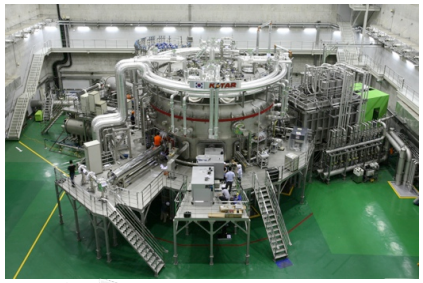
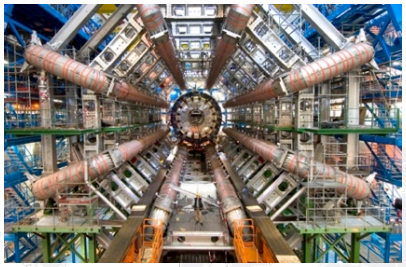
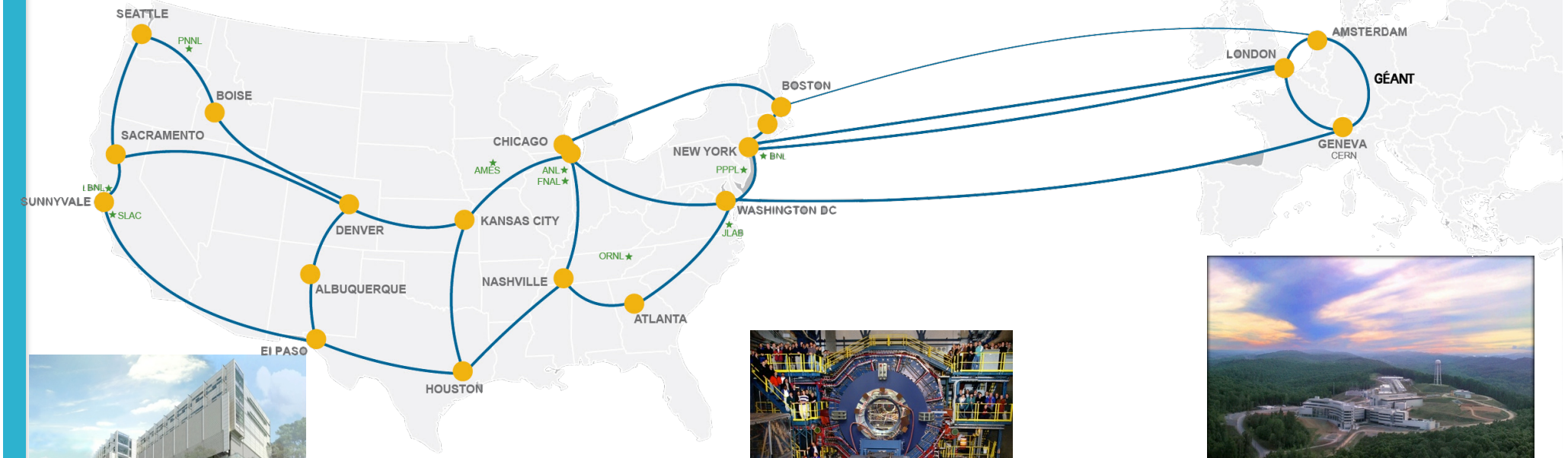
Network as ~~Infrastructure~~ *Instrument*







ESnet Vision: Scientific progress will be **completely unconstrained** by the physical location of instruments, people, computational resources, or data.

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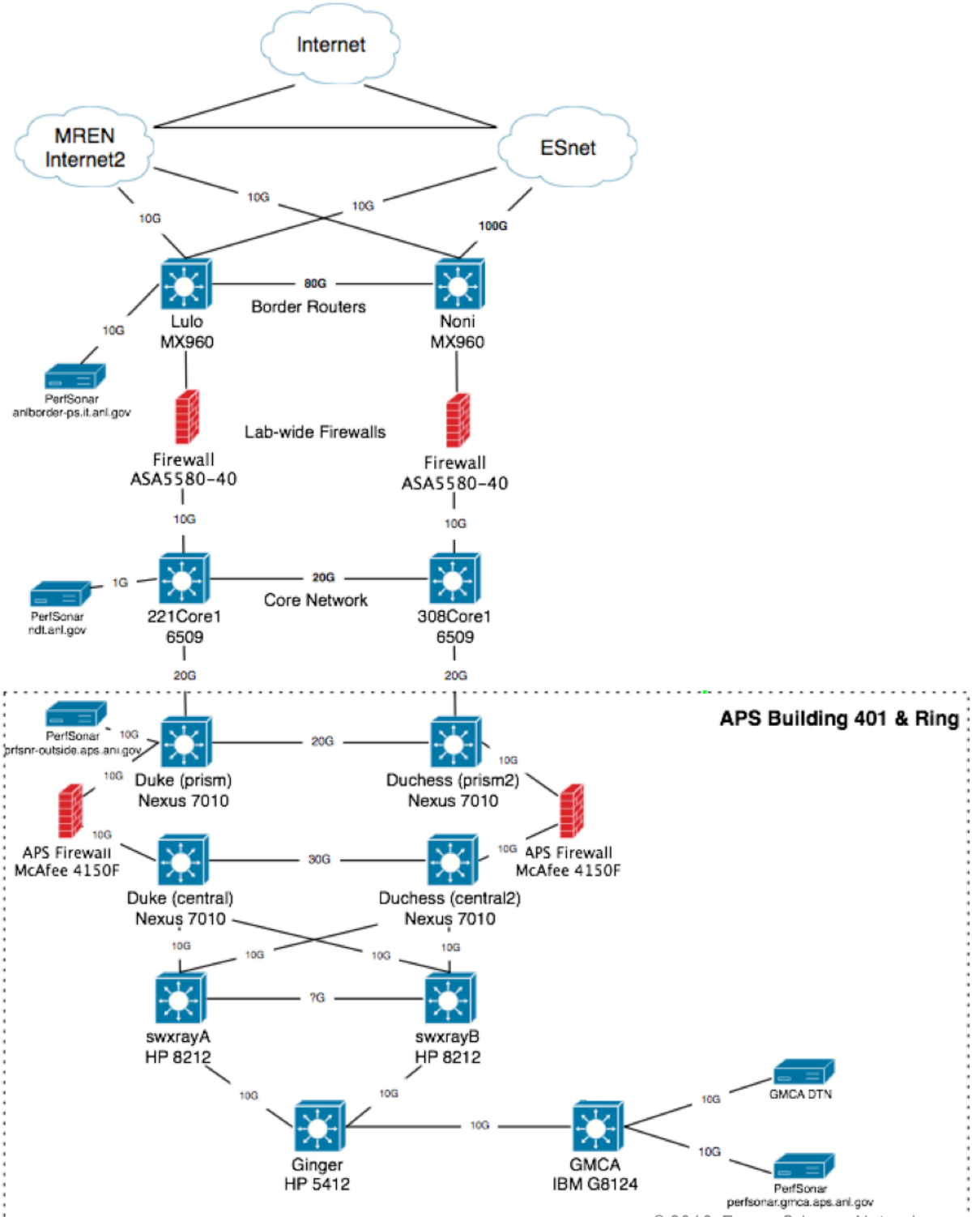
Current Design



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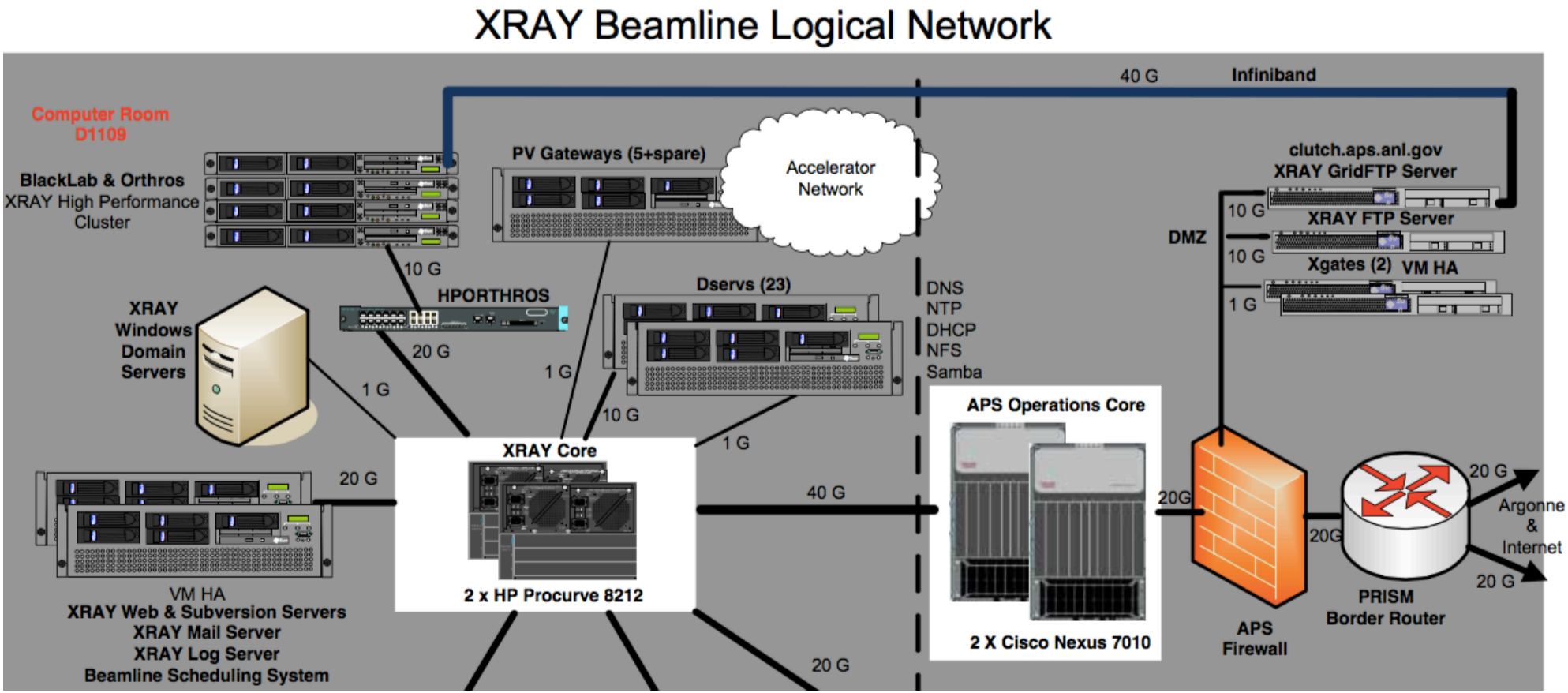

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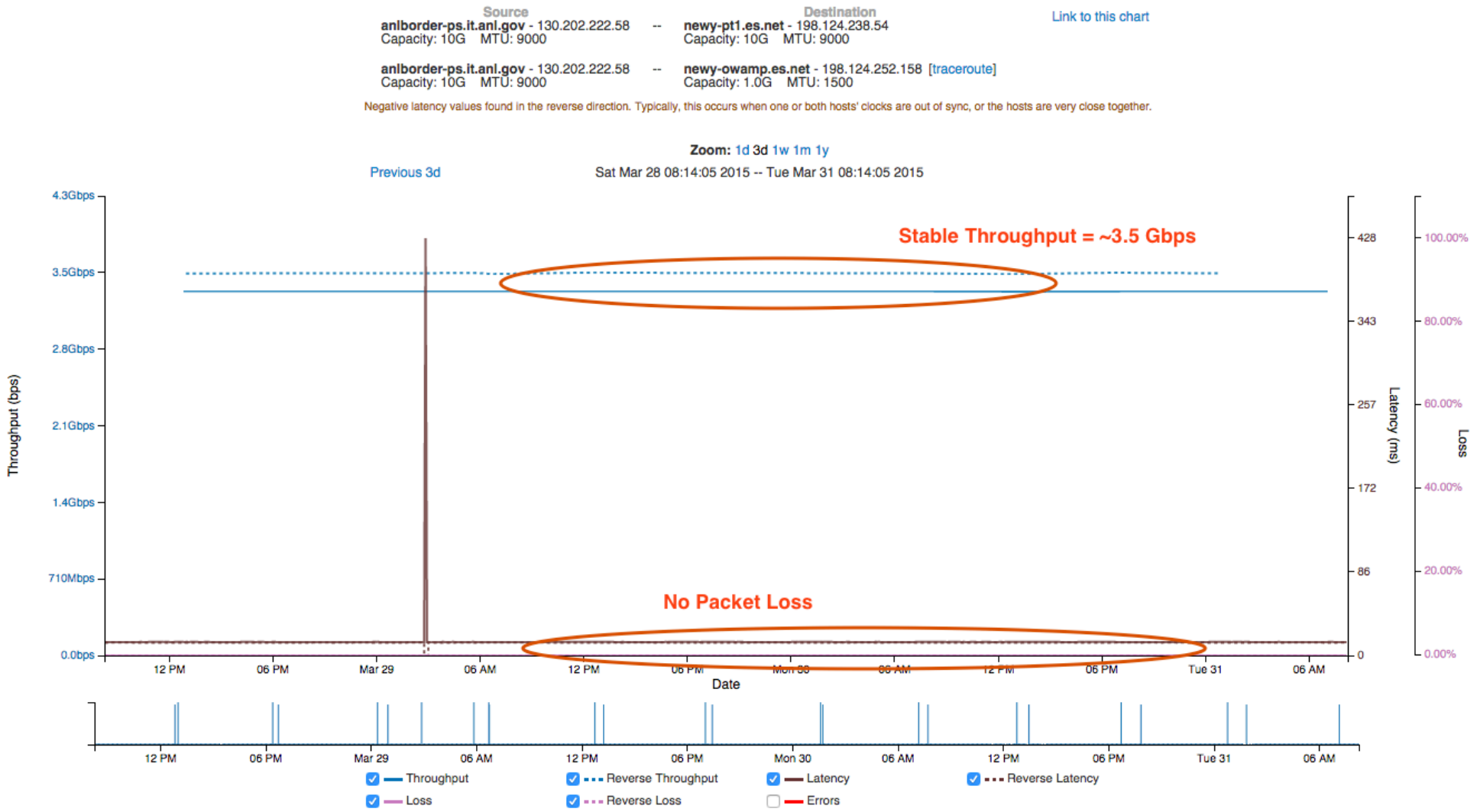
ANL Border to ESnet New York (perfSONAR Test)



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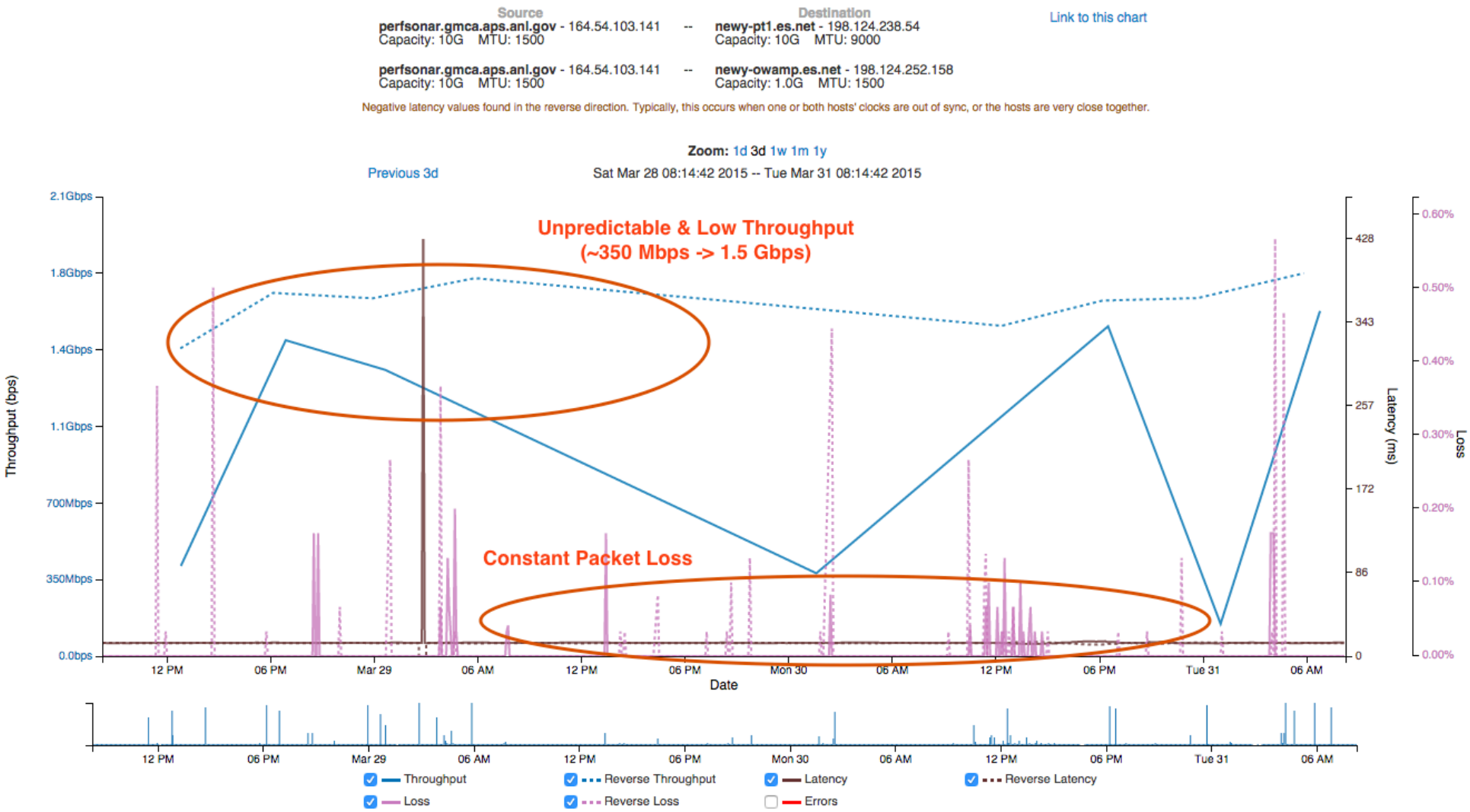
GM/CA to ESnet New York (perfSONAR Test)



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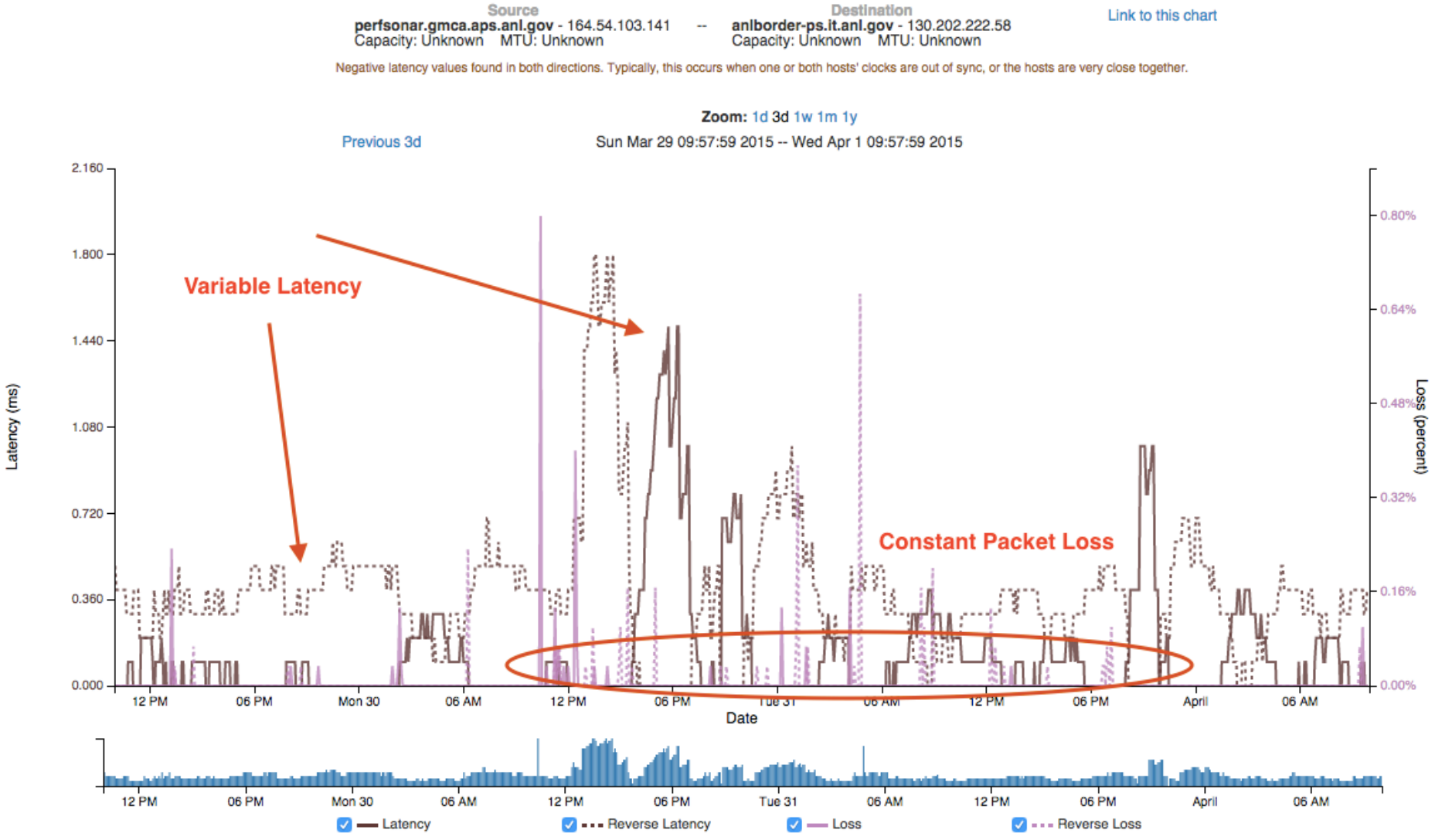
GM/CA to ANL Border (perfSONAR Test)



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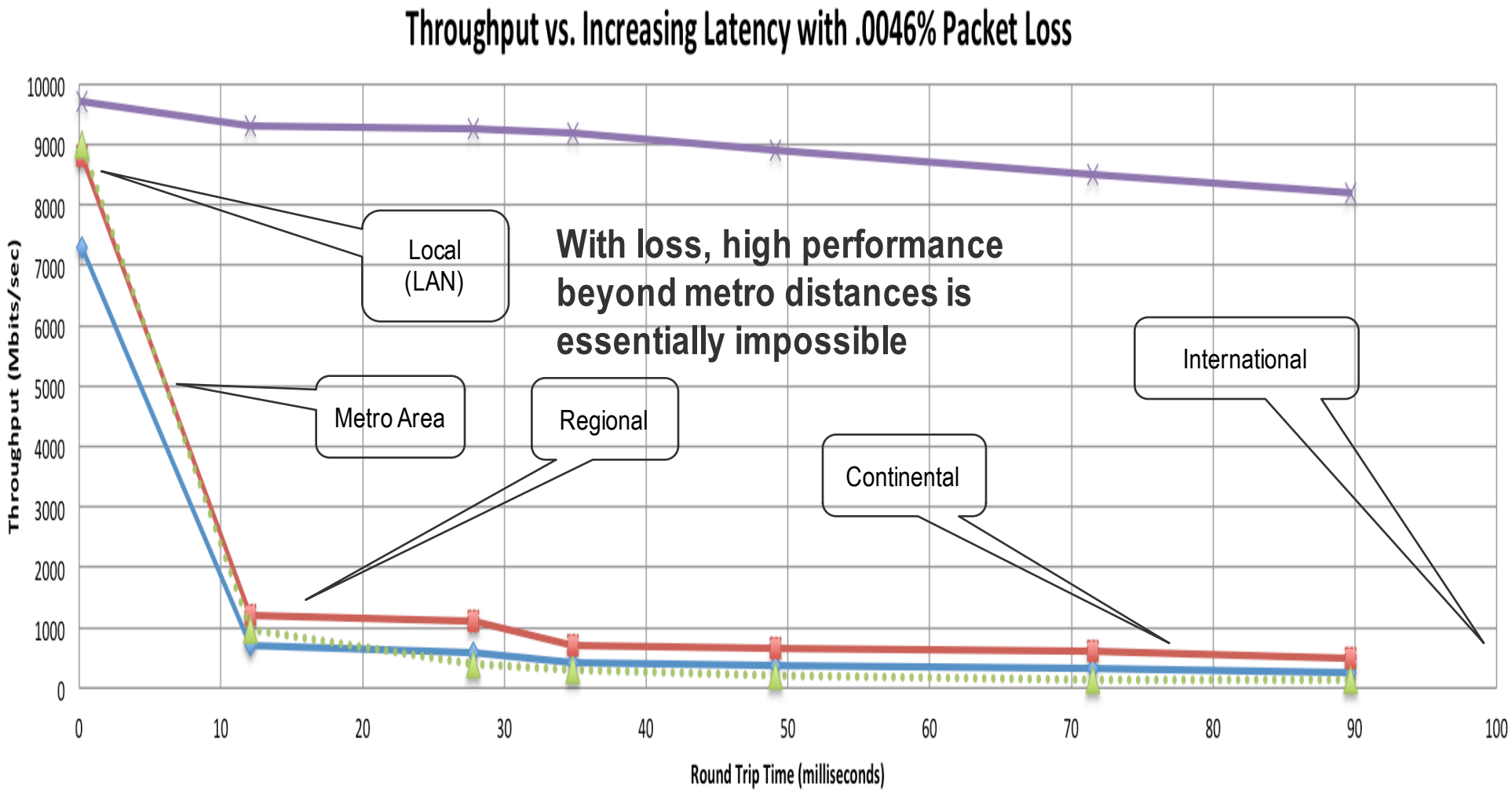
A small amount of packet loss makes a huge difference in TCP performance



$$\text{Throughput} \leq \frac{\text{MSS}}{\text{RTT}\sqrt{P_{\text{loss}}}}$$

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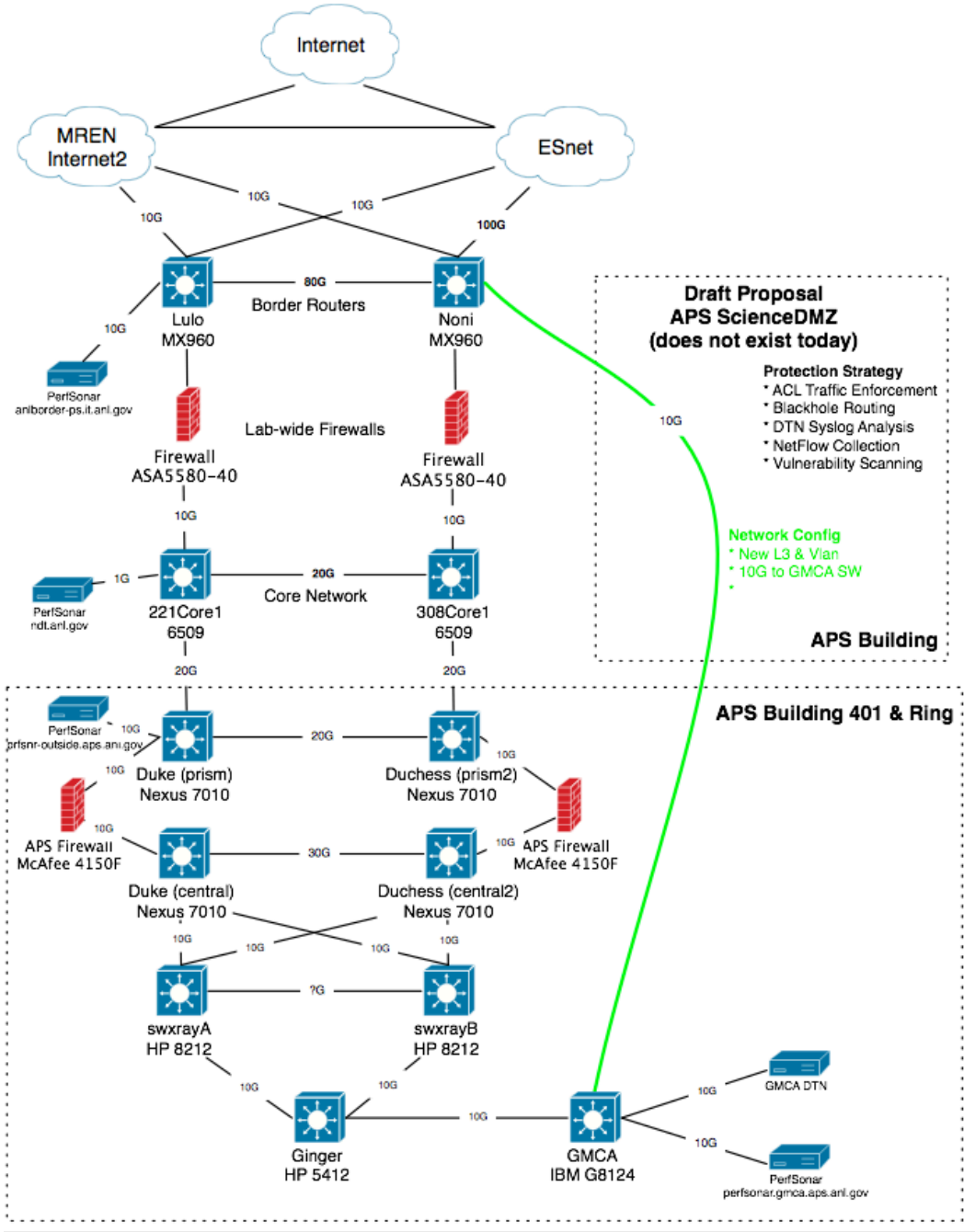
Pilot Network

- Plan:
  - Use campus and building fiber resources for 2nd path
  - Applies to only a limited set of resources (perfSONAR, DTN)
- Benefits
  - Bypass congested local infrastructure
  - Apply targeted (vs. blanket) security policy
- Cautions:
  - Prevent just 'anything' from using fast path – policy to control this
  - Still need to figure out cause of local issues (e.g. this isn't a pave over)



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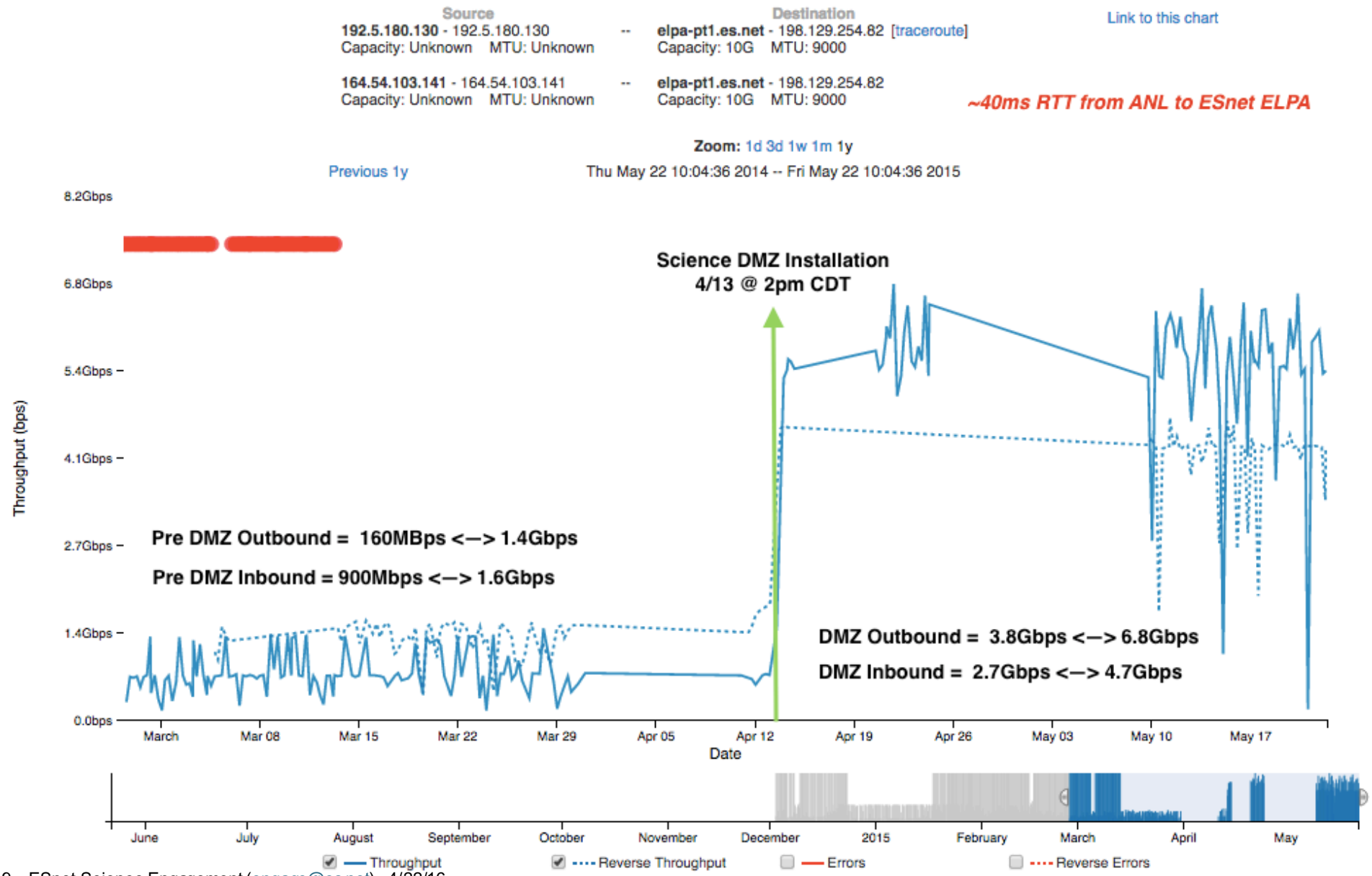
perfSONAR Results



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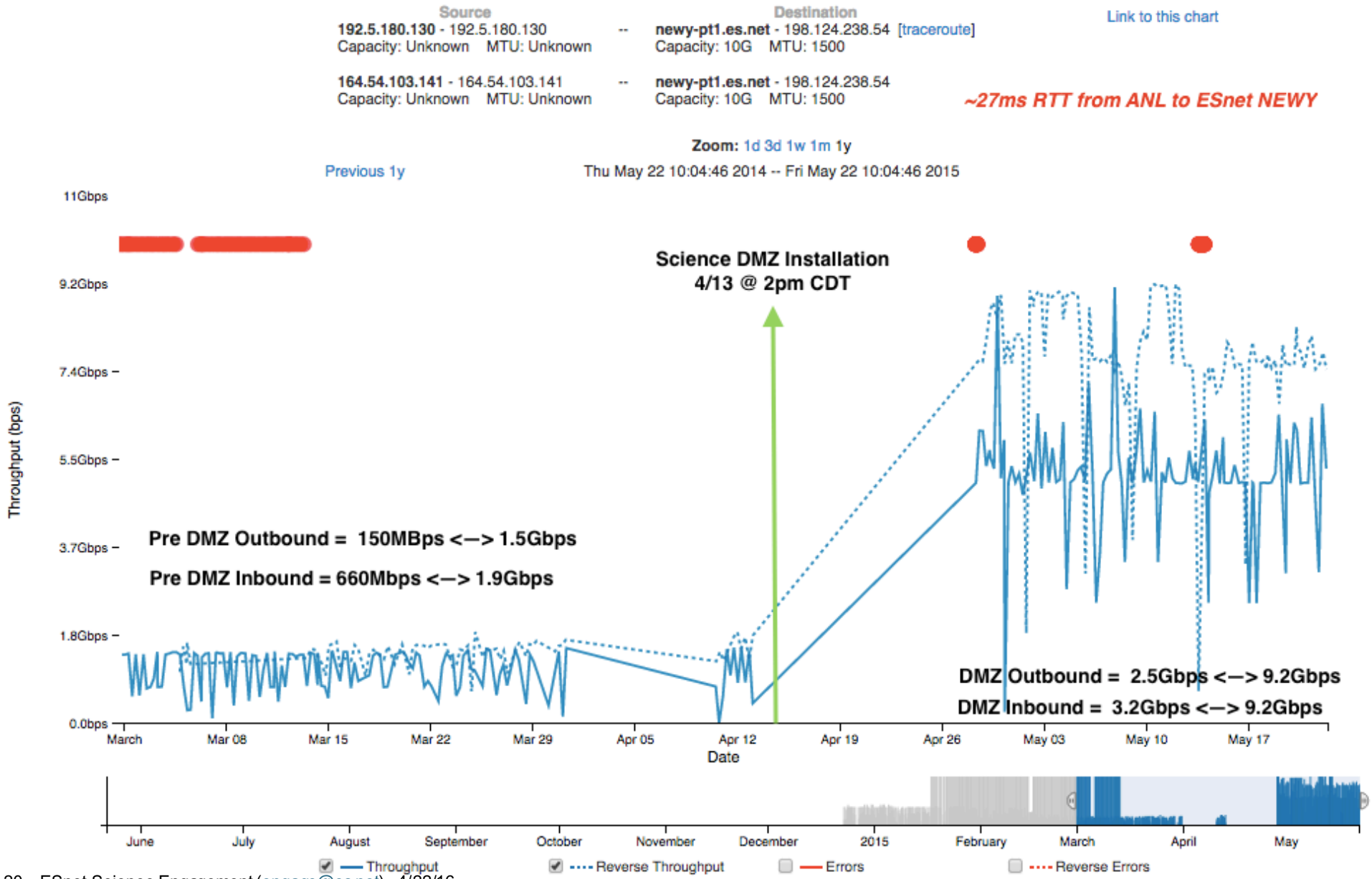
perfSONAR Results



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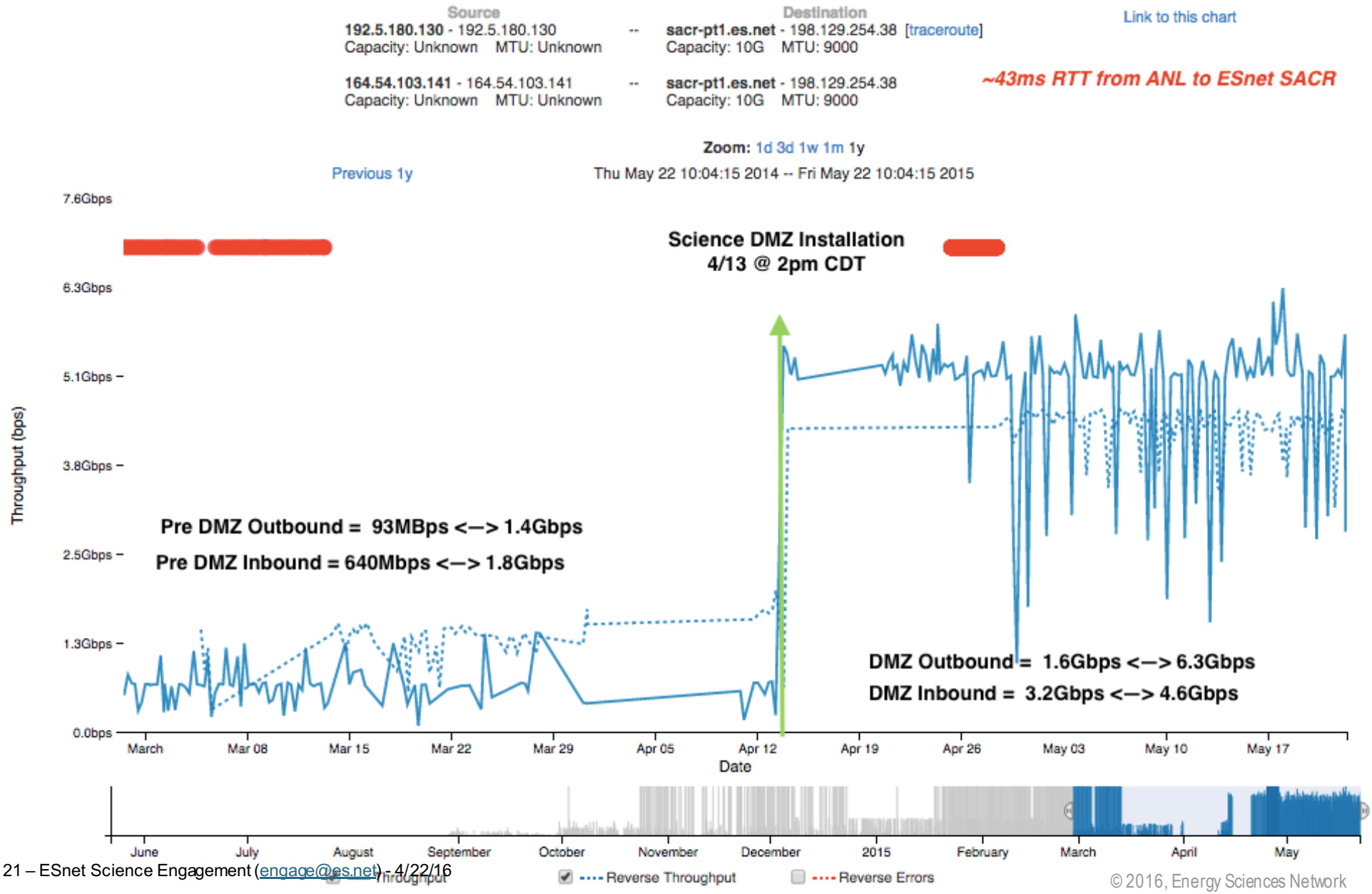
perfSONAR Results



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perfSONAR is One Metric – what about GridFTP?

- Setup of the DTN Architecture:
  - 2 Servers
  - Shared filesystem
  - Each server has 2 interfaces/routes:
    - Science DMZ routes (plumbed to specific external locations via ANL, ESnet/MREN) and avoiding slower path
    - Traditional routes over slower path
  - ***Goal***: show that with the correct network the ***SAME*** underlying infrastructure can perform as well as the perfSONAR testing

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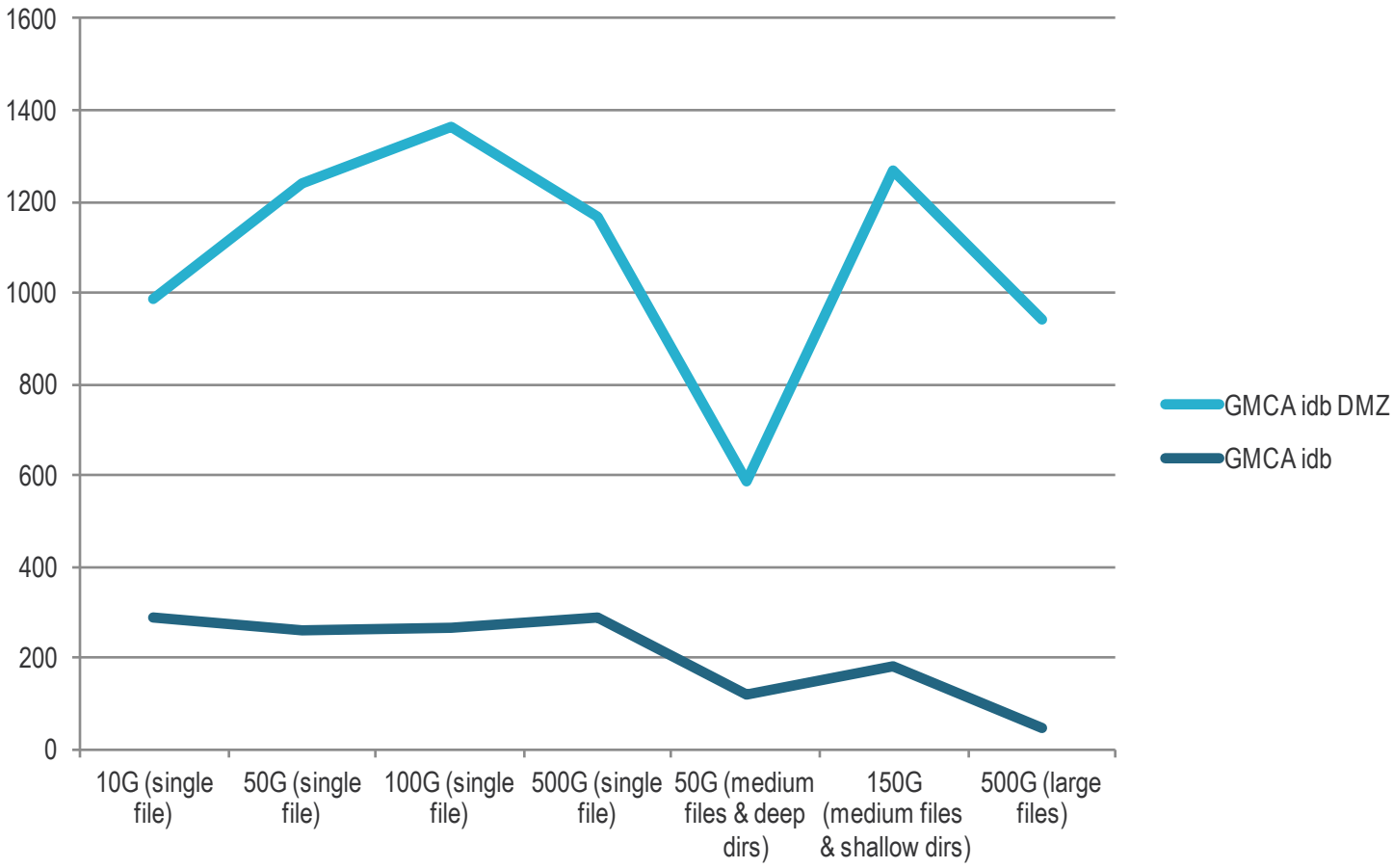
Testing ESnet CERN (long RTT) to GMCA

- Scale is Mbps



- Across the board improvement of around 5x-20x
- Exercise helped to tune filesystem performance.

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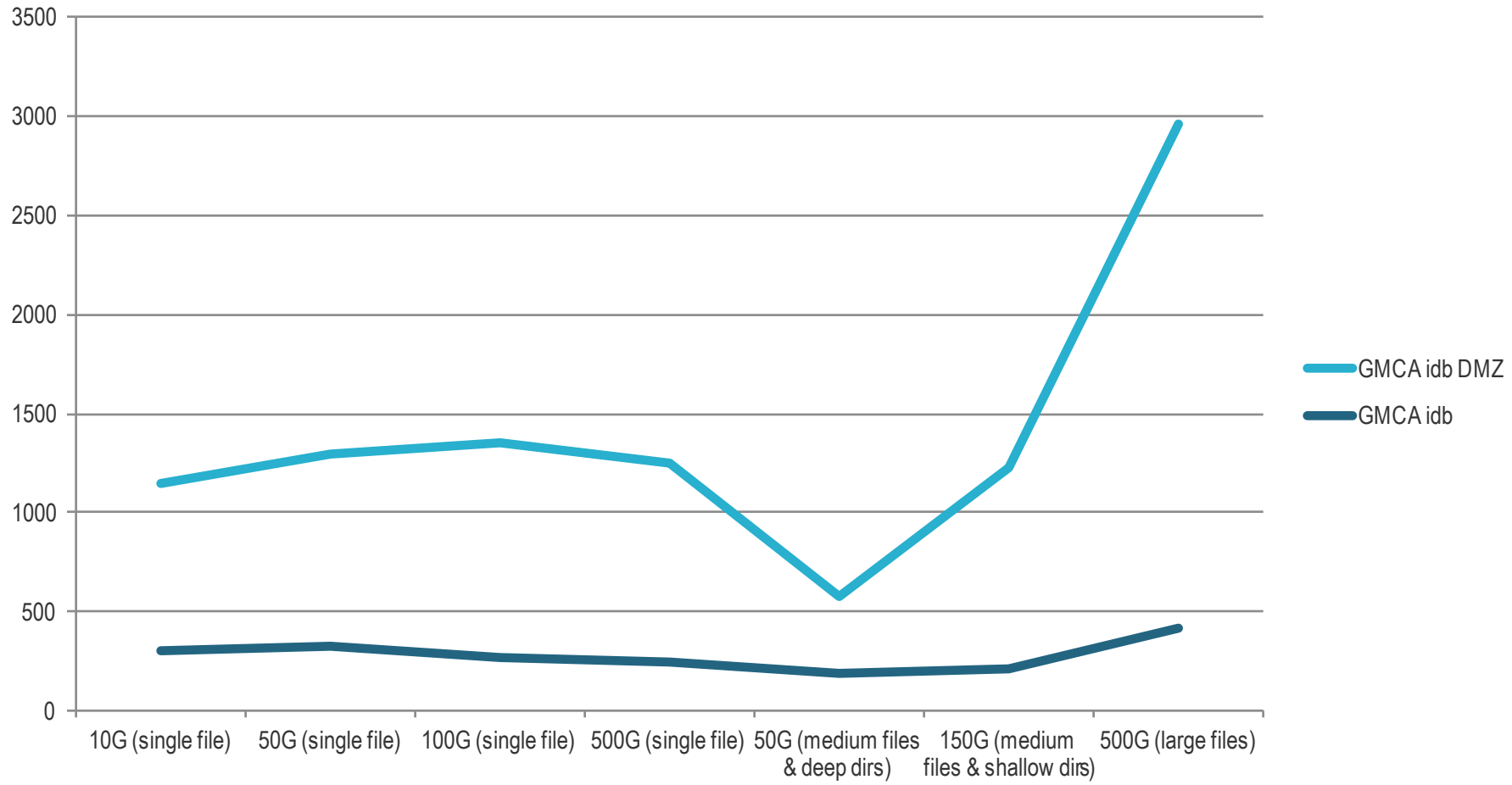
Testing GMCA to ESnet CERN (long RTT)



- Metadata operations (e.g. deeply nested directories) coupled with smaller files remains hard to crank up

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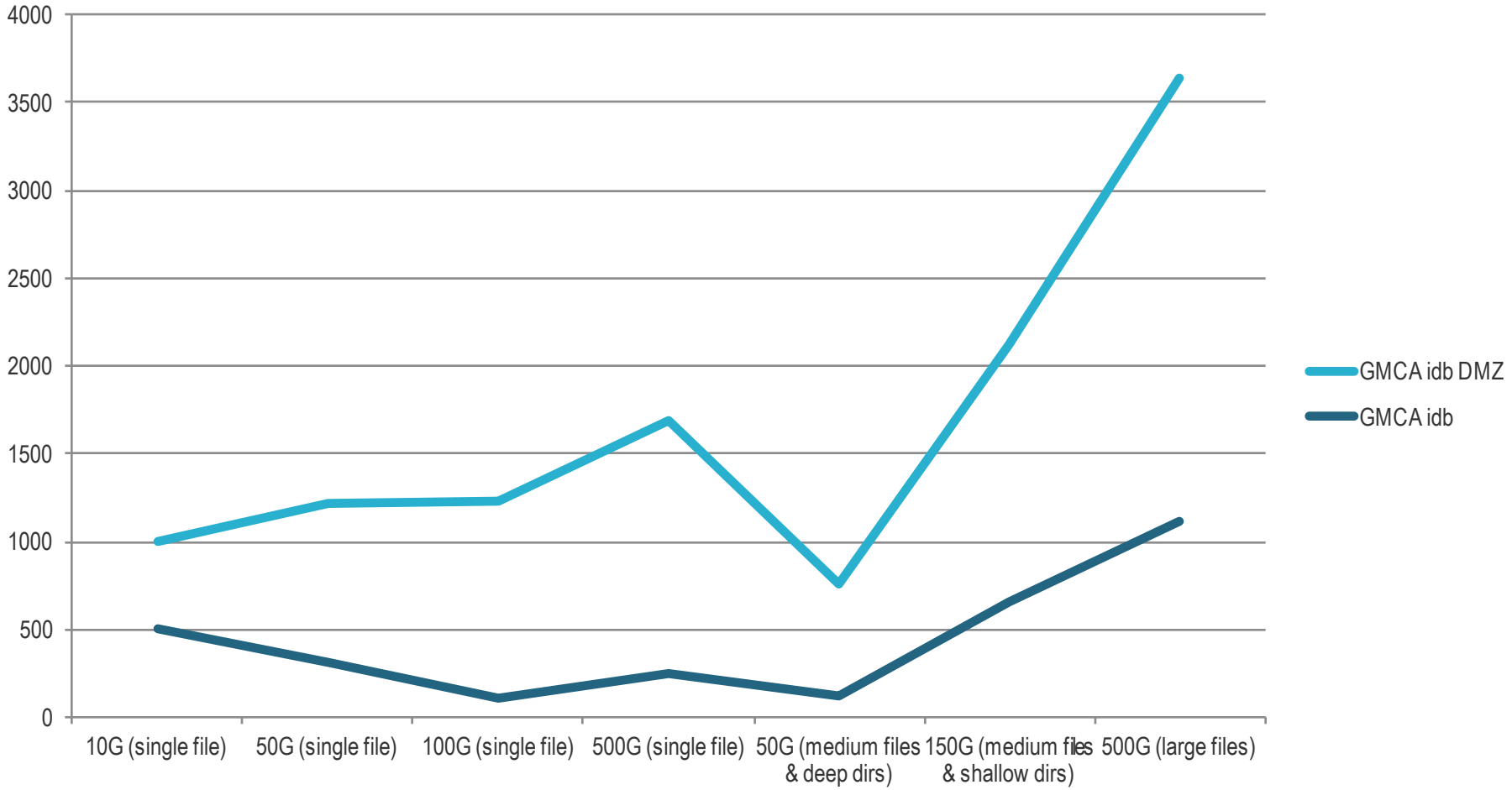
Testing GMCA to ESnet LBL (medium RTT)



- Metadata operations (e.g. deeply nested directories) coupled with smaller files remains hard to crank up

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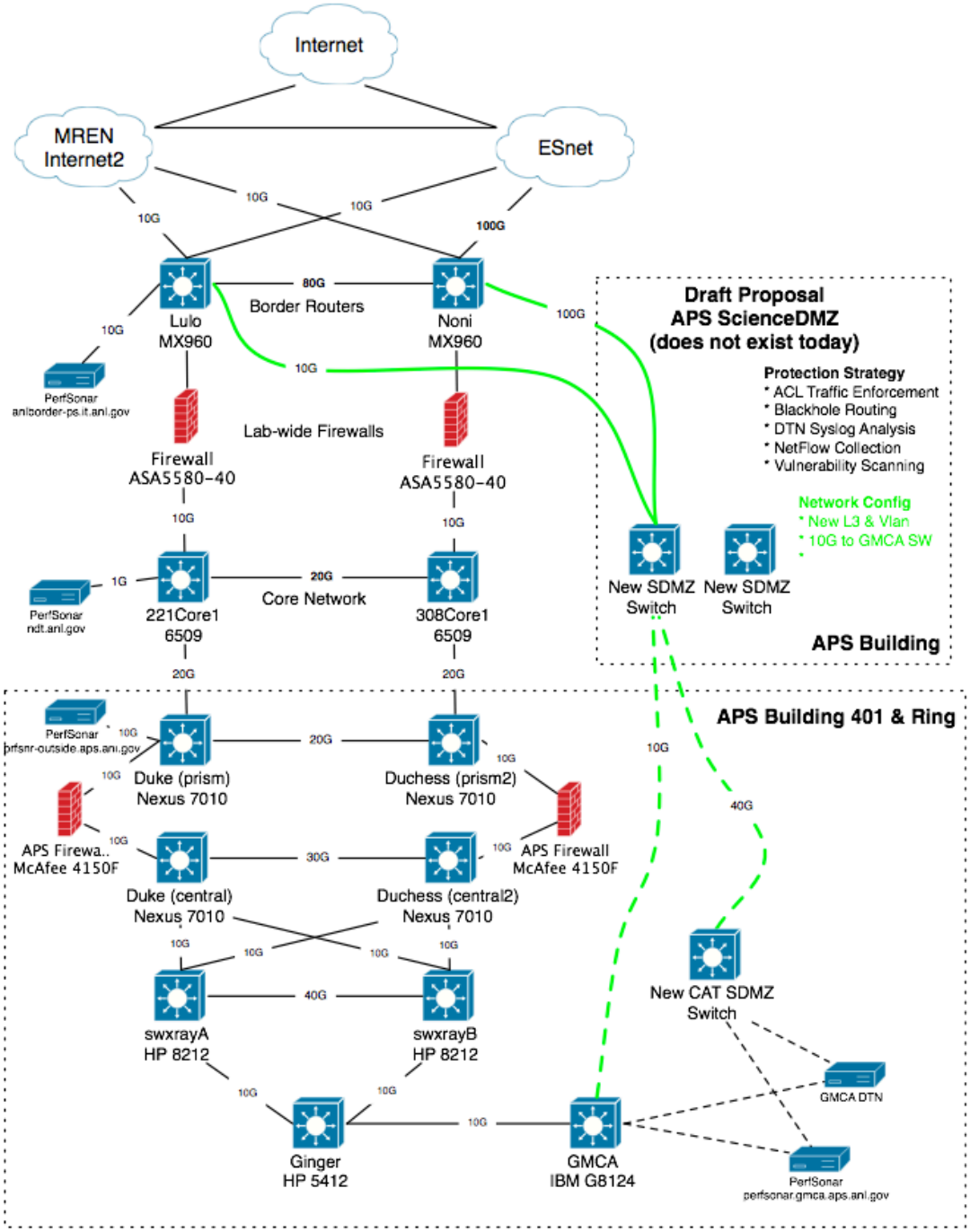
Future

- Wider use @ APS
  - Solution now goes directly to a specific beamline – how to support the entire facility?
- Wider use @ ANL
  - Service for other research groups (e.g. ALCF, ARM, etc.)
  - Pool of DTN resources w/ Globus, instead of each group manning their own (allows to back up to communal storage)
- Defining Policy
  - ACLs – ports exposed for things like perfSONAR, Globus. Shut off for things that don't need it. Gray area is defining what is and is not science.
  - Who gets on, who doesn't
  - Managing routing @ the border to best utilize the available WAN links



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