Overview: The Engagement and Performance Operations Center

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National Science Foundation Award #1826994

Engagement and Performance Operations Center

- Joint project between Indiana University and ESnet
  - co-PI Jent (IU GlobalNOC) and Zurawski (ESnet)
- Part of CC* program for domestic science support
  - Program Officer: Kevin Thompson
- Award #1826994, $3.5M over 3 years
- Partnerships with regional, infrastructure, and science communities that span the NSF and DOE continuum of funding

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Why an Engagement Operations Center?

- Today's science is collaborative science
- Collaborative science
  - Multiple partners
  - Multiple data sets
  - Many points of connection
  - Cross agency cooperation
- With better access to data we ask harder questions
- Interactive data sources change the science we do

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Understanding End-to-End Performance is Hard

- Lots of pieces - Host system through networks to host system
- No one controls all the pieces
- Unknown expectations for what performance should be
- Soft failures are hard to find
- Many, many points of coordination

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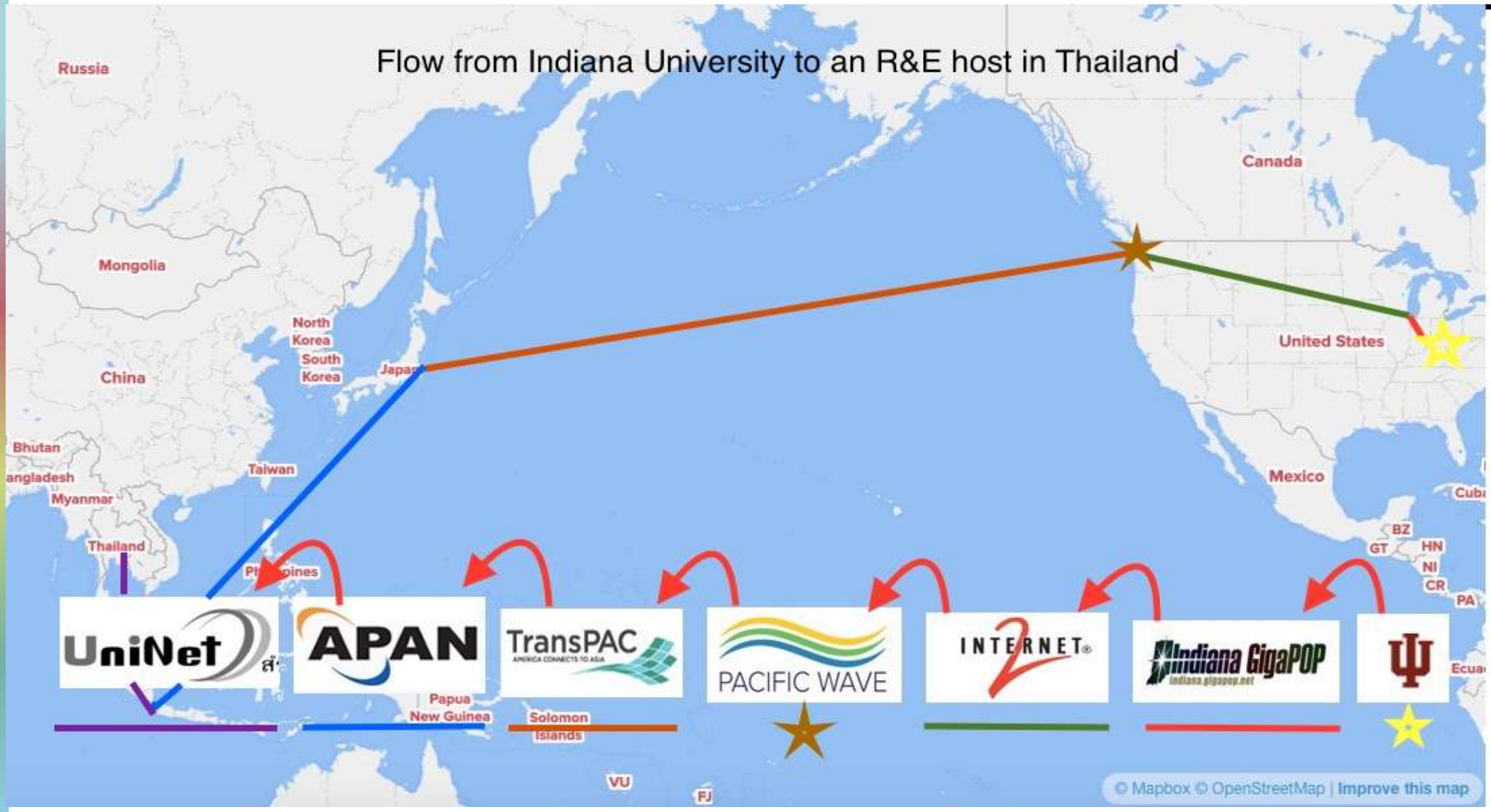
Flow from Indiana University to an R&E host in Thailand
Russia
Mongolia
China
North Korea
South Korea
Japan
Taiwan
Bhutan
Myanmar
Thailand
Canada
United States
Mexico
BZ
GT
HN
NI
CR
PA
Papua New Guinea
Solomon Islands
VU
FJ
UniNet
APAN
TransPAC
PACIFIC WAVE
INTERNET2
Indiana GigaPOP
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Partners are Needed to Scale Engagement

- Regional Network Partners
  - Large scale collaborations each which supports multiple institutions in a given geographical region
- Infrastructure Partners
  - Collaborative teams that coordinate on special areas
- Science Community Partners
  - Significant groups of application domain specialists
- Support that spans federal funding bodies
- Sharing knowledge and lessons between communities

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Initial Regional Network Partners

- The Indiana State Network (I-Light)
- The Ohio State R&E Network (OARnet)
- The Keystone Initiative for Network Based Education and Research (KINBER)
- The Great Plains Network (GPN)
- The Texas State R&E Network (LEARN)
- The Front Range Gigapop (FRGP)

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Initial Infrastructure Partners

- XSEDE
  - Uses Campus Champions to supports a single virtual system
- Campus Research Computing Consortium (CaRC)
  - Consortium of 30+ campuses to facilitate access to CI
- NSF Cybersecurity Center of Excellence (CCOE)
  - Supports cybersecurity for NSF funded projects
- Science Gateway Community Institute (SGCI)
  - Supports for scientists building/using data portals
- Internet2
  - Supports 200+ educational, research and community members
- The Quilt
  - Provides a central organization to share the best practices

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Initial Science Community Partners

- Earth Science Information Partners (ESIP)
  - 180+ member consortium of Earth science data and technologists
- World Climate Research - International Climate Network
  - 1,000s of Earth System scientists using climate repositories
- IU Grand Challenge Precision Health Initiative
  - Broad set of precision health applications
- University of Hawai'i System Astronomy Community
  - 15+ astronomy facilities
- Midwest Big Data Hub (MBDH)
  - 12 state collaboration to supports the use of data
- The Open Storage Network (OSN)
  - Will support dozens of applications across a broad set of domains

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Related Efforts – CI Engineering Coordination

- Discussion community created during the early rounds of CC* Funding
  - Target was to give the newly minted 'CI Engineers' a place to ask questions/discuss items of importance
  - Opened wider to include members of the R&E networking/computing communities - ~500 members.
- Weekly Talks on various Topics:
  - Most Fridays @ 2pm ET – starting March 29th
  - Join list for announcements
- Join the E-mail list:
  - https://groups.google.com/a/lbl.gov/forum/#!contactowner/esnet-cybinf-engr

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Expansion

- EPOC is a starting point, not a destination
- Fully anticipate bringing on additional partners that provide networking, infrastructure, or with a focus on other scientific areas
  - No one will be turned away
  - Mechanisms in place to on-board new participants
- Department of Energy Laboratories and Facilities
  - ESnet Science Engagement has a long history of interaction on addressing reported problems or assisting in evaluating existing and new science efforts
  - Emerging program (via EPOC and regular operation) in 'embedding' resources into a project/facility

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EPOC Five Main Focus Areas

1. Roadside Assistance for Performance Problems
2. Application Deep Dives
3. Network Analysis (NetSage)
4. Services “in a box” (DMZ, testpoint in a box, etc)
5. Training

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Something's Broken

- "My file transfers were working fine last week… but this morning nothing runs?"

- My side?
- Their side?
- Something in between?

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EPOC Roadside Assistance – epoc@iu.edu

- "This file transfer worked last week, but it doesn't anymore?"
  - Think of this like a flat tire, crash repair
- EPOC is a collaboration of 3 teams already supporting this
  - ESnet Science Engagement (engage@es.net)
  - IN@IU
  - IRNC NOC Performance Engagement Team (PET)

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Roadside Assistance Process

- Anyone can submit
  - Don’t have to be NSF funded, specific university
- Contact epoc@iu.edu
  - Within 24 hours, gets triaged
  - Some initial investigation to verify the issues
  - A Case Manager and Lead Engineer are assigned
  - Shareable infrastructure set up

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Problem: Many orgs involved results in many tickets, which no one has all the info about

- Solution; Local experts on both sides pulled in early
  - Partner with campus champions, CaRC, XSEDE, Regionals etc
- Solution: Folder for all engineering docs shared across orgs
  - No single ticketing system is open to everyone
  - Folder had docs, lists of tickets (and contacts), maps/diagrams, etc
  - Anyone working on the case gets access

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Problem: Submitter often doesn't know status

- Solution: online shareable "Customer Case Document"
- Written for non-engineers
- Updated frequently, generally twice a week
  - General overview and goal of the case
  - Contact points (Case manager)
  - Current status and next steps listed

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Troubleshooting

- Understanding the end-to-end path of the data transfer
- Use public test and validation services to identify potential issues
- Coordination with a wide set of engineering help staff along the data transfer path

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Outcomes

- Ticket stays open until reporter is satisfied with result
- Write ups follow
- Engineering guidance added to

  http://fasterdata.es.net

- Sharing how to solve problems is as important as solving them for us!

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Consulting

- Lighter weight than a full roadside assistance
- Submission process same – contact EPOC@iu.edu
  - Suggestions for DTNs, DMZs, firewalls and DMZs,
  - Data projections for science fields
  - Expected (real) performance between two sites
  - Advice on how to conduct a performance assessment of a network and applications
  - Or others!
- Similar operations approach
- Results/suggestions will be added to fasterdata.es.net over time

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EX: PanSTARRS Poor Performance

- Panoramic Survey Telescope and Rapid Response System (Pan-STARRS) collects and shares data to enable researchers to more accurately estimate galaxy redshifts, improving their understanding of the local cosmic expansion and dark energy
- Regular 100TB data transfers
  - Institute for Astronomy at University Hawaii (UH)
  - Space Telescope Science Institute at Johns Hopkins University
  - Experienced only 320Mbps speeds
- End-to-end path believed to be 10 or 100M, so expected multi Gbps at least
- Involved engineers from
  - International Networks at Indiana University (IN@IU)
  - IRNC NOC Performance Engagement Team (PET)
  - ESNet
  - MidAtlantic Cross Roads (MAX)
  - Internet2 NOC

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EX: PanSTARRS: Problem Identification (The Usual Suspects)

- perfSONAR testing identified JHU did not have a 10G connection through MAX to Internet2
  - Campus network upgraded to MAX/Internet2
- perfSONAR testing identified default UH to CONUS route was 10G
  - Updates default route to PIREN 100G Hawaii to LA
- Maximum Transmission Unit (MTU) setting on several routers was less than the recommended 9000 byte size frames (Jumbo Frames)
  - Larger MTU settings make data transmissions more efficient, because the CPUs on switches and routers can process a larger payload for each frame, but only works if each link in the network path -- including servers and endpoints -- is configured to enable jumbo frames at the same MTU
- TCP Buffer settings on end hosts were misconfigured
  - ESnet recommended settings, available at: http://fasterdata.es.net/host-tuning/background/

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EX: PanSTARRS: Problem Identification (The Less Usual Suspects)

- At UH, underpowered Top of Rack (TOR) switch bottleneck, misconfigured access control lists, and misconfigured firewalls
  - Equipment placement redesigned to remove bottlenecks from path
- Bespoke and aging software/systems set up
  - Data spread across many unreliable hosts – work in progress to redesign storage approach
  - Software required manual intervention and many hard to maintain dependencies- software workflow rewrite being discussed

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EX: PanSTARRS Outcome

- Transmission rates went from 320 Mbps to 1Gbps sustained
- Several additional architectural and software issues were identified, which are now part of the project's longer-term upgrade path

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EX: LHC Data Movement Issues between Pakistan and UK

- High Energy Physics, specifically the Large Hadron Collider, is set up to share data from Tier 1 sites, which are large, regional sites storing all or most of the data, to Tier 2 sites, smaller country-level sites, which in turn share data to local universities and researchers
- National Center for Physics (NCP)
  - Tier 2 LHC site at the Quaid-i-Azam University Campus in Islamabad, Pakistan
  - 1G connection to Pakistan national network (PERN)
- Queen Mary University, London
  - Tier 1 site for region
- Transfer rates NCP-QM as low as 40 Mbps
  - NCP-Australia Tier 1 500 Mbps transfers
  - NCP-ESnet Tier 1 280 Mbps transfers
- Additional intermittent performance problems over previous 2 years

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EX: LHC Pakistan-UK Problem Identification (1)

- A traffic shaping misconfiguration on the NCP connection to PERN
  - limited R&E traffic to 50Mbps
  - PERN removed traffic shaping for R&E traffic
- Top of rack switch bottleneck between NCP's file transfer node and edge router
  - Moved file transfer node to the edge router, performance increased from 40Mbps to 100Mbps or better
- Small amounts of ongoing, intermittent packet loss within the campus network
  - Identified by perfSONAR, cause unclear
  - Moving data node closer to the edge of their network to alleviated the issue
  - Work continues to identify source of loss

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EX: LHC Pakistan-UK Problem Identification (2)

- Packet loss identified inside the PERN regional network
  - Specific cause of the loss still unclear, work ongoing
- Additional bottlenecks between PERN and TEIN (Asian) networks
  - 1Gbps between national and regional network
  - Congestion is common, therefore so is packet loss
  - Upgrade to 10Gbps being explored
  - Temporary use of commercial path being explored

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EX: LHC Pakistan-UK Outcome

- Original Data transfer NCP to Queen Mary: 40 Mbps
- After engagement transfer speed: ~480 Mbps
- Additional areas for performance improvements identified
  - Larger scale and longer term changes to infrastructure needed
  - Discussions ongoing

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EPOC Five Main Focus Areas

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EPOC Deep Dives

- Think of this as regular maintenance, oil change, or planning to buy a new car
- Based on seminal work by ESnet to develop Scientific Case Studies
  - Walk through science workflow with the actual scientists
  - Way to understand needs and planning
- Often identifies issues that have ***nothing*** to do with networks, and everything to do with sociology

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Anatomy of a Deep Dive

- Two primary components
  - Narrative
  - Data Estimation
- Built on the ESnet “Requirements Review” template
  - Contains helper text to guide what is wanted
  - Items that make sense for DOE/ESnet, may not make sense for another institution – we’re modifying this as we go
- https://fasterdata.es.net/science-dmz/science-and-network-requirements-review/

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We Walk Through Scientific Components…

1. Background information
   - Brief overview of the facility, nature of the science being performed
2. Collaborators
   - Identify people and institutions that a science group interacts with
3. Instrumentation
   - Local and remote scientific instruments and facilities.
4. Process of Science
   - Explain ‘a day in the life’ of the science group
   - Should tie together the instruments, the people, and the resources

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And Also More Technical Aspects…

- 5. Software Infrastructure
- 6. Network and Data Architecture
- 7. Cloud Services
- 8. Outstanding Issues and Pain Points

→ Local and regional IT staff are critical to these parts, and help form valuable partnerships that may not exist, or could use strengthening

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When This Is Done

- Better understanding of the science, data movement, who's using what pieces, dependencies, and time frames
- Identification of bottlenecks or pain points becomes more obvious
- Relationships build between layers (engineering, science, administration)
- Clear path toward improvement and success

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Need for Network Instrumentation

- Performance and measurement are 2 sides of a coin
- Common basic measurement data is the first step to understanding performance issues
  - E.g. Global perfSONAR Deployment, http://my.es.net

- NetSage framework
  - SNMP, perfSONAR, Flow, Tstat Data
  - Grafana-based dashboards to visualize performance
- http://portal.netsage.global

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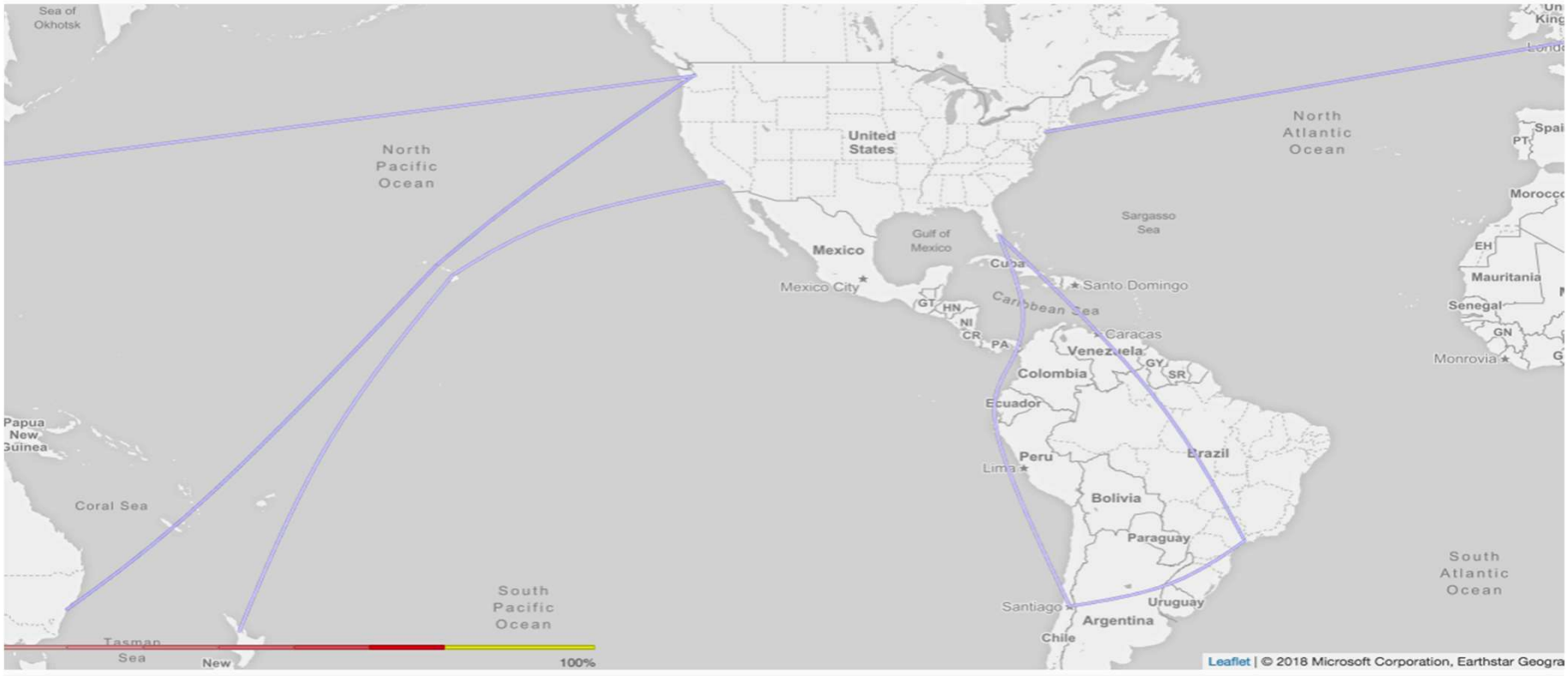
Shift of focus to network owner for US-EU Circuit Normal day: http://portal.netsage.global



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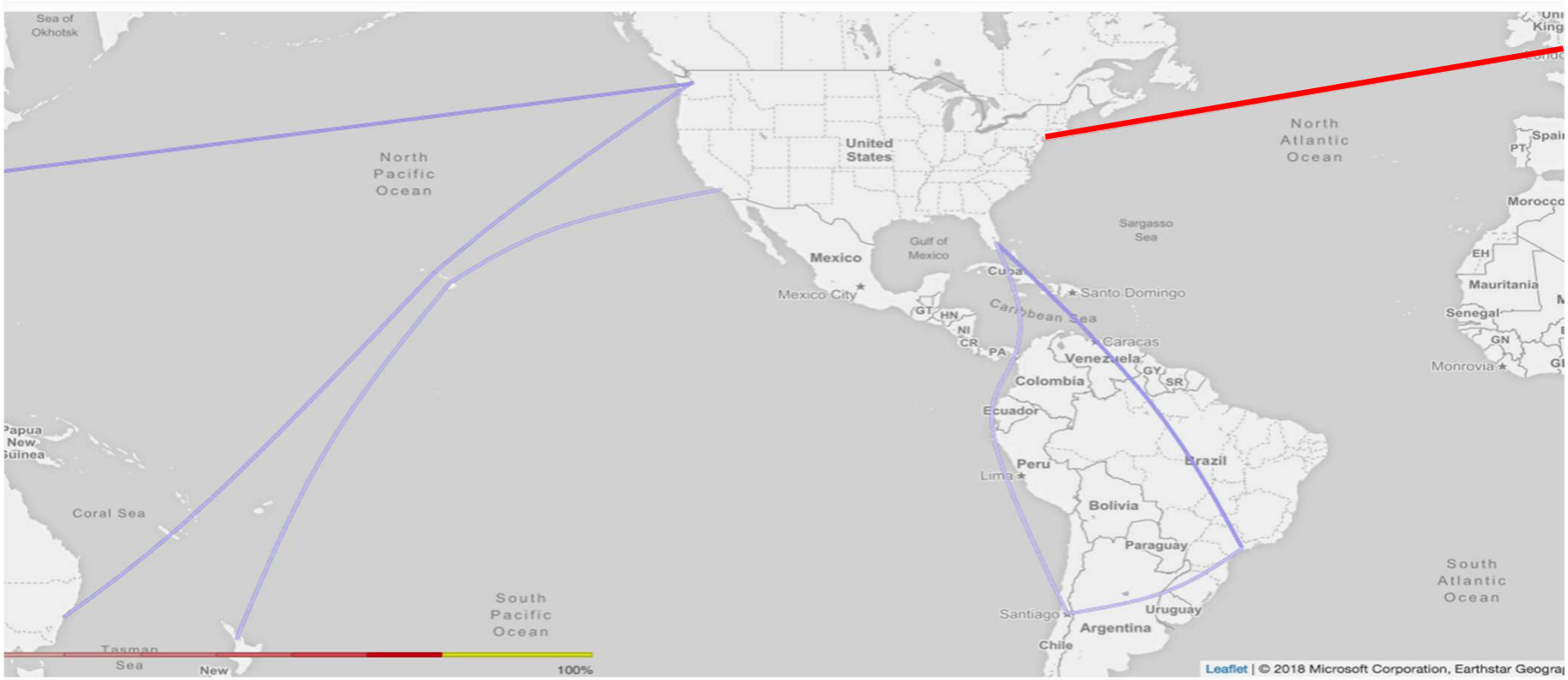
Monday Feb 5



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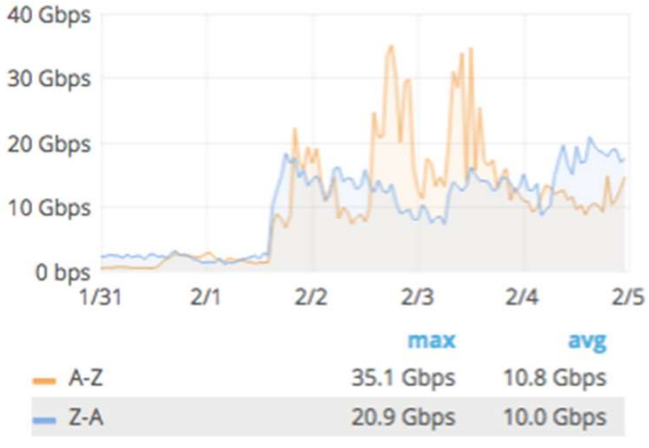
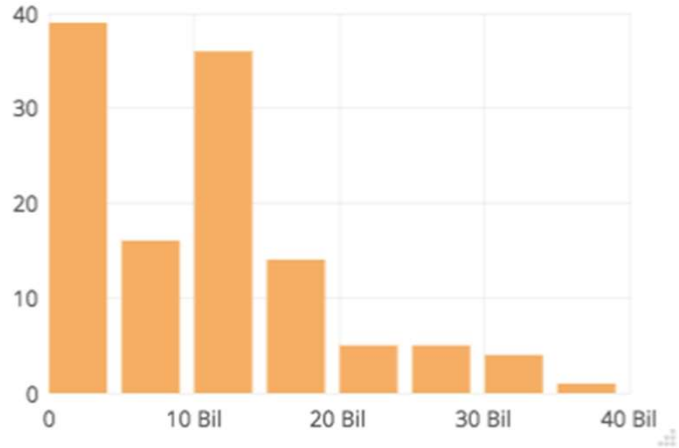
NetSage for NEAAR link Feb 1-5





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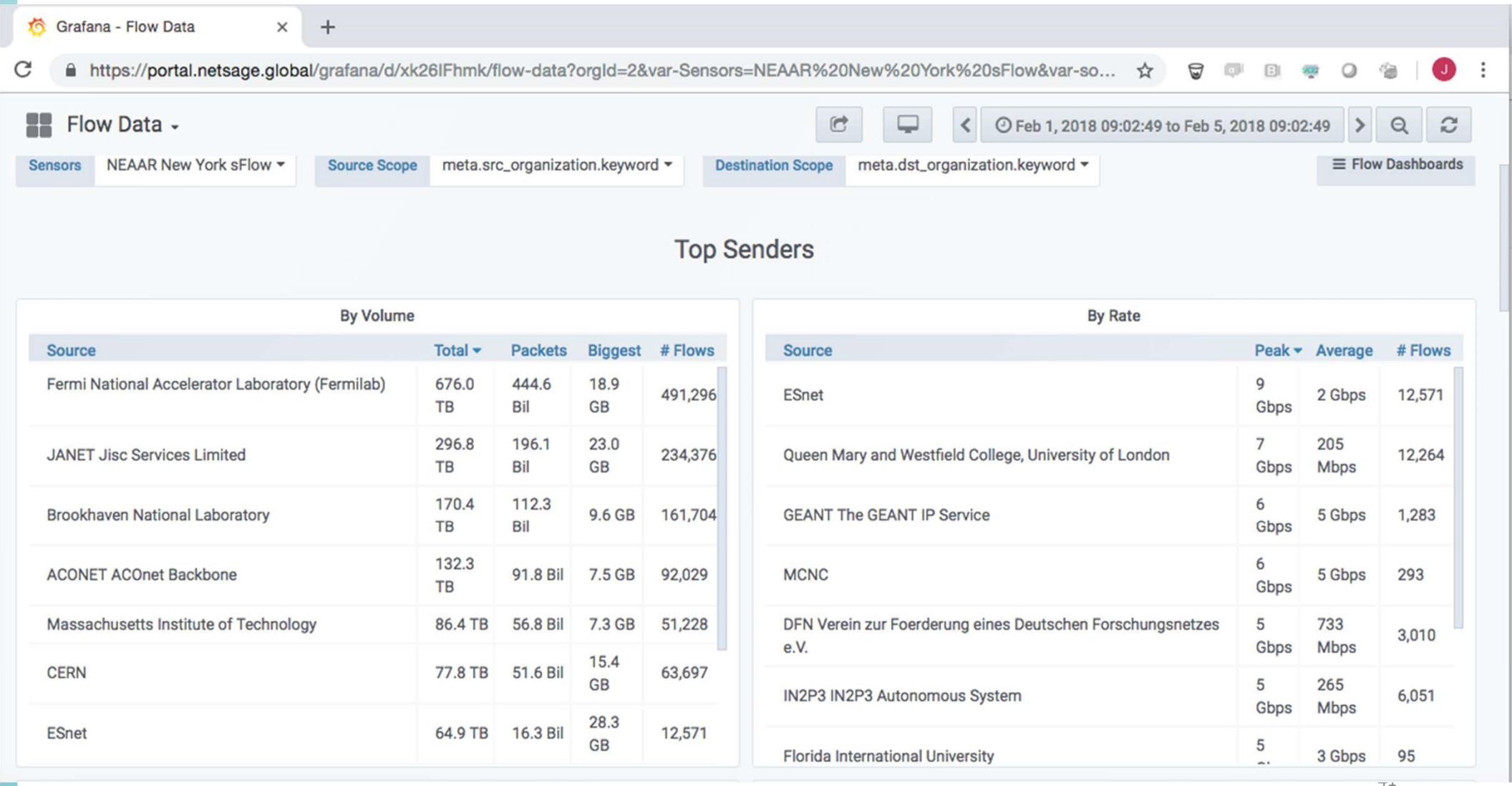
Grafana - Flow Data
https://portal.netsage.global/grafana/d/xk26IFhmk/flow-data?orgId=2&var-Sensors=NEAAR%20New%20York%20sFlow&var-so...
Flow Data
Feb 1, 2018 09:02:49 to Feb 5, 2018 09:02:49
Sensors
NEAAR New York sFlow
Source Scope
meta.src_organization.keyword
Destination Scope
meta.dst_organization.keyword
Flow Dashboards
Top Senders
By Volume
Source
Total
Packets
Biggest
Flows
Fermi National Accelerator Laboratory (Fermilab)
676.0 TB
444.6 Bil
18.9 GB
491,296
JANET Jisc Services Limited
296.8 TB
196.1 Bil
23.0 GB
234,376
Brookhaven National Laboratory
170.4 TB
112.3 Bil
9.6 GB
161,704
ACONET ACOnet Backbone
132.3 TB
91.8 Bil
7.5 GB
92,029
Massachusetts Institute of Technology
86.4 TB
56.8 Bil
7.3 GB
51,228
CERN
77.8 TB
51.6 Bil
15.4 GB
63,697
ESnet
64.9 TB
16.3 Bil
28.3 GB
12,571
By Rate
Source
Peak
Average
Flows
ESnet
9 Gbps
2 Gbps
12,571
Queen Mary and Westfield College, University of London
7 Gbps
205 Mbps
12,264
GEANT The GEANT IP Service
6 Gbps
5 Gbps
1,283
MCNC
6 Gbps
5 Gbps
293
DFN Verein zur Foerderung eines Deutschen Forschungsnetzes e.V.
5 Gbps
733 Mbps
3,010
IN2P3 IN2P3 Autonomous System
5 Gbps
265 Mbps
6,051
Florida International University
3 Gbps
95

NetSage Focus on Use Cases (Questions)

- Bandwidth Dashboard: http://portal.netsage.global
  - How used are the links?
  - Where are congestion points?

- Flow Data Dashboards
  - What are the top sites using the IRNC Links?
  - What are the top sources/destinations for an organization?

- Data Archive Monitoring (tstat)
  - Top Source/Destination pairs (volume, rate)
  - Retransmission stats

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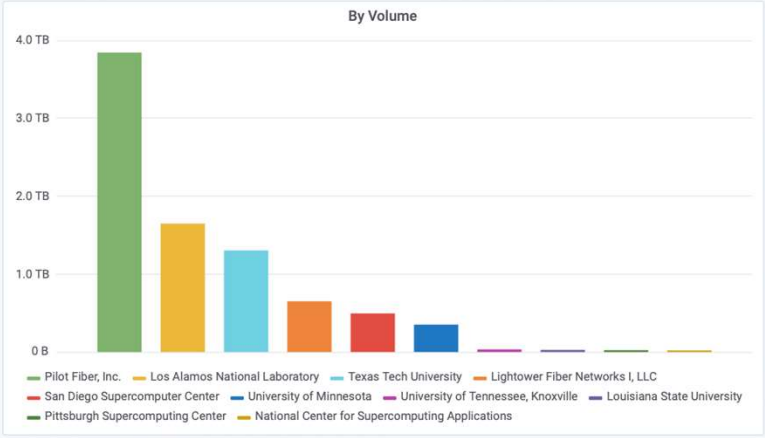
Data Archive Example

Top Senders

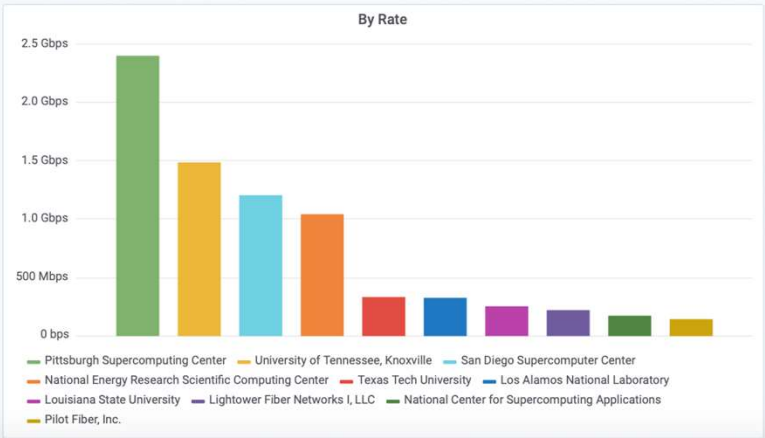
By Volume

Source Institution	Total Volume	Biggest	# Flows
Pilot Fiber, Inc.	3.8 TB	462.1 GB	16
Los Alamos National Laboratory	1.6 TB	234.5 GB	8
Texas Tech University	1.3 TB	202.0 GB	32
Lightower Fiber Networks I, LLC	651.1 GB	126.0 GB	8
San Diego Supercomputer Center	495.8 GB	78.9 GB	23
University of Minnesota	352.1 GB	90.3 GB	4
University of Tennessee, Knoxville	33.6 GB	1.1 GB	32
Louisiana State University	27.1 GB	3.3 GB	13
Pittsburgh Supercomputing Center	24.2 GB	2.6 GB	20
National Center for Supercomputing Applications	21.3 GB	2.0 GB	12



By Rate

Source Institution	Peak ▾	Average	# Flows
Pittsburgh Supercomputing Center	2 Gbps	1 Gbps	20
University of Tennessee, Knoxville	1 Gbps	1 Gbps	32
San Diego Supercomputer Center	1 Gbps	427 Mbps	23
National Energy Research Scientific Computing Center	1 Gbps	543 Mbps	27
Texas Tech University	334 Mbps	141 Mbps	32
Los Alamos National Laboratory	327 Mbps	287 Mbps	8
Louisiana State University	255 Mbps	128 Mbps	13
Lightower Fiber Networks I, LLC	222 Mbps	127 Mbps	8
National Center for Supercomputing Applications	174 Mbps	153 Mbps	12
Pilot Fiber, Inc.	145 Mbps	92 Mbps	16



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Measurement and EPOC

- Expectation that all Regional Network Partners will have at least a partial NetSage deployment
  - Enable better understanding of network performance issues writ large
- Working on methods to integrate infrastructure partners
  - NERSC/TACC so far – let us know if you want to join!
- Goal is to find problems BEFORE the scientist/user community do

- "If you can't measure it – you can't improve it"
  -Peter Drucker

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How to increase adoption/deliver value to partners of smaller size?

- Observations by IU/ESnet after several years of community events (e.g. OIN Workshops):
  - Lots of “interest” in new technologies
  - May not know of (immediate) use cases
  - Resources (time/$) to design/specify/build is hard to come by
    - Easier to pay for a service that is build for you, or maintain something someone else builds
  - *“Why would I need that?”*

- ***Unfunded mandates have a way of being ignored***

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What is a “Service-in-a-Box”?

- Basic idea:
  - Only large facilities with dedicated funding can afford the time/effort to design/install/operate/maintain a dedicated science infrastructure
  - Ameliorate the costs of design/install at a higher level (e.g. regional network).
  - Create infrastructure that can be delivered as a service
  - Operation can be local or regional (offer flexibility based on the environment and resources available)
  - ***Develop a business model that facilitates cost recovery and upgrade schedules***

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What is a “Service-in-a-Box”?

- Goals
  - Offer a way for traditionally smaller/less resourced facilities to use emerging technology to support scientific use cases
  - Create new paths for regionals to interact with/learn about/support scientific use cases
  - Reduce cost for service deployment and operation
  - Increase adoption/improve outcomes on a larger scale

- E.g. Turn ***“I can’t do that”*** into ***“How did I live without this?”***

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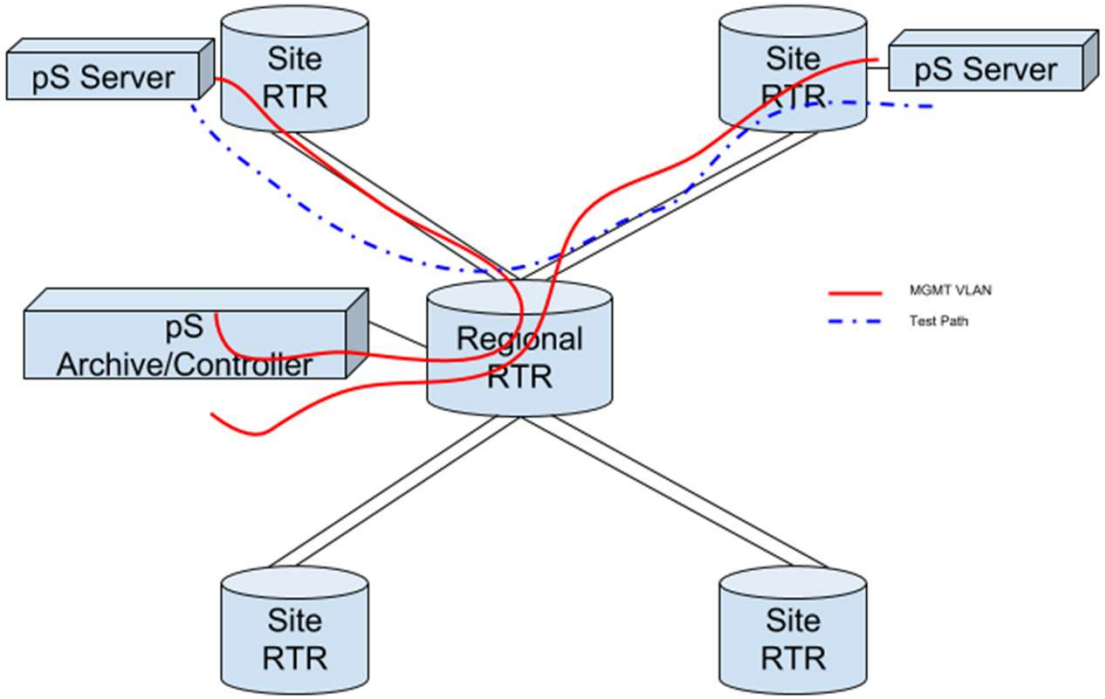
SIAB Locality – perfSONAR (EX)



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Anticipated Offerings

- perfSONAR
- Science DMZ
  - Deployment of regional hardware to support campus high-performance needs
- Data Transfer Hardware/Software
  - Rental or co-location of capable hardware and storage
- Network Capacity Testing
  - Use of 10G/40G/100G/(400G?) hardware to prove out new circuits, or debug old ones
- Security
  - Regionally deployed IDS infrastructure that doesn't impact high performance networking.

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Training

- Follow on to OIN (http://oinworkshop.com) series that reached over 750 people in the NSF/DOE funding space during the 3 year operational period
- Hands on perfSONAR sessions
  - Especially for small nodes
  - Would include file transfer tests
- How to do an Application Deep Dive
  - Also known as “How to talk to Scientists”
- DMZ/DTN Set Up
- To request – send mail to epoc@iu.edu
  - include “Training Request: in the subject line

EPOC
Engagement and Performance Operations Center

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Take Aways

- EPOC is an NSF-funded operations center to help scale science engagement and problem resolution
- Single point of contact to help with end-to-end performance issues
  - epoc@iu.edu
- More about EPOC:
  - http://epoc.global
- Jennifer Schopf, jmschopf@iu.edu
- Jason Zurawski, zurawski@es.net
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Overview: The Engagement and Performance Operations Center

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