Improving Network Infrastructure to Enable Large Scale Scientific Data Flows and Collaboration (Award # 1659348)

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Quad Chart for: Improving Network Infrastructure to Enable Large Scale Scientific Data Flows and Collaboration (Award # 1659348)

Challenge or Approach:

- Rice University network is protected by firewalls and not designed for supporting advanced data-movement
- Researchers in Rice labs consume and produce data volumes that cannot be efficiently supported by current campus wide-area network connections
- Researchers need advance friction free networks to access instruments and computational facilities

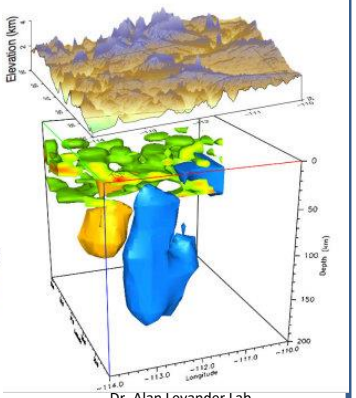
Solution(s) or Deliverables:

- Friction-free network path characterized by highly capable network devices and virtual circuit connectivity options
- Dedicated high-performance (up to 100 gb/s capable) data-transfer node
- BRO Cluster to secure Rice SciDMZ network flows
- Integration of test nodes and performance measurement infrastructure (perfSONAR)

Rice Severe Storm Prediction, Education, and Evacuation from Disasters (SSPEED) Center

RICE
Unconventional Wisdom

Dr. George Phillips



Dr. Alan Levander Lab

Scientific Impact or Broader Impact:

- Ability to conduct multi-disciplinary and collaborative research on campus.
- Ability to conduct multi-institutional research
- Enable the creation of more complex and realistic models and simulations to mimic real world experience and projections.
- Improve access to and ability to share large datasets

Metadata tag:

http://news.rice.edu/2017/01/23/nsf-cyberinfrastructure-grant-will-provide-dedicated-lane-for-research-traffic

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What was the problem?

- Rice runs a complex network that serves research, academic and administrative needs of the university
- To manage institutional risks, Rice installed a campus firewall at the network border in 2014
  - Addressed risk and attack and penetration test findings
  - Firewall blocks on average of 3 million web and application attacks daily
- Firewalls slow down network flows

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SCIENCE DRIVERS FOR CHANGE

Subsurface Imaging and Data Analysis

- Provide access to large scale seismic refraction and reflection data to support fundamental advances in computational mathematics for subsurface imaging and seismic inversion.
- Example:
  - Collaboration between researchers at Rice University (Dale Sawyer, Earth Science) and Columbia University in the U.S., University of Birmingham and University of Southampton in the UK, and the Institute of Marine Sciences and Repsol in Spain
    - Sharing data and results from a seismic survey off the coast of Portugal.
    - Typical datasets ranged from 100GB to 10TB.
    - While some of the data was shared online, much of the data and results could only be shared using “FedEx”, which hampered research progress.

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Urban Data Science, Atmospheric Sciences, and Severe Weather Events

- Provide access to and enable sharing of raw longitudinal data to support ongoing collaboration between scientists, industry and the broader Gulf Coast communities.
- Example:
  - Rice's Severe Storm Prediction, Education and Evacuation from Disasters (SSPEED) Center
    - Research on structural performance assessment during extreme loading, such as wind, wave, seismic, or blast
    - Research on the interdependent response of critical infrastructure systems subjected to natural hazards, such as earthquakes and hurricanes, that also quantifies the impact of this coupled response on society on atmospheric particulate modeling

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Computational BioSciences and Neuro-engineering

- Enable bio-science researchers to share data across institutions that are part of the Texas Medical Center and assure frictionless national access to large genomic datasets.
- Example:
  - Typical data collection from current ALS detectors is 60-180GB (manageable) and 8-9TB in a single experiment at the Free Electron Laser at SLAC (not easily manageable today). Because of its large size, the SLAC data was not transferred back to Rice.
  - A group of researchers at Rice led by George Phillips runs 3- 4 experiments in a month every few months.
  - *Note*: The group at Rice is using Globus-enabled data transfer nodes to support scientific workflow. With the help of Energy Sciences Network staff, the current enterprise network and security infrastructure have been identified as causes for impeding data transfer performance.

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Heavy Ion and Particle Physics

- Facilitate increased access to and improved analyses of particle physics data generated at the Large Hadron Collider and the Relativistic Heavy Ion Collider.
- Example:
  - The ability to connect from data transfer nodes on campus at wide area speeds of 100 gb/s to the LHC Open Network Environment (LHCONE) via Energy Sciences Network (ESnet) and the Internet2 backbone is critical for the Bonner Laboratory, ensuring continued growth of Rice's ability to support this international effort.
  - The SciDMZ will permit high-bandwidth friction-free 100gb/s connectivity for CMS and STAR data flows.

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SOLUTION

Overview

- Install Layer-2 switch equipment and use dark fiber to bring a 100 gb/s circuit
- Install an Optical TAP for visibility into all network traffic that flow to the DTNs
- Install and configure a BRO TAP switch to distribute network traffic to BRO for inspection.
- Install and configure a Rice SciDMZ switch/router with a dedicated Autonomous System Number (ASN) and direct peerings to R&E networks using IPv4 and IPv6.
- Connect existing 10 gb/s DTNs and one proposed, 100 gb/s DTN with flash storage.
- Relocate existing perfSONAR nodes to more optimal locations for measurement.

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Passive Optical TAP

- Eliminates as many active network devices in the pathway between national and regional R&E networks and the Rice SciDMZ
- Directs 50% of the optical power level (and related signaling) to the Rice SciDMZ switch for handling by the DTNs
  - Remaining 50% power is directed towards a BRO TAP switch with Data ANalyZer (DANZ) and Latency ANalyZer (LANZ) technologies to support streaming packet analysis by a BRO cluster.
- No latency is introduced into the DTN traffic flows.

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BRO Cluster

- Five BRO nodes, each with a 10 gb/s network interface cards (NICs) capable of “sampling and sniffing” 40-50 gb/s network flows, a realistic peak on a 100 gb/s link.
- All five deployed as BRO “worker” nodes used to analyze inbound and outbound traffic flows
- One node will also serve as the BroControl node.

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Data Transfer Node

- Dedicated and upgraded data transfer node (DTN) with support for 100 gb/s network interface.
- To help overcome the storage interface bottleneck this proposal includes a new DTN with a high-performance flash storage array to serve as a data source/sink.

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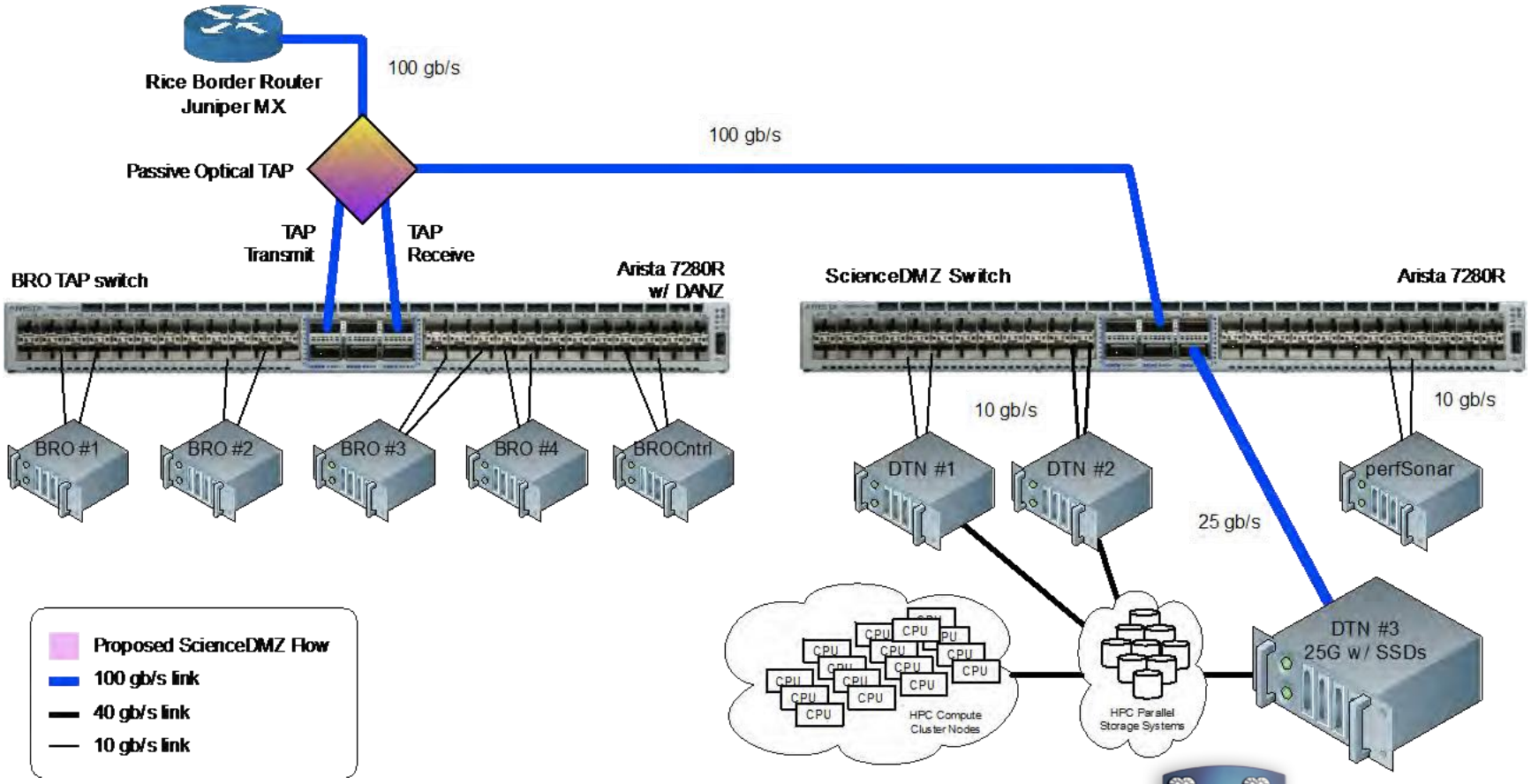
Architecture



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THANK YOU! QUESTIONS?

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