ADASS 2017 – Santiago, Chile – October 24th 2017

International Networking in support of Extremely Large Astronomical Data-centric Operations

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Large Synoptic Survey Telescope

Outline



- A bit of history: international networks in South America to support astronomical operations
- A bit of future: the Large Synoptic Survey Telescope
- Key Challenges for Inter-Domain provisioning to support extremely large astronomical data-centric operations
- LSST Network Engineering Team Goals
- Conclusion

A bit of past: networking needs



Back in the 90s, *high-bandwidth* connections (256kbps) were used for basic communication and coordination:

- Satellite connections for point-to-point connection
- Data was shipped via Fedex

In the 2000+, *high-bandwidth* links (45 - <1Gbps) were used for data transfer in a very limited fashion:

- In 2011, Chile was home to 42% of the world's astronomical infrastructure
- It was still not unusual to have data shipped via Fedex
- In South America, projects such as AURA, GEMINI, ALMA, NOAO and others started *demanding* more network capacity
- Many projects and partnerships were created to deal with this demand for networking capacity, for example, the Americas Lightpaths (AmLight) project, that connects South America to the U.S.
- In 2013, at AmLight, 20+ Gbps of total capacity was available in Chile to support data transfers.

A bit of future: Large Synoptic Survey Telescope

Composed of **multiple** Data Management facilities

Multiple data streams summing up 90 Gbps:

 Every 30 seconds during observing, a 12.7GB data set must be transmitted from La Serena to the U.S. in 5 seconds!

The path created from the Base Site to Archive Site is composed of multiple academic networks with multiple high bandwidth links



The end-to-end path must provide **high resilience**, low delay, and an efficient control plane to act in all network status changes!!

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Challenges...

Inter-Domain Coordination



Leveraging multiple academic network operators has many advantages:

- Academic networks are usually more flexible for complex requirements
- Shared costs help lower the total cost per Mbps

However, it has challenges:

- Each academic network might have a completely different technology, configuration or vendor making interoperability complex
- Most academic networks rely on static provisioning and multidomain provisioning can easily take weeks to be completed

Inter-Domain Coordination [2]



The LSST network is being created with multiple 100G links involving many academic networks:

- REUNA
- AmLight
- CLARA
- ANSP
- RNP
- FLR
- Internet2
- ESNet
- StarLight
- NCSA



High Delay*Bandwidth Product

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- The "distance" (delay) from La Serena to Champaign, Illinois varies from 140ms (primary path) to 280ms (backup path)
- Most Layer 4 Transport protocols (including TCP) were not made to operate with such long *delay*
 - 0.001% of packet loss with this delay is enough to kill a data transfer:



Performance Measurement is key in this kind of environment

Performance Measurement



perfSonar framework is the primary solution for performance measurement in the academic community

• More than 2000 installations

To measure end-to-end performance, each domain has its own nodes sending results to a centralized measurement archive:

• Maddash



Networking Requirements



Even with no errors, our job as network engineers is not done: Best Effort & Bursts are always testing us!

The LSST network requirements specifies different traffic types with minimum bandwidth reservation when using shared infrastructure

 A complex inter-domain QoS framework is being evaluated

An "almost deterministic" network is the main goal.



Next Steps...

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LSST NET Goals



Centralized Network Monitoring System will track all domains and network layers (optical and packet)

Performance Measurement: multiple perfSonar nodes at 100G!

Network Automation as much as possible for future provisioning activities

Better interfaces for researchers: Software-Defined Exchanges

Conclusion



Deploying an international network to support data-centric operations is challenging but possible!

LSST Network Engineering Team includes network engineers and operators from domains in the path <u>Meetings every month</u>

A lot of coordination in the present to automate the future!



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Thank you! Questions?

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