Multi-Tiered Storage with Xrootd at ATLAS Western Tier 2

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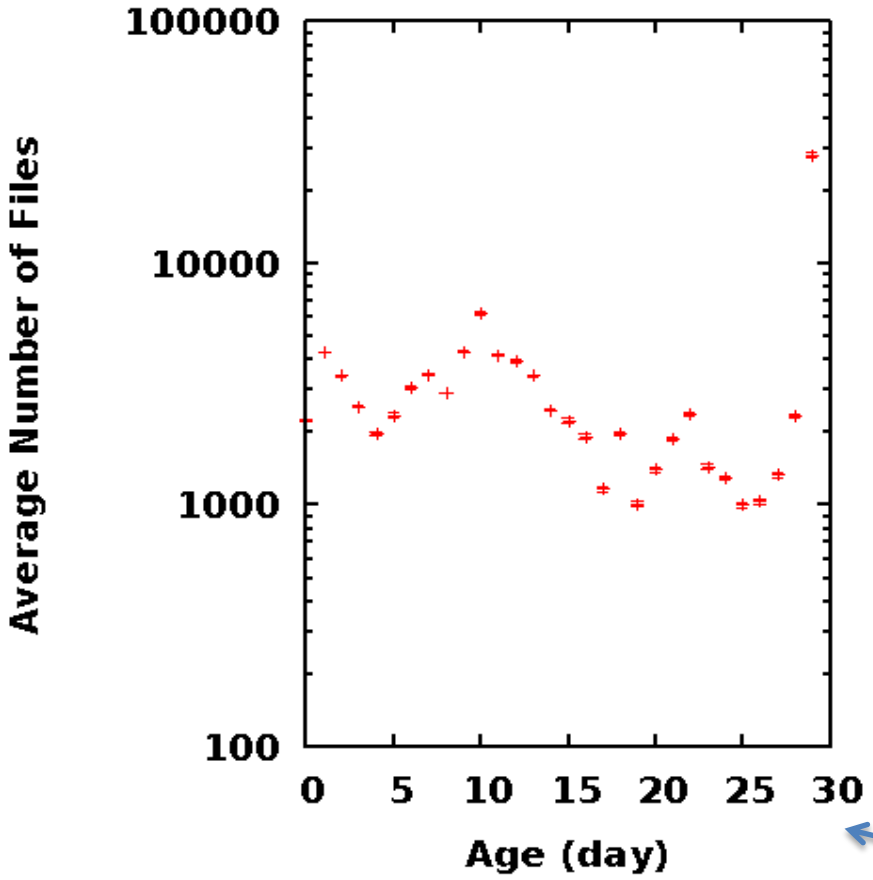
Why Divide Storage into Tiers?

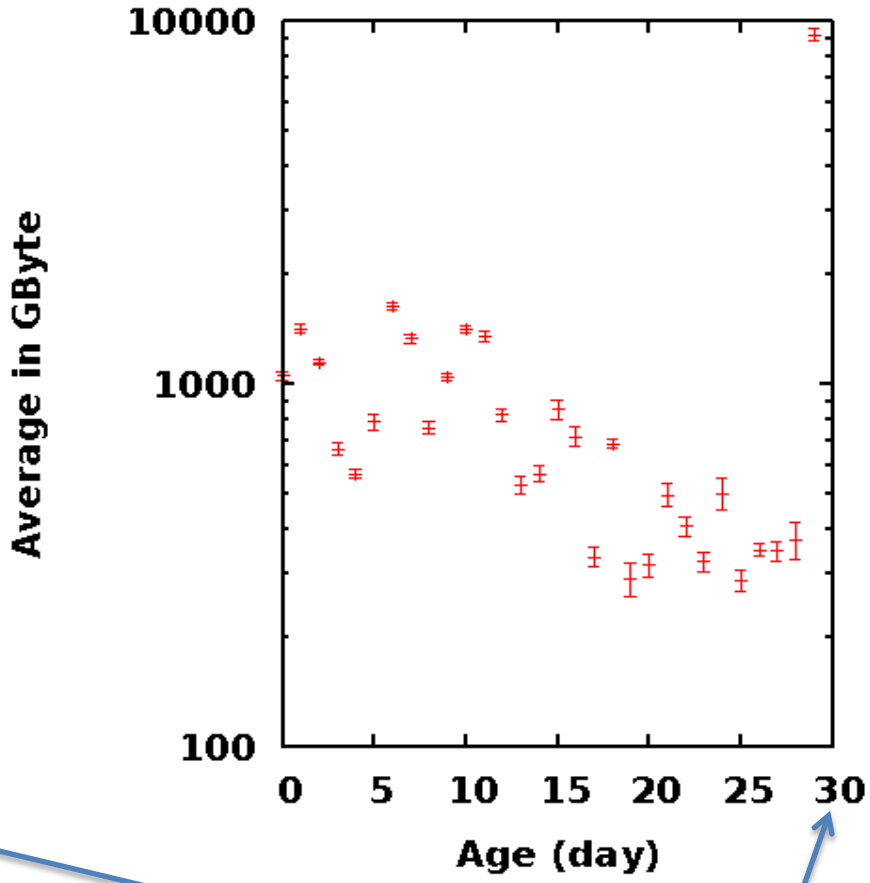
- ALTAS production jobs stage input files to batch nodes, **BUT** analysis jobs read directly from Xrootd storage
- Need high performance storage to serve the random/sparse IO from analysis jobs
- Data becomes cold quickly

Questions:

- Do we really need to keep on buying high performance storage for all data?
- Can we divide storage into tiers and federate them?

Data is cooling down …





Age: Last access time in days

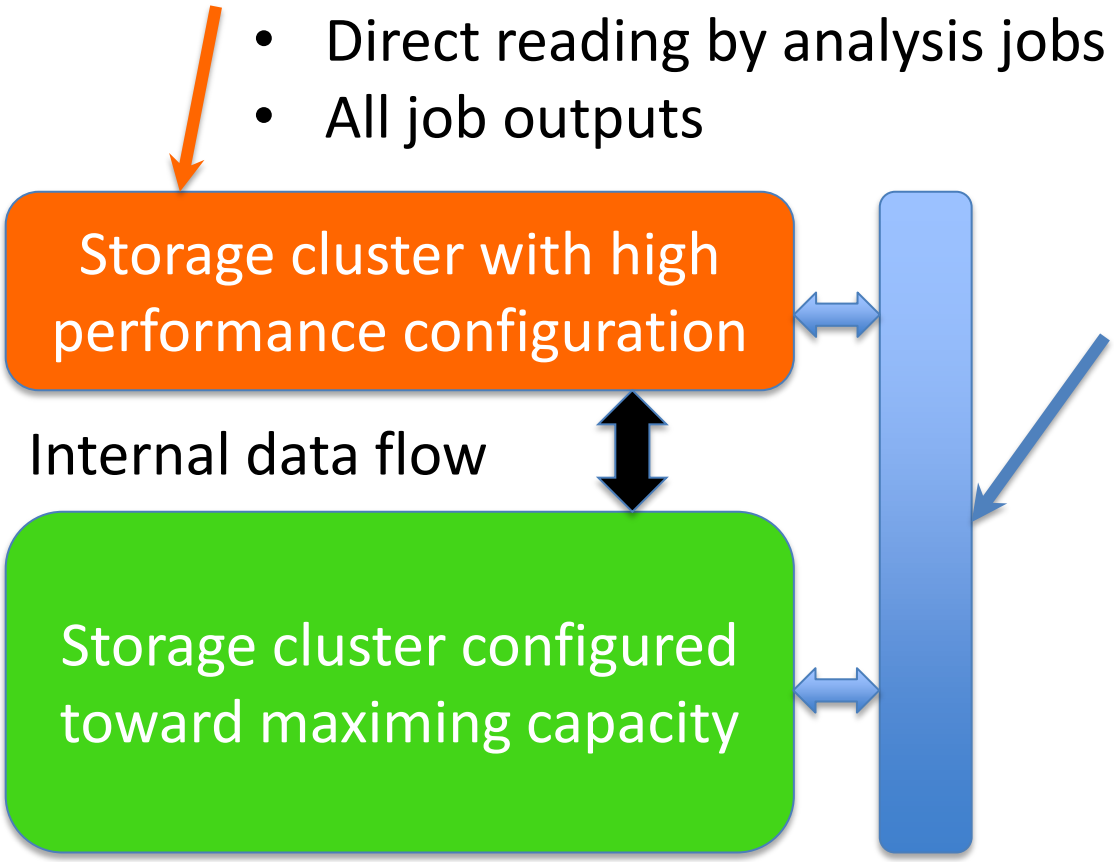
Average over 17 identical Thumpers/Thors

Over 30 days

Design a Two-Tier Storage for ATLAS?

Top tier entrance:

- GridFTP data import (over WAN)
- Direct reading by analysis jobs
- All job outputs



All tier entrance sees all storage:

- SRM & Data management
- Data stage-in by production jobs
- GridFTP data export

Design details

- Uniform name space
- Data move between storage tiers automatically
  - Top moves cold data to back when space is needed
  - Reading at top triggers data stage-in from bottom
- Data movement is driven by the top tier
  - transparent to jobs, use Xrootd/FRM
- Validate checksum for all data movement

File Residency Manager

- FRM glues the two storage tiers together
  - It is Xrootd's generic virtual remote storage interface.
  - What it does? Stage, Migration, Purge

Stage: frm.xfr.copycmd in your_stage-in_script $LFN other_args
Migration: frm.xfr.copycmd out your_migrate_script $LFN other_args
Purge: frm.purge.policy * 1024g 2048g hold 48h polprog
frm.purge.polprog pfn | your_purge_script other_args

"**stage**" will put open() on hold until file is staged

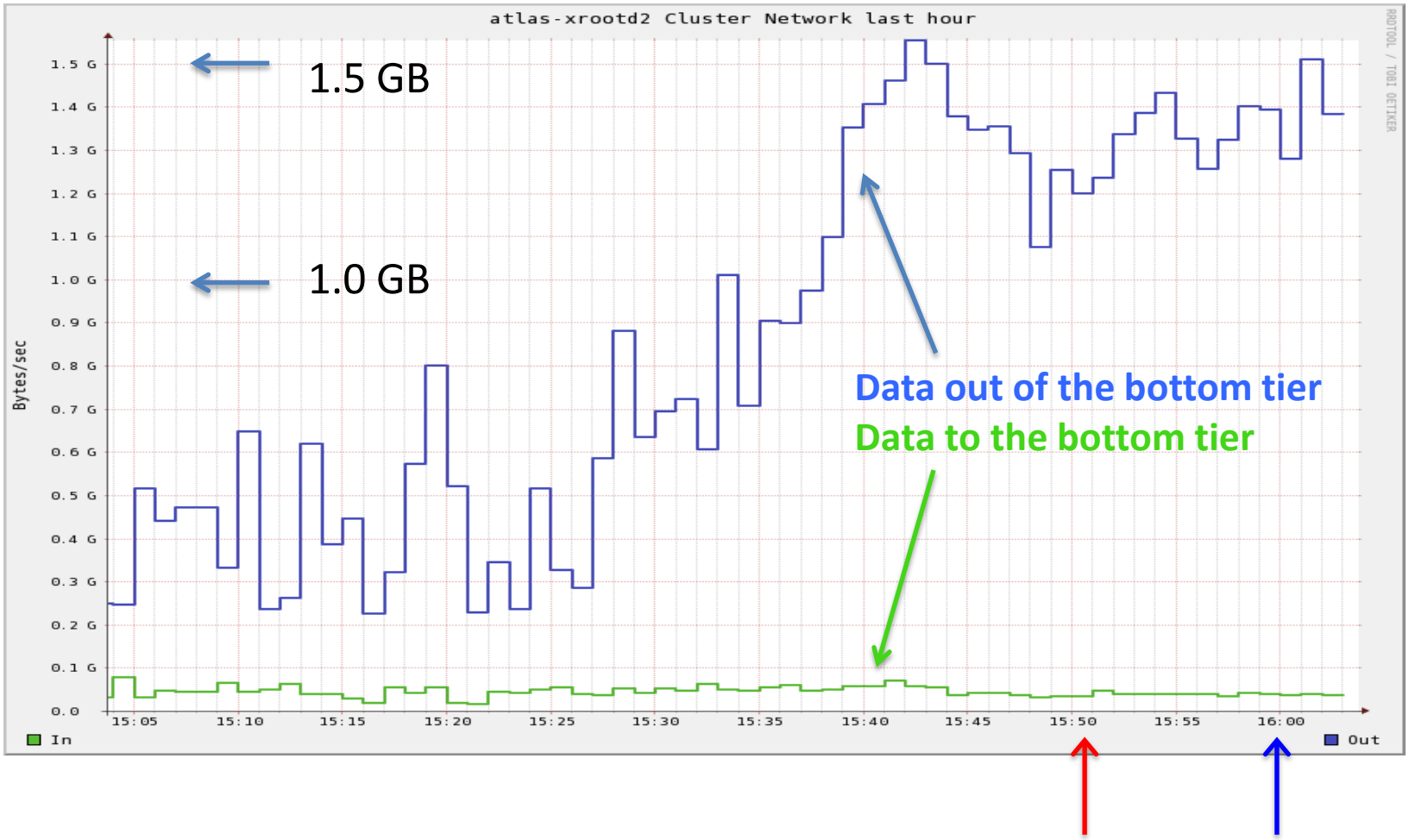
- Simple to use.
  - Scripts. You have full control
  - Scripts' return code and stdout will be checked
- Checking status:

```
frm_admin –c config_file query all lfn qwt
```

Implementation at SLAC

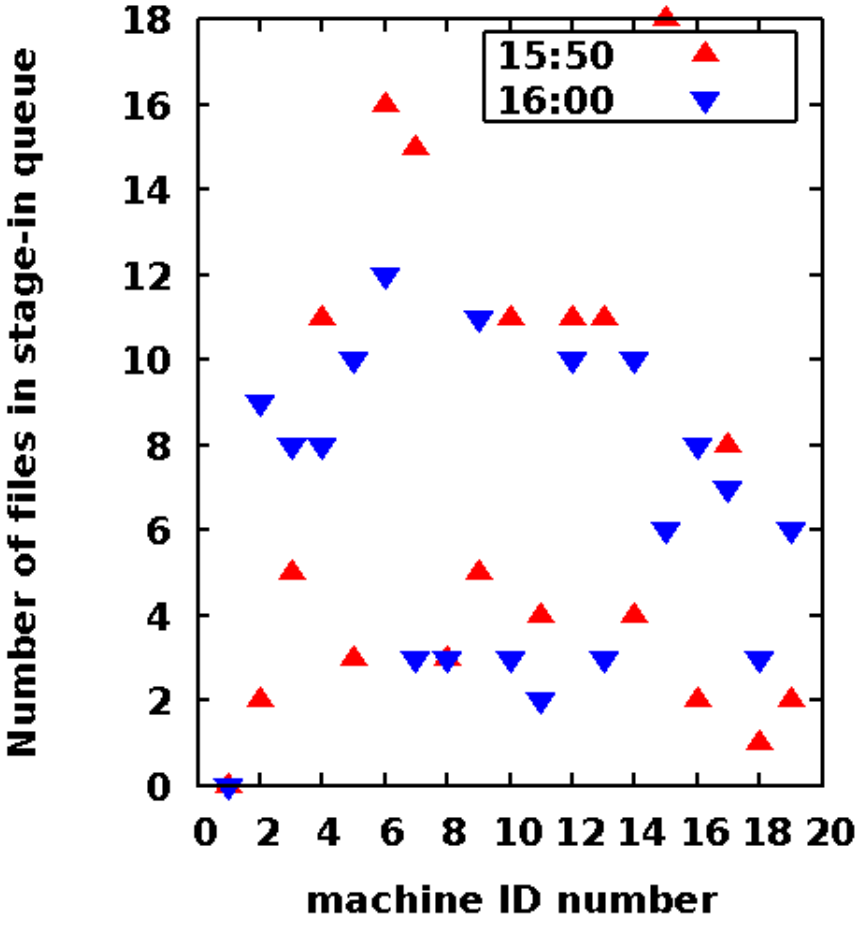
- Top Tier storage
  - 17 Thumpers/Thors with Solaris/ZFS
  - 1TB /2 spindles, raid 1 (mirror), 7200rpm SATA
  - Total 748 spindling disks, ~340TB usable
  - Run xrootd/cmsd/FRM
- Bottom Tier storage
  - 5 hosts, each 6x 30-disk raid 6 + 1 hot spare
  - 1 host, 6x 15-disk raid 6 + 1 hot spare
  - 2TB/spindle, 5400rpm SATA
  - Total 990 spindling disks, ~1.6PB usable
  - Run xrootd/cmsd

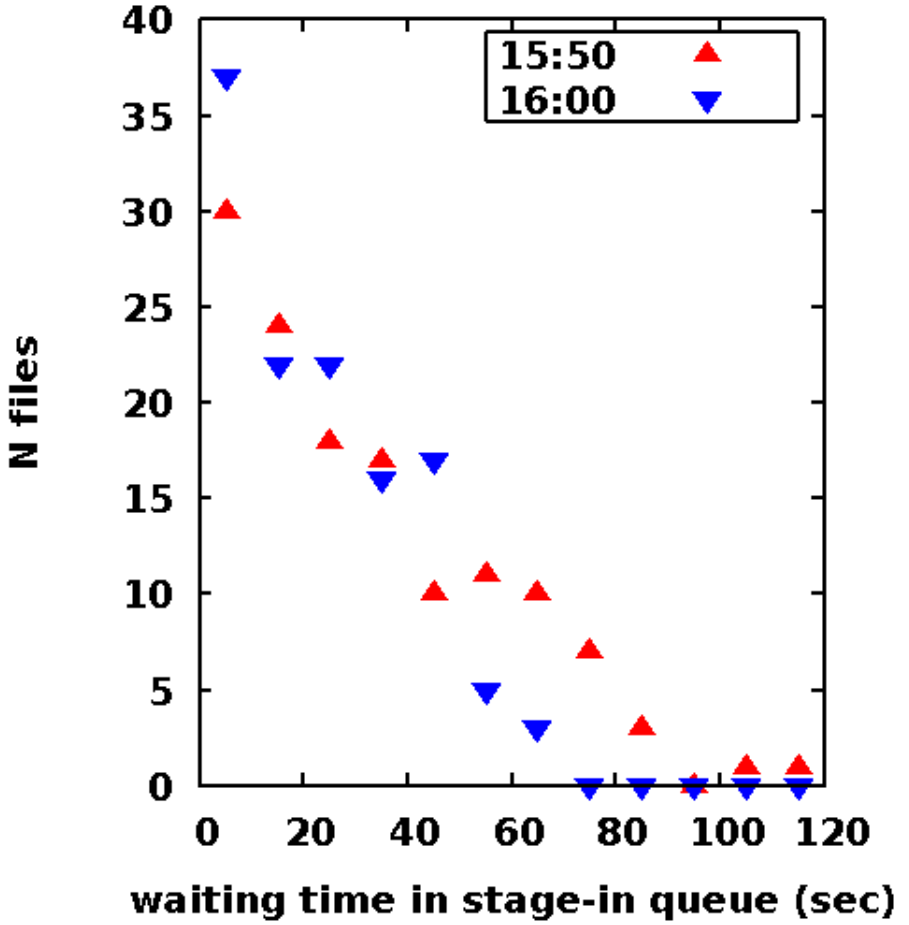
Activity at Bottom Tier



Activity at two time spots 10 minutes apart: 15:50 16:00

Cost (delay) of Stage-in





~400 running jobs

Other benefits of tiered storage

- Outage of a node in bottom tier has very little impact to the operation
- Allow scheduling top tier node outage without down time
  - Need to vacation the data, could be days
- Data constantly spread across all top tier nodes.
  - Natural avoids hot spots.
  - Bottom tier doesn't have to have more space

Operational Experience

- Moving small files is inefficient
  - This is the case for all storage and data transfers
  - Xrootd's look-up delay for new files is expensive for small file migration from top to bottom.
    - Bypass back tier redirector to improve performance
- Resource intensive operation when vacating a storage node.
  - Multiple steps, need to be careful

Future Developments

- Build 3 tier storage system
  - Top SSD (an array of 12 SSD's is ready)
    - We know we can get 48Gbps with 250K IOPS
  - Middle 7,200rpm HD's
    - First stop for new data
  - Bottom 5,400rpm HD's
- Trick will be to properly manage the SSD's
  - We suspect that as SSD's become cheaper 2-tier setup will be more appealing