Lessons and Observations of a Large Filesystem

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Installation of a 1+TB/sec filesystem

Sequoia Storage Installation

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Installation Details-Grove +

- Grove 384 Controller pairs, 23040 3TB Seagate drives, 768 OSS nodes
  - Performance peak 1.3+TB/sec
- 48 RBODs in Vulcan
- 40 RBODs in Porter
- 40 RBODs in Marzen
- 8 RBODs in Stout
- 2 RBODs in Lager

~ Performance well over 2TB/sec ~
Key areas of focus

- Understand and CONTINUALLY monitor:
  - Heat
  - Higher component failures/trending
  - Bandwidth
  - Latency

- Trust no firmware/hardware:
  Trust nothing/Test everything
  Code is tested in a mirrored configuration
  Spares are cooked and tested
TS Nock-ten and Performance

This is a blowup of the 1M Random Read portion of the XDD test only. The 70MB/s drop per node is very noticeable. There are 2 nodes per RBOD/array.

Actually, the drop is 140MB/sec per RBOD when both nodes are considered. EVERY array in Phase 3 had at least 5 or more Hitachi mechs. The small differences noted are due to the number of mechs or background rebuild activity occurring.

140MB/s x 384RBOD = 53.76GB/sec total degradation
Duct Tape and Sand bags and Heat

* The first known proper use of duct tape in history!
Many places to monitor heat and flow

• All disk drives have temperature sensors
• All trays have 2 sensors
• All other components have AT LEAST 2 sensors
• 100+ temperature monitoring points

• Most installations use one—the light on the front of the box
Tracking Average response time
OSS's that have individual LUNs 10% different than that particular OSS average

based on Average Read Response Time for that LUN

disc rebuild on s150 affected this lvol

These 3 LVOLs are 10% or more different in response time than their 2 LVOL partners in same OST pool. This deserves a little more investigation.
Tools developed to monitor-DDRT

Figure 60 Disk Drive Response Time by Volume Group Report—Summary Table
Workload in Pictures—clustered FS

128MB as IO burst
Drive are not failing!

- 57 drives in 342 days (49 weeks) = 1.16 drive failures per week

- 57 drive failures out of 23,040 drives
- .247% total disc failure in a year (not even 1%)

By the way, we just racked our 500th E5460 over in Bldg 451 on Tuesday. By the time we rack these next 7 RSSU's, we will have a total of 546 E-Series enclosures out here at LLNL.
The case for RAID6
Test-Everything

- Test code @ Hyperion
  - found a firmware issue, reboot avoided

- Test spares at site Hyperion
  - cold spares CANNOT be trusted
  - still have not used initial 100 spare drives
  - previous slide show where magic smoke escaped from component
Thank you