Latest Production Experiences with HP SFS

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Outline

- Description of SSCK’s 4 HP SFS systems
- Performance graphs
- HP SFS versus open source Lustre
- Configuration decisions for our new SFS system
- Some not fully solved problems
- Operational experiences
- Future plans
Itanium test system (xc0)

12 clients (Itanium)

Quadrics QSNet II Interconnect

<table>
<thead>
<tr>
<th></th>
<th>$HOME</th>
<th>$WORK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacity</td>
<td>0.5 TB</td>
<td>0.5 TB</td>
</tr>
<tr>
<td>Write performance</td>
<td>120 MB/s</td>
<td>120 MB/s</td>
</tr>
<tr>
<td>Read performance</td>
<td>190 MB/s</td>
<td>190 MB/s</td>
</tr>
</tbody>
</table>
Itanium production system (xc1)

120 clients (Itanium)

Quadrics QSNet II Interconnect

<table>
<thead>
<tr>
<th></th>
<th>$HOME</th>
<th>$WORK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacity</td>
<td>3.8 TB</td>
<td>7.6 TB</td>
</tr>
<tr>
<td>Write performance</td>
<td>220 MB/s</td>
<td>380 MB/s</td>
</tr>
<tr>
<td>Read performance</td>
<td>340 MB/s</td>
<td>580 MB/s</td>
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</tbody>
</table>

Notes:
- Performance is reduced by fragmentation
- Higher fragmentation of $WORK
Opteron test system (xc3)

12 clients (Opteron)

InfiniBand 4X DDR Interconnect

<table>
<thead>
<tr>
<th></th>
<th>$HOME</th>
<th>$WORK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacity</td>
<td>2 TB</td>
<td>4 TB</td>
</tr>
<tr>
<td>Write performance</td>
<td>90 MB/s</td>
<td>180 MB/s</td>
</tr>
<tr>
<td>Read performance</td>
<td>150 MB/s</td>
<td>300 MB/s</td>
</tr>
</tbody>
</table>

Notes:
- $HOME file system uses mirrored OST luns
- SFS20s use RAID ADG
Opteron production system (xc2)

760 clients (Opteron)

InfiniBand 4X DDR Interconnect

Notes:
- $HOME file system uses mirrored OST luns
- Preliminary results for $WORK: was only tested once

<table>
<thead>
<tr>
<th></th>
<th>$HOME</th>
<th>$WORK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacity</td>
<td>8 TB</td>
<td>48 TB</td>
</tr>
<tr>
<td>Write performance</td>
<td>360 MB/s</td>
<td>1850 MB/s</td>
</tr>
<tr>
<td>Read performance</td>
<td>600 MB/s</td>
<td>3000 MB/s</td>
</tr>
</tbody>
</table>
Applications with high I/O load:

- Computer algebra application
  - Could create output files in TB range
- Applications doing scratch I/O on each task
  - Capacity of local disk is not sufficient
- ABAQUS
HP SFS versus open source Lustre

» HP SFS
- Easy installation, configuration and upgrade
- Additional software for failover, management and client build
- Additional tests and patches to supply hardened Lustre version
- Very good support
- System health check, SFS log database and email alerts
- Performance monitoring
- Good documentation

» Open source Lustre
- Flexibility in choice of server and storage hardware
  • Hard job to find appropriate storage, good drivers and firmware levels
- Flexibility to use newest software versions
  • Possible impact on stability
- No license costs
Configuration decisions for our SFS system on xc2

» Default stripe size of 4
  - Wanted to have very good performance from a single node
    • I/O is often done from a single task of a large parallel job
  - Offers best load distribution on $HOME (4 OSTs)
  - Metadata performance with stripe size 1 is not much better

» Use RAID ADG (RAID6)
  - With huge storage capacity high risk to loose data with RAID5
  - Moderate performance reduction (10% for writes)
  - No capacity reduction with 250 GB disks and fully populated SFS20s

» On SFS20 use rebuild_priority=medium
  - Performance is much better during rebuild than with default
    • 26 MB/s versus 4 MB/s when using rebuild_priority=high
  - Rebuild time is not extensively higher than with default
    • 12 hours versus 5.5 hours when using rebuild_priority=high
Configuration decisions for SFS on xc2 (continued)

» Use OST lun mirroring for file system $HOME
  – Broken SFS20 controller would normally not hang up the file system
    • This is not true if service lun is located on the broken SFS20
  – Possibly break the mirror if the capacity is no longer sufficient
    • Solution without restoring the data is theoretically possible

» Distribute the MDS services of the 2 file systems
  – Load distribution to Admin and MDS node
  – Makes the file systems independent of each other
Some not fully solved problems

» Fragmentation reduced performance by 10 to 30%
  – Fix needs recreation of file systems
  – Risk is reduced on newer systems because of ext3 extents

» Many broken FC disks
  – Rate is much higher if I/O load on system is high
  – Number of broken disks was lower during last months

» SFS20 with service lun is single point of failure
  – Creates extreme load on Admin node and stops complete system
    • This problem is under investigation
  – Mirroring service luns would be a good enhancement
Operational experiences

» Only one complete outage during last 10 months
   - Both OSS crashed permanently
     • Started after broken EVA controller was repaired
     • Reason: LAST_ID was not incremented while objects were created
     • Fix needed file system check
     • Delete dumps if hidden file system /local is full

» Administrative challenge to identify critical errors
   - LustreError on client and server might indicate a critical issue
     • Lots of error messages which are not really critical
   - Use syscheck to check the system’s health

» New applications sometimes create new errors
   - E.g. MPI-IO test program causes lots of errors on clients
   - Some error messages appear when high load is created

» Collectl performance monitoring on client to identify critical users
Future plan for a central parallel file system

Infiniband Switch

Ethernet Switch

Campus network
Additional requirements for central parallel file system

» Version compatibility
  – Upgrade of all clients together with servers is not reasonable

» Reduced kernel and distribution dependency
  – Support for more kernels and distributions is required
  – Patchless client might help

» User level security
  – Need to export file systems with high performance to untrusted clients
  – Kerberos security should provide this feature
    • Was unfortunately delayed several times

» Server system upgrade while file systems are online
  – File systems should have no downtime
  – This could be possible by upgrading servers in failover mode
Summary

» Lustre provides a scalable and stable parallel file system

» HP SFS supplies additional features
  – which make it a real product

» Some non-default configuration settings could be useful

» Further experiences with HP SFS:
  – http://www.rz.uni-karlsruhe.de/dienste/lustretalks