Lustre* Troubleshooting

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Module Overview

Topics covered in this module include:

- Preventing data loss
- Types of Lustre* failures
- Data collection
- Troubleshooting Lustre* - Sample flowchart
- Resolving specific Lustre* issues

Preventing Data Loss
An ounce of prevention is worth a pound of cure

Preventing Data Loss

- Lustre* distributes data across multiple storage targets
- Storage targets constructed from arrays of many disks
- Disks occasionally fail - sectors, heads, firmware, etc.
- With many arrays, mean time between failure decreases
- Storage targets need redundancy and hot spares
- The Lustre* architecture protects against data loss very well
  - Keeping backups of critical files is recommended
- Lustre* does not protect against loss of disks or arrays

Lustre* Failures and Kernel Errors

Types of Lustre* Failures

Automatically recoverable failures

- Normal for distributed file systems with many components
- Lustre* clients and servers maintain file system consistency

Manually recoverable failures

- Loss of AC power
- Component failures without implementing any high availability

Unrecoverable failures

- Complete failure of a storage target, or a system administrator “goof”

Kernel Errors (1 of 3)

Lustre* runs (mostly) in the Linux kernel

Types of kernel errors

- Hard Panic (Aiee!)
- Soft Panic (Oops!)
- Linux Bug (BUG)
- Lustre* Bug (LBUG)

Next two slides will cover these kernel errors

Kernel Errors (2 of 3)

Hard Panic (Aiee!)

- Panic routine called: registers / stack trace on console – crash dump saved
- Capture console / note prior events for analysis / analyze dump
- Reboot node, run hardware diagnostics, put back into service...?

Soft Panic (Oops!)

- Kernel assertion failure, exception, etc.
- Thread killed / system not trusted / should reboot
  - Can force panic with /proc/sys/kernel/panic_on_oops
- Collect console and events data / reboot node / run diags

Kernel Errors (3 of 3)

Linux Bug (BUG)

- Pointer error, divide by zero, etc.
  - Should be caught in a subsequent OOPS
- Lockups
  - Soft lockup (no new tasks started)
  - Hard Lockup (no more interrupts happen, either)
  - Can trigger kernel panic - see doc "lockup-watchdogs.txt"

Lustre* Bug (LBUG)

- Panic-style assertion for the executing thread
- Thread is halted / reboot needed to remove halted thread
  - Thread / system untrusted, gather stack trace and reboot
  - Lustre* log file written to /tmp/lustre-log.{timestamp}
- Or, can force panic with /proc/sys/lnet/panic_on_lbug
  - Collect console data / reboot node / run diags

Data Collection

Items of Concern

If you suspect a Lustre* error, examining the recent kernel logs is a great start in trying to identify a Lustre* issue

Clients

- Lustre*, Applications, Client Hardware, ...

Servers

- Lustre*, Attached Storage, Server Hardware, ...

Networks

- Fabric Manager, Connectors, Cabling, Switches, ...

Some Places to Check

Network Management System (NMS)

- Intel® Manager for Lustre* software, etc.

Consoles

- Servers, Switches, Fabric Manager, ...

Logs *(see additional information in the Elite - Lustre* Debugging Module)*

- Servers, Clients, Switches, ...

Kernel (ring) Buffers *(see additional information in the Elite - Lustre* Debugging Module)*

- Lustre* Servers and Clients

Data Collection

Intel® Manager for Lustre* software - or other NMS

- Intel® Manager for Lustre* software troubleshooting covered in the next module

Simple tools and scripts for system status

- Use pdsh/dshbak to parallelize data collection
  - Start with something simple (clientdf.sh), then expand upon it
  - Then create another script for another check, and another
  - Soon, you will have a set of powerful, easy to use tools

Easy Checks via Scripting

Lustre* provides a *high-level* health status

/proc/fs/lustre/health_check

Should contain the text "healthy" - anything else is bad

"pdsh it" across all the Lustre* nodes

pdsh -g allnodes "lctl get_param health_check" | dshbak -c

Should return "healthy" for all nodes

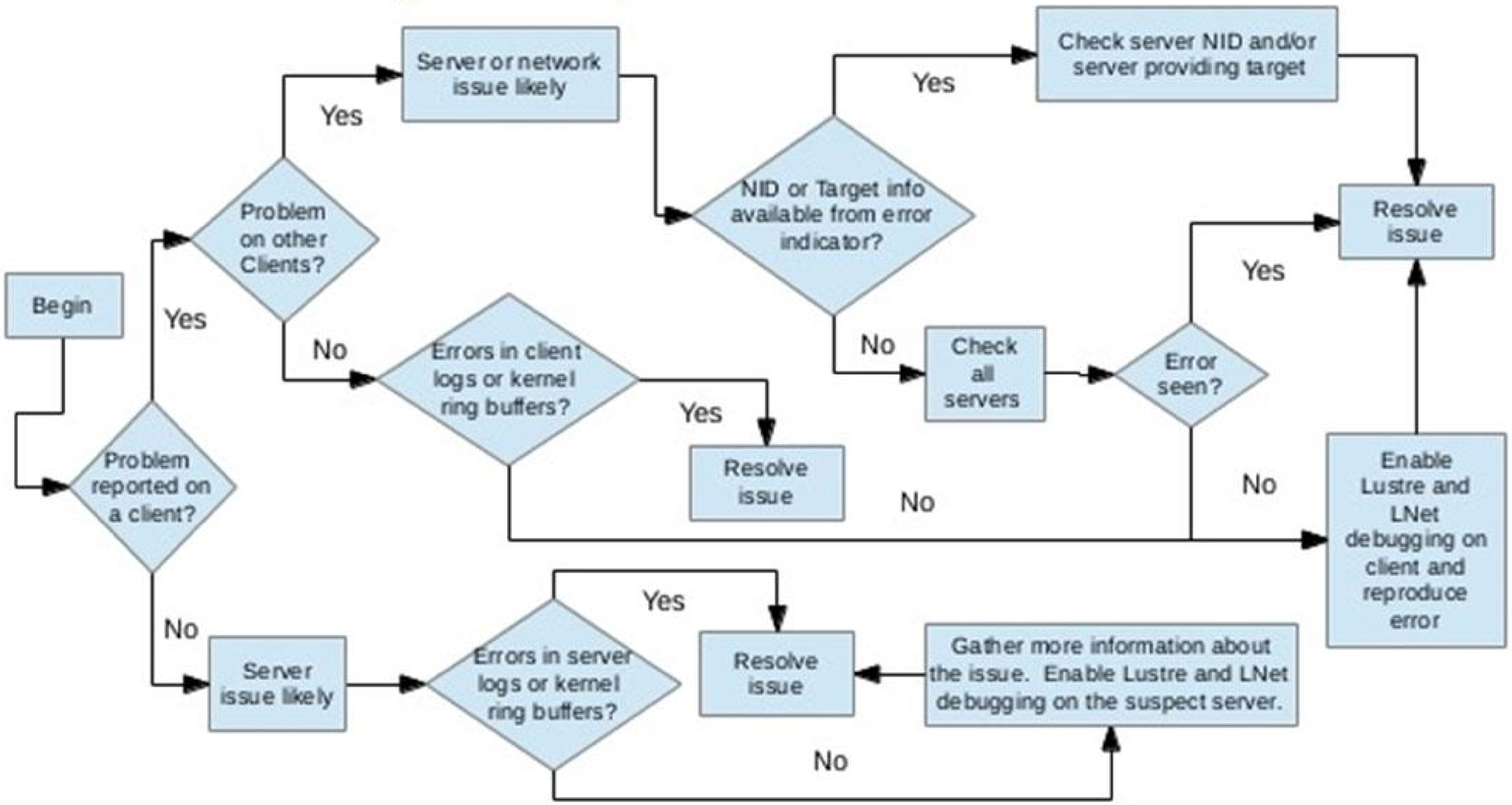
Other easy checks to "pdsh" include

lfs check servers

lctl dl (print device list - all should show UP)

Troubleshooting Lustre* - Sample Flowchart

Troubleshooting Example



Resolving Specific Lustre* Issues

OST Troubleshooting

Deactivating an OST (no new creates)

- A use case is where the OST starts to get too full

Disabling an OST (remove from service)

- A use case is that an entire OST has failed

Marking an OST as degraded (performance)

- A use case is where the RAID set is rebuilding

Deactivating an OST

When to deactivate an OST

- When the OST is in danger of reaching full capacity

Deactivate the OST on the MDS

- Determine the device number of the OST to be deactivated

```
mds# lctl dl | grep " osc "
22 UP osc bleefs-OST0000-osc-ffff8800384efc00 <UUID> 5
23 UP osc bleefs-OST0001-osc-ffff8800384efc00 <UUID> 5
24 UP osc bleefs-OST0002-osc-ffff8800384efc00 <UUID> 5
```

- Deactivate OST0001 via its device number

```
mds# lctl --device 23 deactivate
```

- If OST is still serviceable, do not deactivate on clients
  - This allows reads and writes from a deactivated OST to continue

Verify the correct OST is inactive (IN)

```
mds# lctl dl | grep " osc "
22 UP osc bleefs-OST0000-osc-ffff8800384efc00 <UUID> 5
23 IN osc bleefs-OST0001-osc-ffff8800384efc00 <UUID> 5
24 UP osc bleefs-OST0002-osc-ffff8800384efc00 <UUID> 5
```

Disabling an OST

Used when an OST is completely unavailable

- e.g: fatal RAID controller failure, or server permanently decommissioned

Needs to be disabled on both the MDS and clients:

```
# lctl conf_param osc.<fsname>-<OST name>-*.active=0
```

For example: `# lctl conf_param osc.bleefs-OST0001-*.active=0`

Reads/writes to that OST will fail with I/O error

To enable the OST again:

- Make sure the OST is restored and running

Then run the command: `mds# lctl conf_param osc.bleefs-OST0001-*.active=1`

After enabled, OST will move into recovery

- And after recovery the reads/writes to the OST resume

Marking an OST Degraded

Marking an OST as degraded does not stop IO, but rather it is a hint to the MDS to not allocate new files on that particular OST

On the OSS, write a non-zero value:

```
oss# lctl set_param obdfilter.bleefs-OST0000.degraded=1
oss# lctl get_param –n obdfilter.bleefs-OST0000.degraded=1
```

MDS *is informed* by the OSS that an OST is degraded

- OST is avoided, if possible, in new object allocation
- Helps to prevent global slow-down of file system
- Striping policy may still override
- Should be combined with monitoring of the health of the array

Return to normal by writing zero to the *degraded* file. Flag is reset to zero by a remount of the OST

OST Imbalances - Effect of Full OST

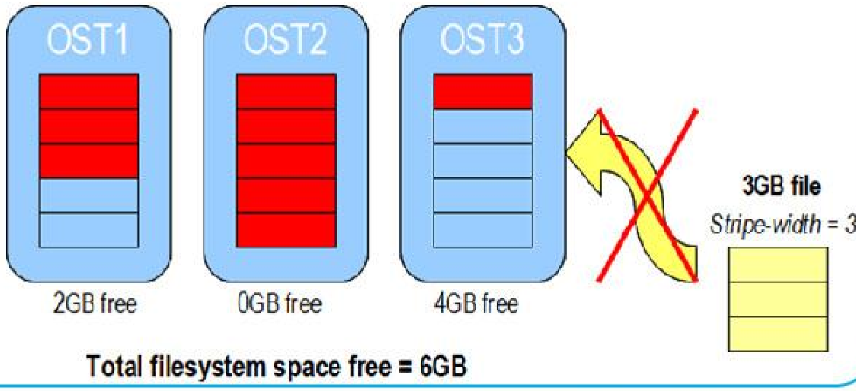
OST Imbalances: OSTs that have a high percentage of utilization – meaning, the amount of free space on the storage target is low

It is fine to have a significant amount of deviation when the capacity utilization for each OST is low, but not so much when the utilization is high

Lustre* attempts to maintain OST balance

If striping policy causes a write to a full OST:

- Application will receive out-of-space error (ENOSPC)
- Even if other OSTs have free space available



OST Imbalances - Query OST Capacity Utilization

Linux *df* reports aggregated utilization

Lustre* *lfs df* reports aggregated and individual target utilization

```
# lfs df
UUID                 1K-blocks       Used   Available Use% Mounted on
bleefs-MDT0000_UUID     786256      35796      698032   5% /lustre[MDT:0]
bleefs-OST0000_UUID   10446648     549016     9373280   6% /lustre[OST:0]
filesystem summary:   10446648     549016     9373280   6% lustre
```

```
# lfs df -i
UUID                    Inodes      IUsed       IFree IUse% Mounted on
bleefs-MDT0000_UUID     524288         24      524264   0% /lustre[MDT:0]
bleefs-OST0000_UUID     153600         88      153512   0% /lustre[OST:0]
filesystem summary:     524288         24      524264   0% /lustre
```

```
# lfs df -h (human readable format)
```

OST Imbalances - Automated Rebalancing

Disks are fastest when they are empty!

MDS has two (2) algorithms for object allocation

- Round Robin (RR)
  - Allocates objects ***equally*** across OSTs
- Quality of Service (QOS)
  - Uses ***weighted free space*** for allocation decisions

Only one of the algorithms is used for each new file

QOS tunables are configurable on the MDS

- Use “lctl get_param” and “lctl set_param” to fetch and set parameters
  - lov.*.qos_threshold_rr is free space skew between OSTs for QOS
  - lov.*.qos_prio_free is weighting given to balance space vs. performance

File Allocation Algorithms – Round Robin

Round Robin (RR)

- Is the **faster** algorithm of the two
- Allocates objects sequentially across all the available OSTs
- Object allocation example using different stripe counts
  - File 1: OST0, OST1, OST2
  - File 2: OST3, OST4, OST5, OST6
  - File 3: OST7, OST0, OST1, OST2, OST3, OST4, OST5
  - File 4: OST6, OST7, OST0, OST1, OST2

Note: The MDS does NOT order OSTs by their index number as shown above. Also, the ordered list is not a static list, as it changes over time

RR always used when OST's are "equally full"

- "Equally full" is defined by the value in:
  /proc/fs/lustre/lov/*/qos_threshold_rr (default value is 17%)
- Meaning: If OST % available space differs by less than 17%, RR is used

File Allocation Algorithms – Quality of Service

- Always used when OST's are not "equally full"
  - OST % available space differs by qos_threshold_rr or more
- OST's are sorted by capacity utilization
- Allocation of objects is based on the sorted list
  - QOS uses a **weighted** free space algorithm
  - % utilization, as well as other factors
- May, but more likely may not, allocate objects equally across OSTs
  - Meaning, some OSTs may get more than one object, while others may get no objects
- Allocation of objects to OST's is impacted by this variable

  /proc/fs/lustre/lov/*/qos_prio_free (default value is 91%)
    - 0 means each OST is allocated once (priority for balance)
    - 100 means OSTs are selected proportional to % utilization
  - Less full OSTs are more likely to be selected more than once

Rebalancing OSTs Manually

Use *lfs_migrate* script to re-balance OSTs

- Simple process

```
Client# lfs_migrate  /lustre              <— Entire file system
Client# lfs_migrate /lustre/bigfiles <— Subset of the file system
```

- What happens in the lfs_migrate process
  - Objects "move" AWAY from more full OSTs, and TO less full OSTs
    - While the Lustre* file reference stays in the same directory
    - Keeps the same stripe count, stripe size, etc.
  - Objects are redistributed by
    - Creating new objects on different OSTs
    - Deleting the old objects
    - Before the deletion of the old objects, a "file" verification takes place
  - In short: Copy, checksum, delete old, rename new

Rebalancing OSTs Manually - Examples

These examples demonstrate how to use *lfs_migrate* to move objects away from full OSTs, as well as to move objects to new or lesser filled OSTs

Example 1: Migrate objects away from OSTs

OST000[2,4] are too full from files from last 2 days

```
$ lfs find /myth -type f -mtime -2 -size +2G \
    --ost myth-OST0002 --ost myth-OST0004 | lfs_migrate -y
```

Example 2: Migrate objects to OSTs

OST000[5,6] are newly added (empty) OSTs

- Move files TO the empty OST's
  - Argument (!) means find files not on the named OSTs

```
$ lfs find /myth -mtime +90 -size +20G -name "*.iso" \
    ! --ost myth-OST0005 ! --ost myth-OST0006 | lfs_migrate -y
```

Storage Target(s) Not in Service

Lustre* uses ldiskfs and ZFS* as storage target (backing) file systems

- Services associated with targets cannot start without the target mounted
- Services unable to start if backing file system corrupted

Causes

- Hard shutdown, hardware failure or errors, operational errors, etc.

Options

- Debugging the storage target(s)
- Run a file system check (e2fsck) to repair the ldiskfs targets
- Perform a “writeconf” to clear and regenerate the targets’ config logs
- Restore from backup and reintegrate restored target(s) into the file system

Storage Target(s) Not in Service - Debugging

Start by debugging the problem

- Attempt to mount the target in service mode
  - Monitor client output as well as syslog/console output on the server
- Attempt to mount the target in non-service mode
  - Pass the "-i nosvc" option to the mount command
    - Mount occurs but Lustre* services do not start
  - If the nosvc mount fails, run e2fsck in "non-fixing mode" (-n arg)
- If e2fsck finds errors, a full e2fsck should be executed
  - Covered later

Storage Target(s) Not in Service - Writeconf (1 of 2)

If the configuration logs get corrupted; a Lustre* writeconf can help get those logs back into a functional state

Performing a writeconf

- Erases the system configuration logs on all targets
- Forces the regeneration of the configuration logs on mount
- MGS gets a new copy of the file system information

Uses

- Recover from catastrophic damage to existing config logs
- Changing a server NID
- Mount an OST on an OSS that is not a designated failnode

Concerns

- File system must be down (all clients and servers un-mounted)
- Erases all pool definitions and changes made with conf_param
  - Keep pool definitions and conf_param settings in a script!

Storage Target(s) Not in Service - Writeconf (2 of 2)

All Lustre* services must be stopped

- Ensure that all clients and all management, metadata, and object storage targets are unmounted
- Ensure that failover software is stopped (if in use)
- Ensure Lustre* backing file systems are healthy
  - mgs# tunefs.lustre --writeconf <MGT disk device>
  - mds# tunefs.lustre --writeconf <MDT disk device>
  - oss# tunefs.lustre --writeconf <OST disk device>

Restart Lustre* in the following order:

- MGS, MDT, OSTs, and then mount all clients

Storage Target(s) Not in Service - LFSCK (1 of 2)

- Most serious of the options - not a Linux fsck
- Use when file system corruption exists
  - Dangling inode – inode exists but missing object on OST
  - Orphaned objects – OST has object but no MDT inode
  - Corrupted MDT – multiple inodes reference objects
- Use after MDT is restored / out of sync with OSTs
- Should be run on a quiesced file system
  - Fastest if run on an idle system
- Time to run depends on size of file system
  - Can take a very long time on a large file system
- Rarely necessary to run Lustre* *fsck*
  - Lustre* can work fine without it
- Run in a *script* session to save the output

Storage Target(s) Not in Service - LFSCK (2 of 2)

The Lustre* fsck (lfsck) process has several steps:

- For all targets, run the Lustre* "e2fsck -f" to fix any problems with the underlying file system
- On the MDS:
  - Create a database of the MDS inodes - MDS DB
  - Run e2fsck in non-fixing mode (-n) – create an MDS DB using the mdsdb option
  - Make the MDS DB (a file) available on all the OSS's
- For every OST:
  - Run e2fsck in non-fixing mode (-n) – create a OST DB using the ostdb option
- Mount all targets as type Lustre*
- Mount the Lustre* file system on any client or MDS
- Run the Lustre* *lfsck* from the node where the Lustre* file system is mounted
  - Lustre*'s *lfsck* uses the mdsdb and ostdb's to resolve corruption

Summary

Summary

Preventing data loss

Types of Lustre* failures

Data collection

Troubleshooting Lustre* - Sample flowchart

Resolving specific Lustre* issues

Congratulations! You have completed:

Lustre* Troubleshooting