Karlsruhe Institute of Technology

Lustre tools for ldiskfs investigation and lightweight I/O statistics

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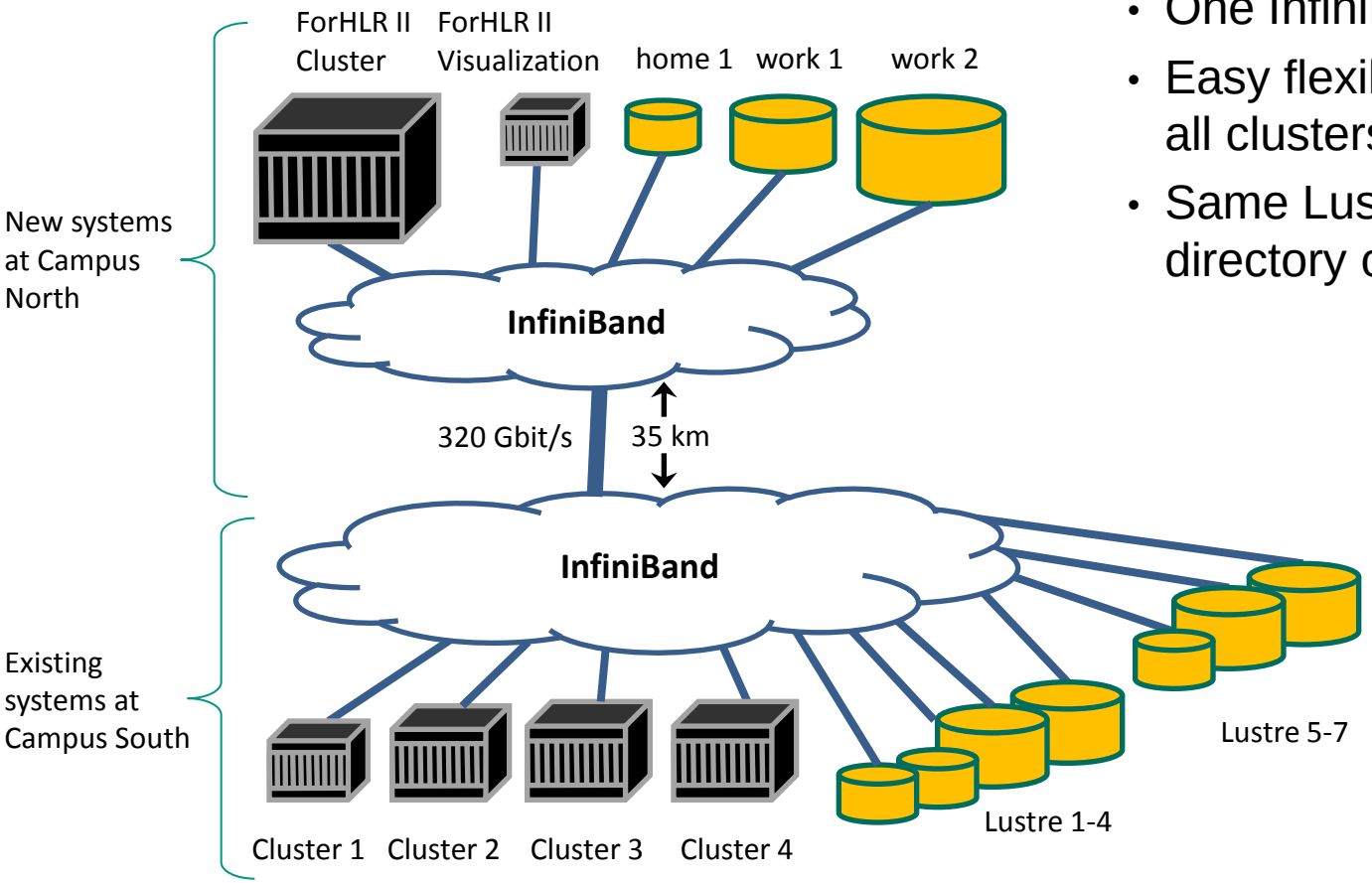
Overview

- Lustre systems at KIT
  - Short preview on our next Lustre system
- Lessons learned from wrong quota investigation
  - Developed tools for ldiskfs investigation
- How to easily provide I/O statitics to users
  - Developed tools for lightweight Lustre jobstats usage

Lustre systems at KIT - diagram



- One InfiniBand fabric
- Easy flexible mount on all clusters
- Same Lustre home directory on all clusters

Lustre systems at KIT - details

System name	pfs2	pfs3	pfs4 (Dec 15)
Users	universities, 4 clusters	universities, tier 2 cluster (phase 1)	universities, tier 2 cluster (phase 2)
Lustre server version	DDN Lustre 2.4.3	DDN based on IEEL 2.2	DDN based on IEEL 2.x
# of clients	1941	540	1200
# of servers	21	17	23
# of file systems	4	3	3
# of OSTs	2*20, 2*40	1*20, 2*40	1*14, 1*28, 1*70
Capacity (TB)	2*427, 2*853	1*427, 2*853	1*610, 1*1220, 1*3050
Throughput (GB/s)	2*8, 2*16	1*8, 2*16	1*10, 1*20, 1*50
Storage hardware	DDN SFA12K	DDN SFA12K	DDN ES7K
# of enclosures	20	20	16
# of disks	1200	1000	1120

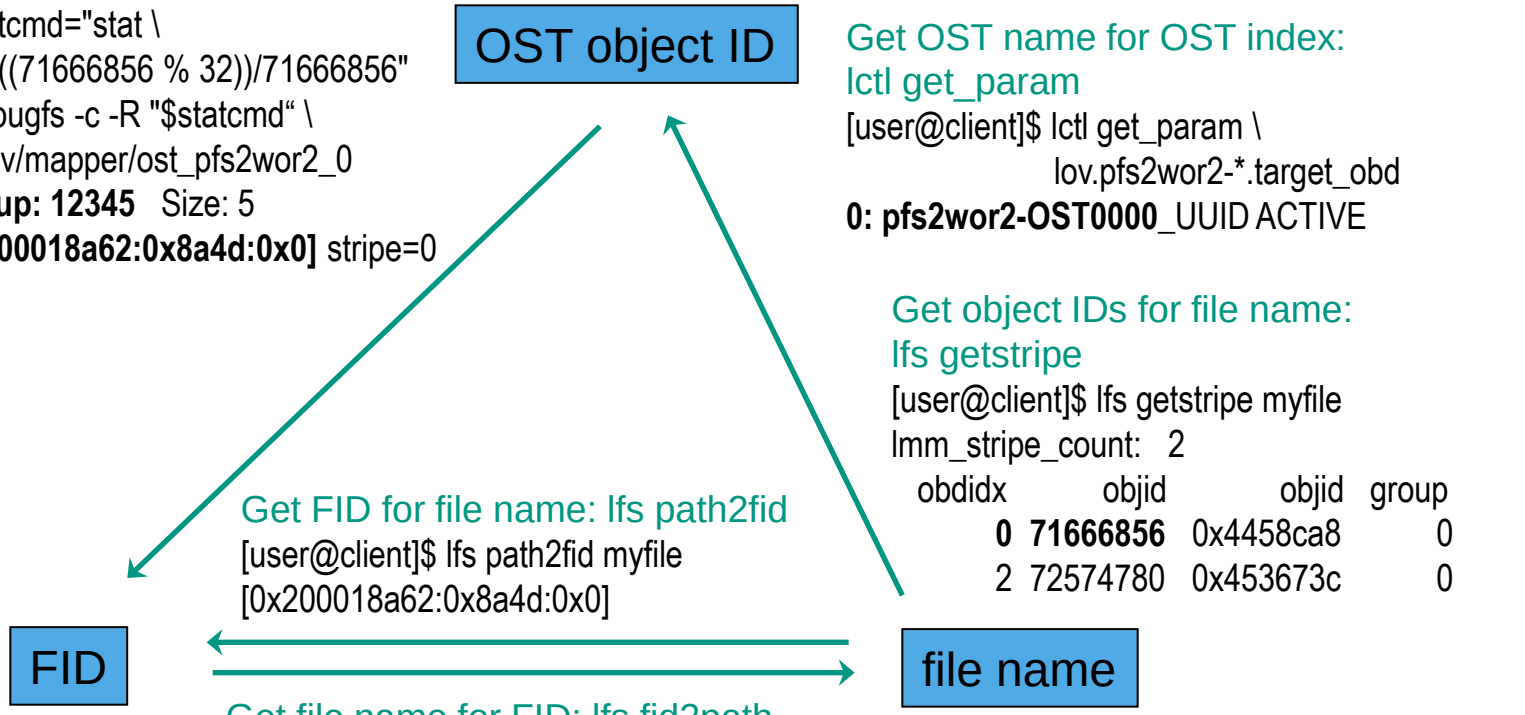
Wrong quota investigation - general

- How we recognized that quotas are wrong
  1. Difference between du –hs <user dir> and lfs quota –u <user> <filesys>
  2. Perl script sums all user and group quotas per OST
     - Used /proc/fs/lustre/osd-ldiskfs/<ost>/quota_slave/acct_user & acct_group
     - Should be very similar but showed few per cent deviation
  3. Perl script walks through file system, sums capacities and compares with quotas
     - User / group capacity quotas were up to 30 % wrong
- Support pointed to LU-4345 (http://review.whamcloud.com/11435)
  - UID / GID of OST object could be set to random value on ldiskfs
  - Capacity quotas are computed from ldiskfs quotas on OSTs
  - Bug fixed with Lustre 2.5.3 but wrong UID / GID values do not disappear
  - Wrong UID / GID of OST object possibly fixed with LFSCK of Lustre 2.6

Wrong quota investigation - basics

Get parent FID and UID/GID of OST object: debugfs stat

```
[root@OST0]# statcmd="stat \
            /O/0/d$((71666856 % 32))/71666856"
[root@OST0]# debugfs -c -R "$statcmd“ \
                /dev/mapper/ost_pfs2wor2_0
User:  8972   Group: 12345   Size: 5
 fid: parent=[0x200018a62:0x8a4d:0x0] stripe=0
```



Get OST name for OST index: lctl get_param

```
[user@client]$ lctl get_param \
            lov.pfs2wor2-*.target_obd
0: pfs2wor2-OST0000_UUID ACTIVE
```

Get object IDs for file name: lfs getstripe

```
[user@client]$ lfs getstripe myfile
lmm_stripe_count:   2
  obdidx        objid        objid   group
       0     71666856     0x4458ca8       0
       2     72574780     0x453673c       0
```

Get FID for file name: lfs path2fid

```
[user@client]$ lfs path2fid myfile
[0x200018a62:0x8a4d:0x0]
```

Get file name for FID: lfs fid2path

```
[root@client]# lfs fid2path pfs2wor2 \
            [0x200018a62:0x8a4d:0x0]
<path_to_myfile>/myfile
```

Get UID/GID for file name: stat

```
[user@client]$ stat --format="%u %g" myfile
8972 12345
```

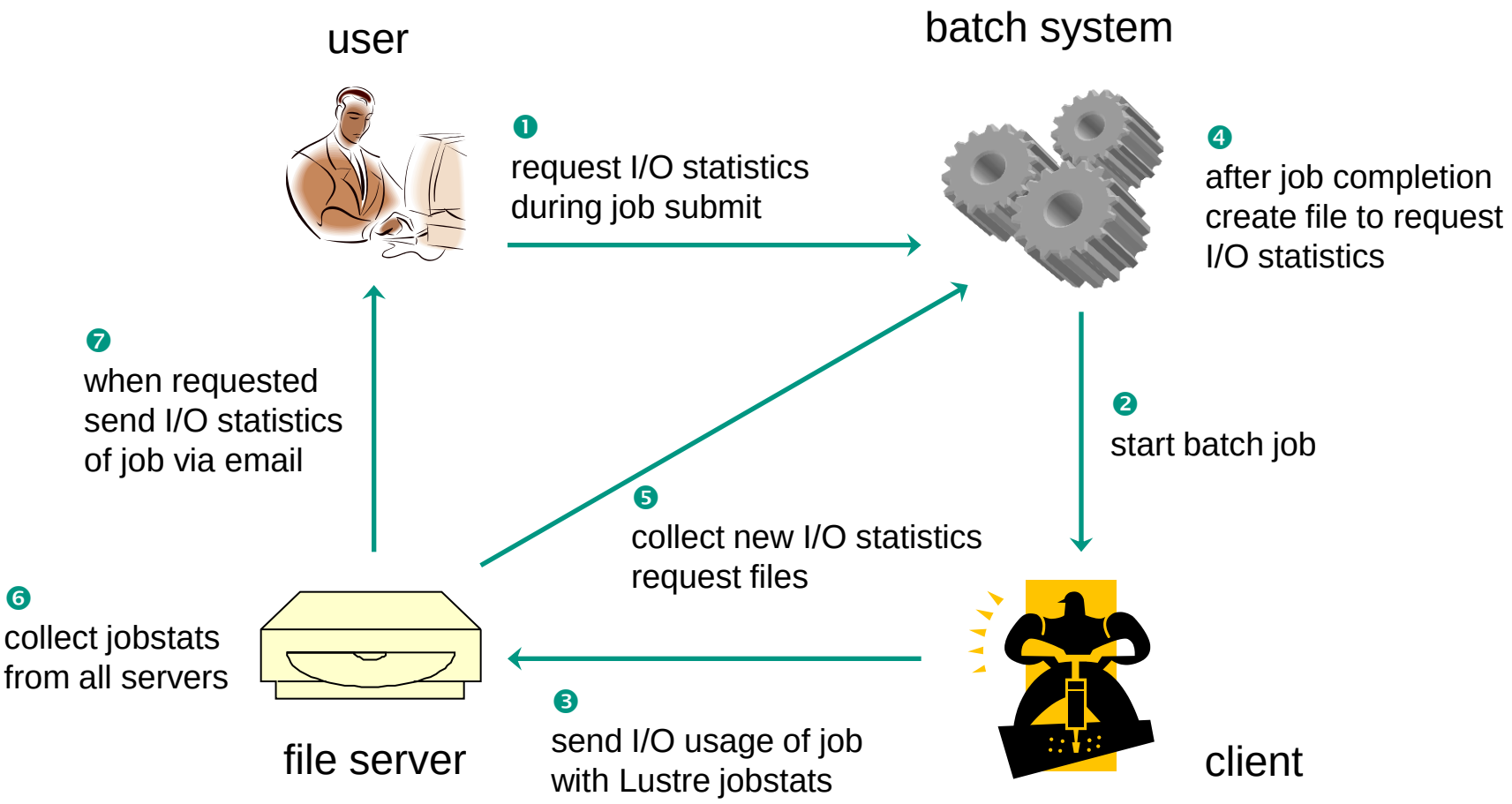
Wrong quota investigation – details (1)

- Motivation
  - Check if bug of LU-4345 caused all quota problems
- Idea
  - During production, use debugfs to stat all OST objects
    - compare UID / GID with values on file system (MDS)
  - Get biggest object ID:
    - debugfs -c -R "dump /O/0/LAST_ID /tmp/LAST_ID" <OST device>
    - od -Ax -td8 /tmp/LAST_ID
  - Show object status on ldiskfs:
    - debugfs -c -R "stat /O/0/d$<object ID modulo 32>/<object ID>" <OST device>
- Problem
  - How to do this fast enough?

Wrong quota investigation – details (2)

- Solution
  - Perl script pipes many stat commands to same debugfs call
    - Number of commands and when to restart debugfs configurable
  - Use another perl script to filter output
    - If object belongs to inspected user print object ID and parent FID
    - OR: Check if UID and GID is inside valid range
- Results
  - Investigated only one OST
    - Investigation is still time consuming i.e. can take days
  - Indeed found lots of objects with wrong UID / GID
  - Found a number of orphaned OST objects
    - Unknown reason why they still existed
  - Used procedure also helpful for other investigations

Lightweight I/O statistics - diagram



Lightweight I/O statistics – steps in detail (1)

1) Enable jobstats for all file systems
   - on clients: lctl set_param jobid_var=SLURM_JOB_ID
     - Make sure clients have fix of LU-5179
     - Slurm job IDs are used by Lustre to collect I/O stats
   - On servers increase time for holding jobstats
     - E.g. to 1 hour: lctl set_param *.*.job_cleanup_interval=3600
2) User requests I/O statistics with Moab msub options:
   - -W lustrestats:<file system name>[,<file system name>]...
   - Optionally: -M <email address>
3) On job completion Moab creates files to request I/O stats
   - File name: lustrestat-<file system name>-<cluster name>-<job ID>
   - File content: account name and optionally email address

Lightweight I/O statistics – steps in detail (2)

4) Perl script runs hourly on each file system
   - Uses different config file for each file system
     - Defines names of request files and of batch system servers
       - Allows to collect request files from different clusters
     - Defines which servers are used for the file system
   - Transfers files from batch systems and deletes remote files
     - Uses rsync and rrsync as restricted ssh command for login with key
   - Reads data including job IDs and account name
     - If not specified asks directory service to get email address of account
   - Collects and summarizes jobstats from all servers
   - For each job sends an email
     - Email is good since jobstats are collected asynchronously

Lightweight I/O statistics – example email

Subject: Lustre stats of your job 1141 on cluster xyz

Hello,

this is the Lustre IO statistics as requested by user john_doe
on cluster xyz for file system home.

Job 1141 has done ...
... 1 open operations.
... 1 close operations.
... 1 punch operations.
... 1 setattr operations.
... 10 write operations and sum of 10,485,760 byte writes (min IO size: 1048576, max IO size: 1048576).

Lightweight I/O statistics – experiences

- Users do not care much about their I/O usage
  - Tool was not yet frequently used
- No negative impact of jobstats activation
  - Running since 6 weeks
- Another perl script checks high I/O usage per job
  - Collects and summarizes jobstats from all servers
  - Reports job IDs over high water mark for read/write or metadata operations
  - Extremely useful to identify bad file system usage

Summary

- Currently our main Lustre problems are related to quotas
  - Tools helped to analyze on the ldiskfs level
  - New LFSCK features will hopefully fix wrong quotas
  - Quotas on directory tree would be very helpful
- Lustre jobstats are extremely useful
  - Not available with other file systems
  - It‘s incredible what users are doing
- All my talks about Lustre
  - http://www.scc.kit.edu/produkte/lustre.php
- roland.laifer@kit.edu