Metadata Benchmarks and MD Performance Metrics @ LUG 2014

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OpenBenchmark Metadata Performance Evaluation Effort (MPEE) Team

- Leader: Sorin Faibish - EMC
- Members:
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  - Richard Roloff - Cray
  - Cheng Shao, Wang Yibin - Xyratex
  - Keith Mannthey, Bobbie Lind – Intel
  - Gregory Farnum - Inktank

Metadata Performance Evaluation Effort Charter

- Build/select tools that will allow evaluation of File System Metadata performance and scalability
- The tools will help detect pockets of Metadata low performance in cases when users complain of extreme slowness of MD operations
- Benchmark tools will support: POSIX, MPI, and Transactional operations (for CEPH and DAOS)
- Address the very high end HPC as well as small and medium installations benchmark needs
- Tools applicable to Lustre and: CEPH, GPFS…

MPEE Proposed Tools

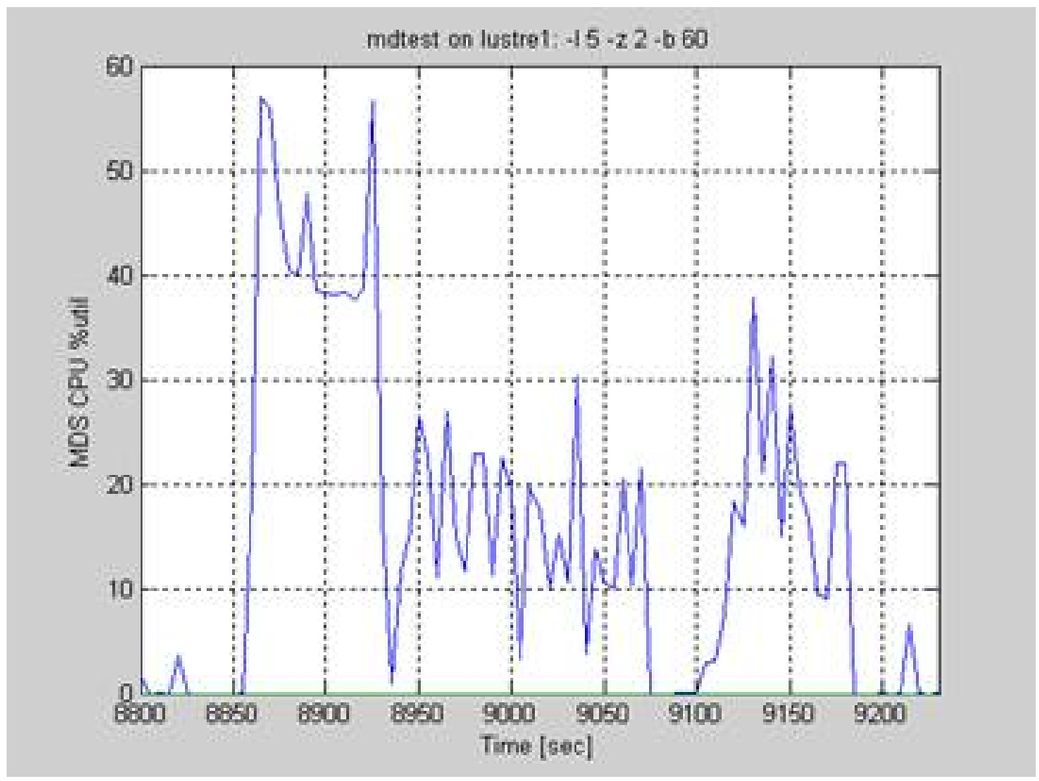
- The current proposed list of benchmarks:
  - **mdtest** – widely used in HPC
  - fstest - used by pvfs/OrangeFS community
  - **Postmark** and MPI version - old NetApp benchmark
  - **Netmist** and MPI version – used by SPECsfs
  - Synthetic tools – used by LANL, ORNL
  - **MDS-Survey** - Intel's metadata workload simulator.
  - Any known open source metadata tools used in HPC
  - Add new Lustre statistics specific to MD operations.

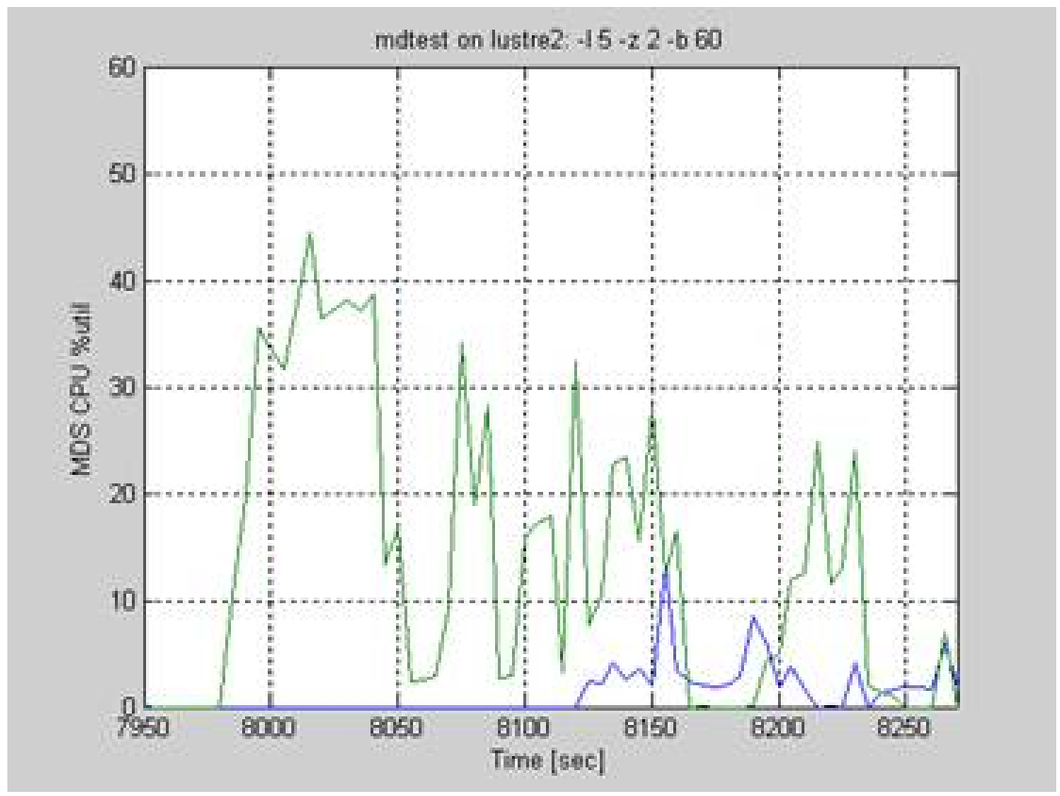
Testbed

- 2 Lustre FS with different characteristics:
  - ✓ Lustre1 using SAS based MDS (4+1) server and disk OST(6x(8+2) SATA
  - ✓ Lustre2 using 400GB SSD devices and SSD MDT/OST
- Monitored just block storage utilization using iostat
  - ✓ Monitored both MDT and OST
- We used mpi based benchmarks: mdtest, postmark, netmist
- Focus on characterization of storage load of MDT and OST for metadata intensive benchmarks.
- New Lustre specific statistic tools?

Mdtest benchmark Low Load

•# mpirun -np 32 -hostfile hostfile /lab/mdtest-1.9.1/mdtest -I 5 -z 2 -b 60 -u -w 1 -d /mnt/lustre1

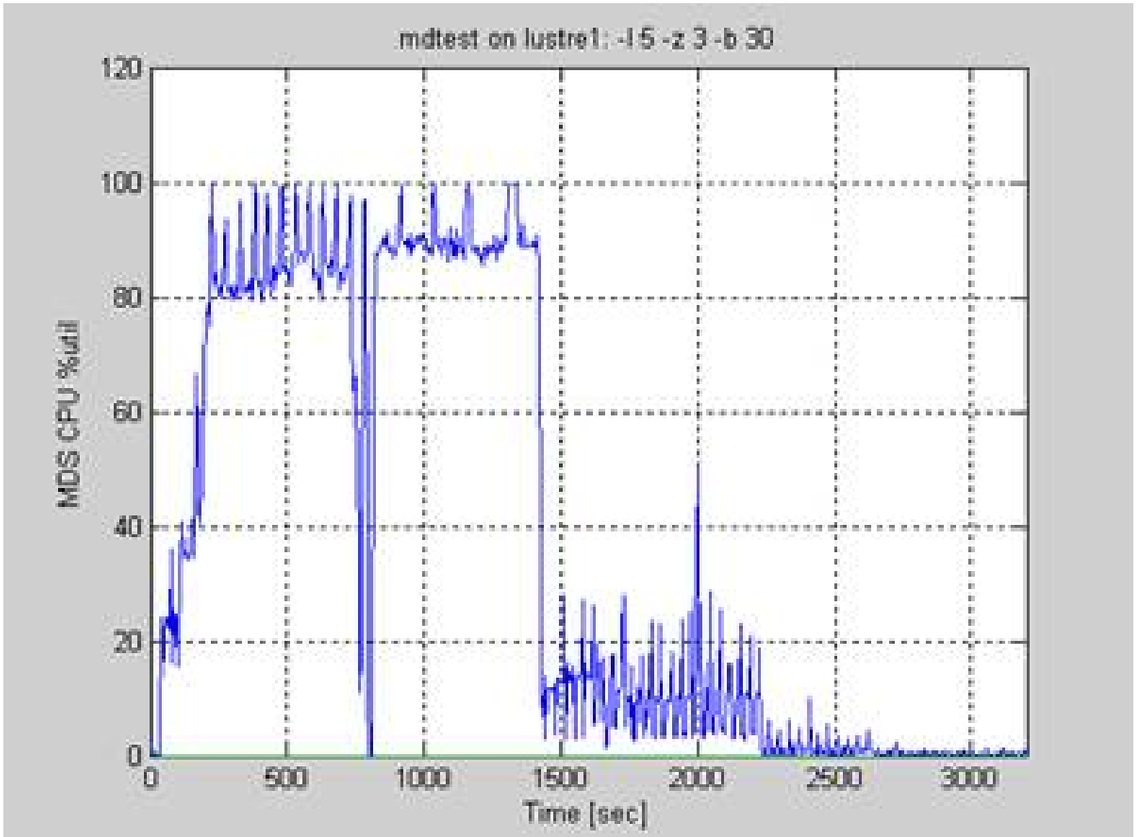


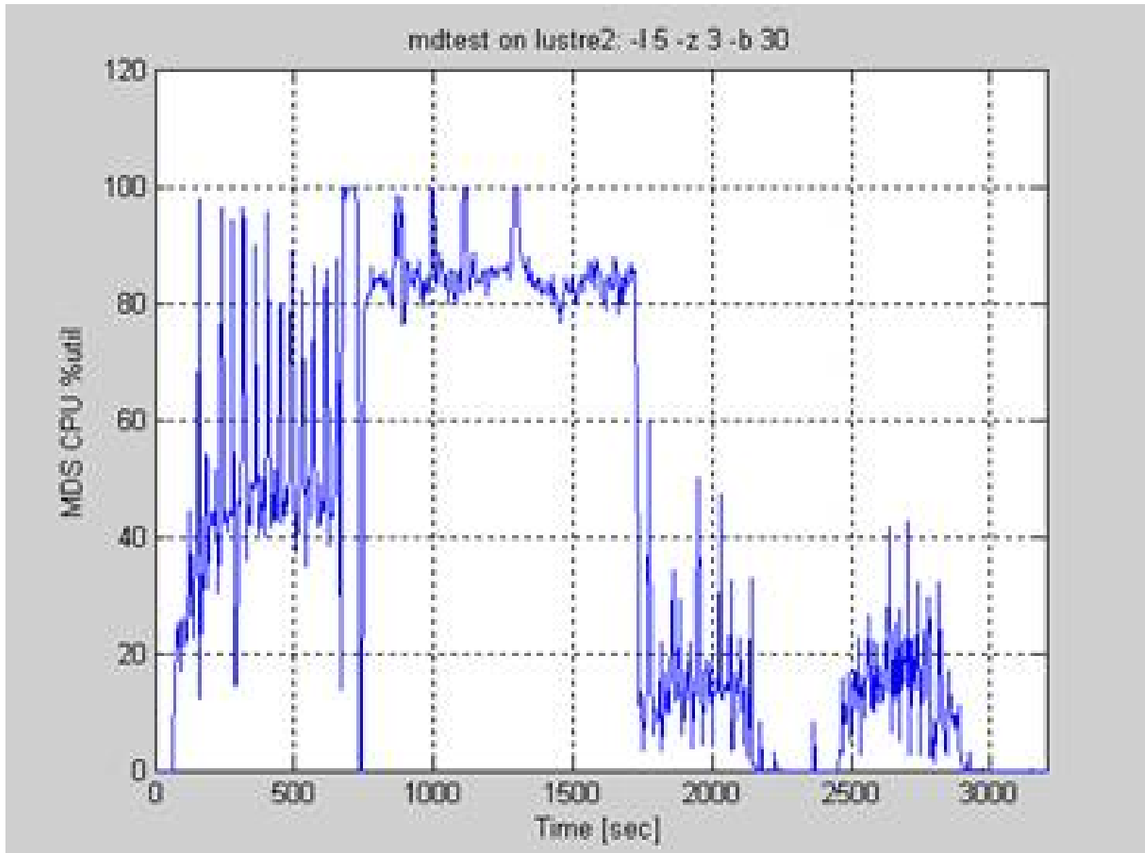


		Directory creation	Directory stat	Directory removal	File creation	File stat	File read	File removal	Tree creation	Tree removal
585760	lustre1	9206	136182	8291	9270	48415	23881	9877	319	277
585760	lustre2	10615	119646	9271	12253	91307	21311	15255	461	336

Mdtest benchmark results high load

•# mpirun -np 32 -hostfile hostfile /root/mdtest-1.9.1/mdtest -I 5 -z 3 -b 30 -u -w 1 -d /mnt/lustre2/





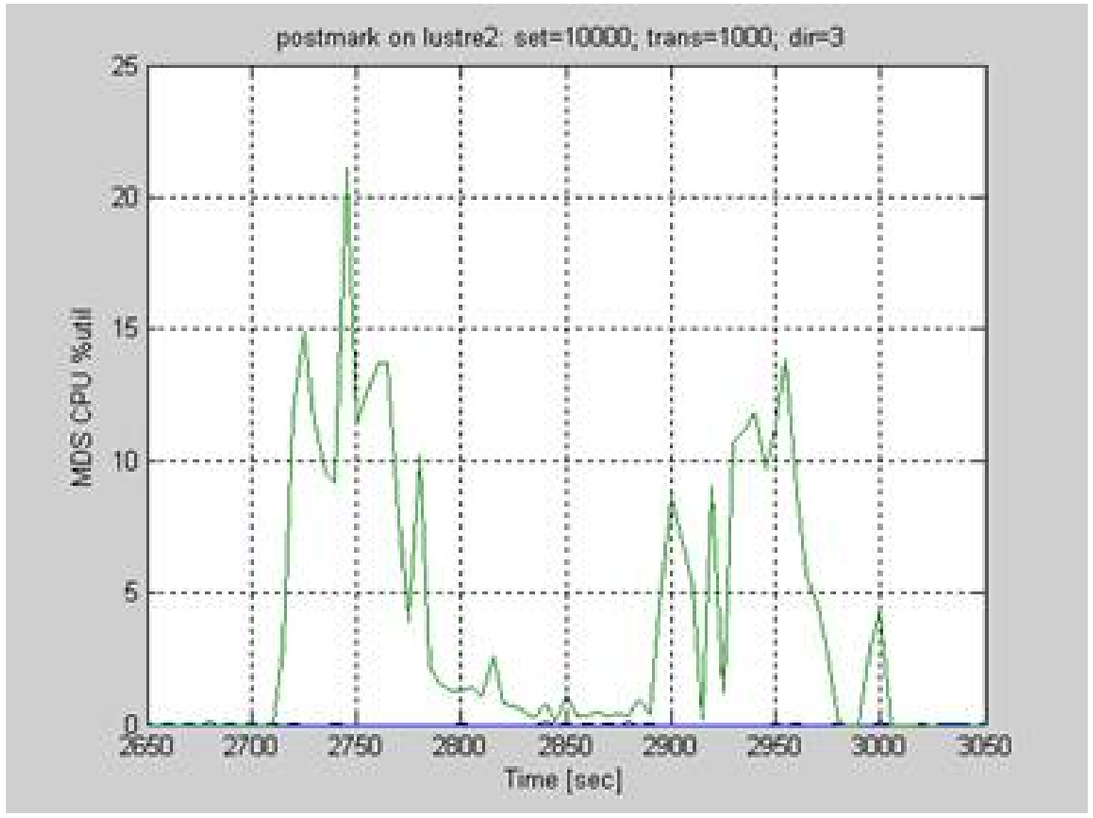
		Directory creation	Directory stat	Directory removal	File creation	File stat	File read	File removal	Tree creation	Tree removal
4468960	lustre1	6960	69041	4020	8091	31136	22331	8169	287	261
4468960	lustre2	8025	60658	4495	10694	58720	19928	12617	415	317

Postmark mpi benchmark

mpirun -np 32 -hostfile hostfile /root/mpipostmark-1.5.1/postmark pmtest

Pmtest file:

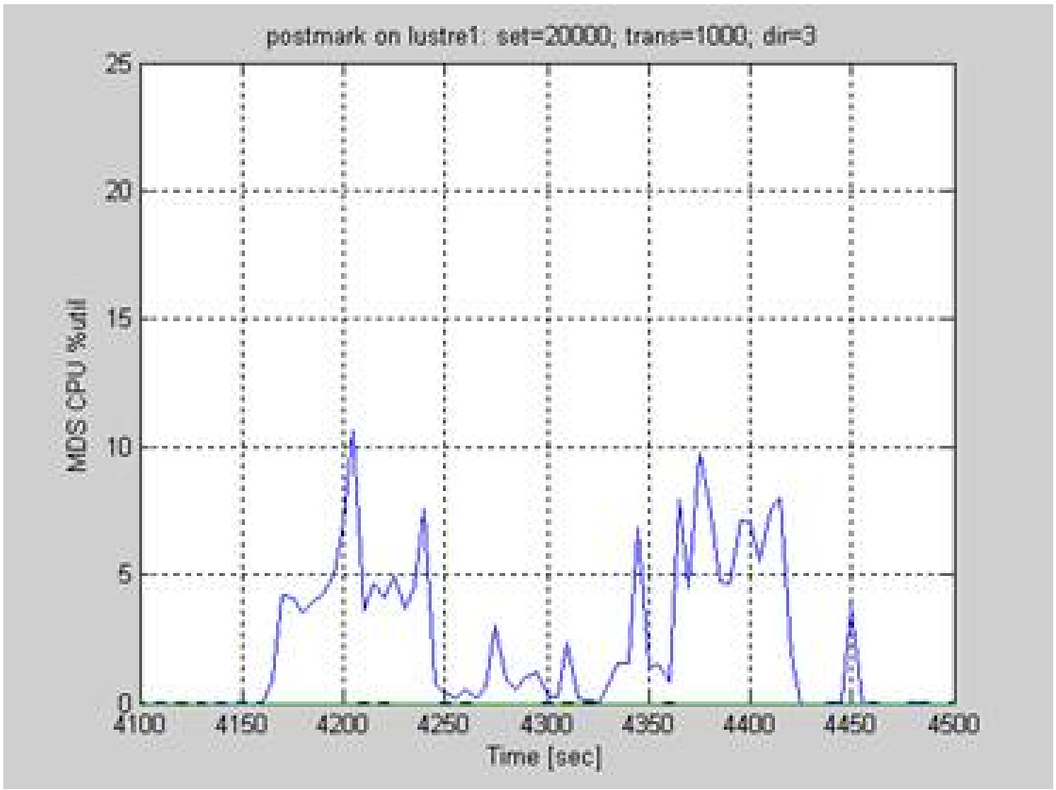
```
set location /mnt/lustre1
set number 10000
set transactions 1000
set subdirectories 3
set size 32768 400000
set bias read 16384
set write 16384
set partition prefix
set report cluster
run
quit
```

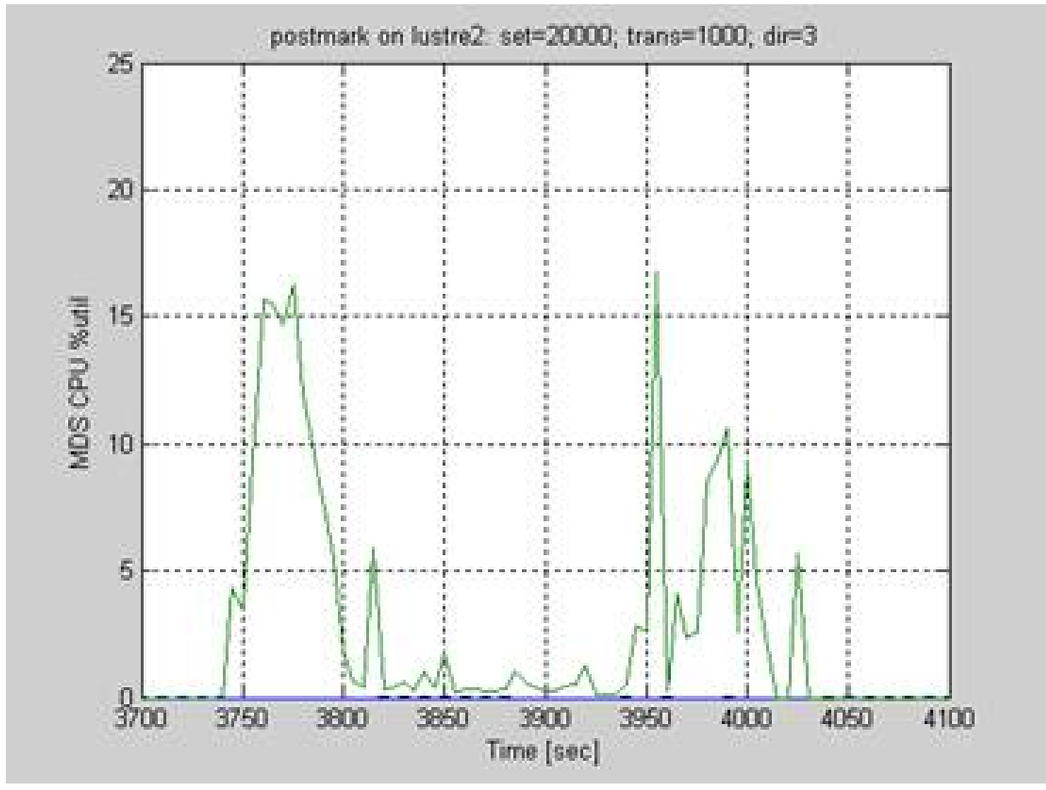


Total files	Tested FS	File Trans/s	File Creates/s	File Reads /s	File Append/s	File Delete/s	Read MB	Write MB	Read MB/sec	Write MB/s
335840	lustre2	2108	4344	1085	1068	4344	3338	71443	44	964

Postmark benchmark for 2 FS

- 20000, 1000, 3





Total files	Tested FS	File Trans/s	File Creates/s	File Reads/s	File Append/s	File Delete/s	Read MB	Write MB	Read MB/sec	Write MB/s
656064	lustre1	1066	3928	549	515	3927	3477	137296	21	841
656064	lustre2	1777	5151	1049	984	5151	3477	137296	28	1103

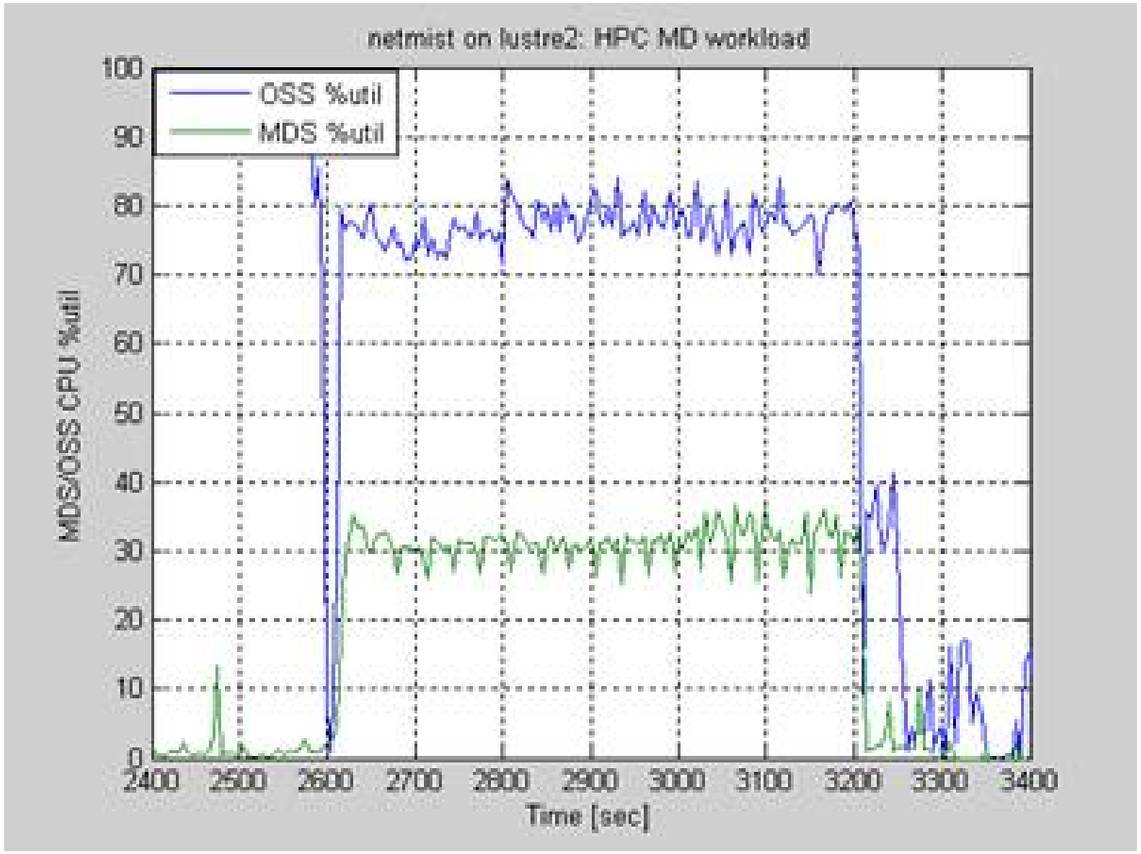
Netmist benchmark workload

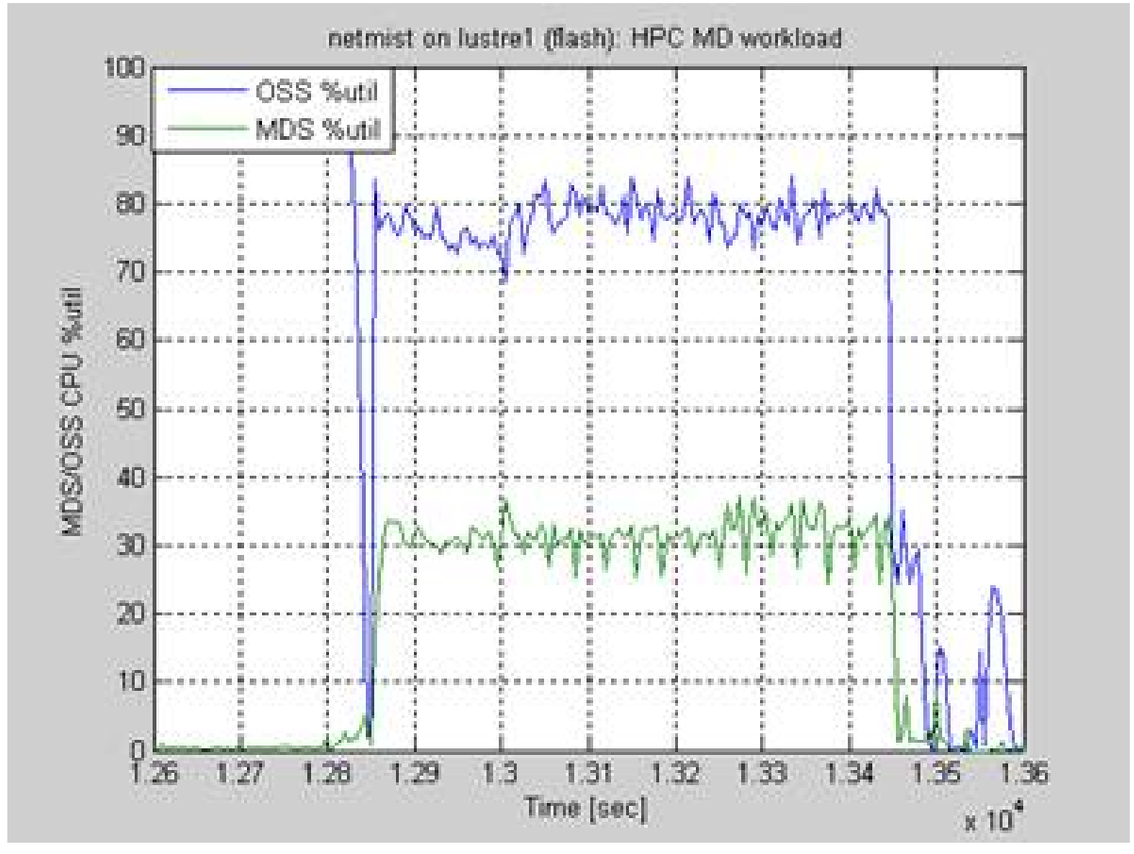
 # ./netmist -b 128 -d 8 -B 1 -t 300 -w 300 -f client_list

Netmist HPC POSIX on lustre2 (disk)	Netmist HPC POSIX on lustre1 (flash)
Test run time = 300 seconds, Warmup = 300 seconds. Running 32 copies of the test on 4 clients Results directory: /lab/demo/netmist_pro_mpi Clients have a total of 512 GiBytes of memory Clients have 16384 MiBytes of memory size per process Clients each have 8 processes Adjustable aggregate data set value set to 1 GiBytes Each process file size = 16800 kbytes Client data set size = 1181250 MiBytes Total starting data set size = 4725000 MiBytes Total initial file space = 4725000 MiBytes Total max file space = 5250000 MiBytes Starting tests: Tue Oct 22 18:35:28 2013 Launching 32 processes. --- Overall average latency 3.32 Milli-seconds Overall Netmist_2012 Ops/sec 9628.83 Ops/sec Overall Read_throughput ~ 34558.33 Kbytes/sec Overall Write_throughput ~ 47386.56 Kbytes/sec Overall throughput ~ 81944.90 Kbytes/sec Public Finger Print 841881307 ---	Test run time = 300 seconds, Warmup = 300 seconds. Running 32 copies of the test on 4 clients Results directory: /lab/demo/netmist_pro_mpi Clients have a total of 512 GiBytes of memory Clients have 16384 MiBytes of memory size per process Clients each have 8 processes Adjustable aggregate data set value set to 1 GiBytes Each process file size = 16800 kbytes Client data set size = 1181250 MiBytes Total starting data set size = 4725000 MiBytes Total initial file space = 4725000 MiBytes Total max file space = 5250000 MiBytes Starting tests: Tue Oct 22 21:26:13 2013 Launching 32 processes. --- Overall average latency 3.29 Milli-seconds Overall Netmist_2012 Ops/sec 9729.73 Ops/sec Overall Read_throughput ~ 34893.23 Kbytes/sec Overall Write_throughput ~ 47683.99 Kbytes/sec Overall throughput ~ 82577.22 Kbytes/sec Public Finger Print 842271196 ---

Netmist benchmark on 2 FS

./netmist -b 128 -d 8 -B 1 -t 300 -w 300 -f client_list
Client_list included 4 clients and 8 threads each or 32 threads





Total files	Tested FS	Rand read	rand write	rmw	mkdir	unlink	append	access	stat	chmod	readdir	statfs
650000	lustre2	481	481	96	1540	1540	1540	1540	578	193	1540	96
650000	lustre1	486	486	97	1557	1557	1557	1557	584	195	1557	97

MDS_survey benchmark

thrlo=64 thrhi=2048 file_count=200000 dir_count=64 tests_str="create lookup md_getattr setxattr destroy" mds-survey

mdt 1 ,file 200000, dir 64, thr 64

Create	Lookup	md_getattr	setxattr	destroy
70894.61	1077702	711298.26	48365.36	67280.78

Lustre 2.4, single MDS server, 2 OSS servers, 12 OSTs

mdt 1, file 200000, dir 64, thr 2048

Create	Lookup	md_getattr	setxattr	destroy
60852.58	1148586	619296.27	61283.87	59644.49

MPEE Proposed Questions

- Should focus on MDS/MDT performance
- Needs to help select best MDS server or help characterize all MD types including directories
- Should we aim to characterize the OST load for small I/O's?
- How important is to test both data and MD access?
- What tools do we use for characterization? Lustre or storage or both. Do we need additional tools?
- We need to help users select the right storage for the MDS/MDT.

MPEE Asks from BWG

- Share any open source synthetic benchmarks code
- Share a list of MD benchmark tools they currently use to allow select the most suitable and used candidates
- Share MD operations tested to allow build Netmist workload objects
- Share the MD workloads that create pain points to Lustre FS
- Share cases of poor MD performance workloads and applications
- Propose Lustre statistic tools to use

Thank you!