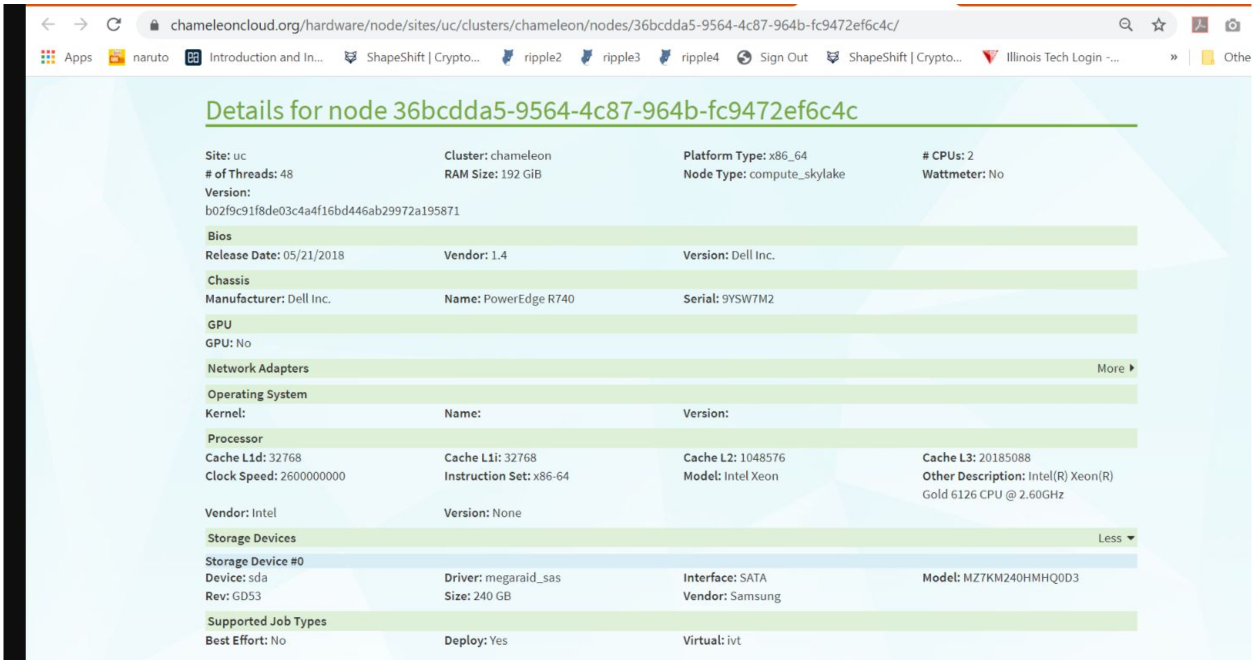
This assignment implements the Shared-Memory TeraSort application .

The experiments are performed on Chameleon Cloud using bare metal instances having following configuration



Details for node 36bcdda5-9564-4c87-964b-fc9472ef6c4c

Site: uc **Cluster:** chameleon **Platform Type:** x86_64 **# CPUs:** 2

# of Threads: 48 **RAM Size:** 192 GiB **Node Type:** compute_skylake **Wattmeter:** No

Version: b02f9c91f8de03c4a4f16bd446ab29972a195871

Bios

Release Date: 05/21/2018 **Vendor:** 1.4 **Version:** Dell Inc.

Chassis

Manufacturer: Dell Inc. **Name:** PowerEdge R740 **Serial:** 9YSW7M2

GPU

GPU: No

Network Adapters More ▸

Operating System

Kernel: **Name:** **Version:**

Processor

Cache L1d: 32768 **Cache L1i:** 32768 **Cache L2:** 1048576 **Cache L3:** 20185088

Clock Speed: 2600000000 **Instruction Set:** x86-64 **Model:** Intel Xeon **Other Description:** Intel(R) Xeon(R) Gold 6126 CPU @ 2.60GHz

Vendor: Intel **Version:** None

Storage Devices Less ▾

Storage Device #0

Device: sda **Driver:** megaraid_sas **Interface:** SATA **Model:** MZ7KM240HMHQ0D3

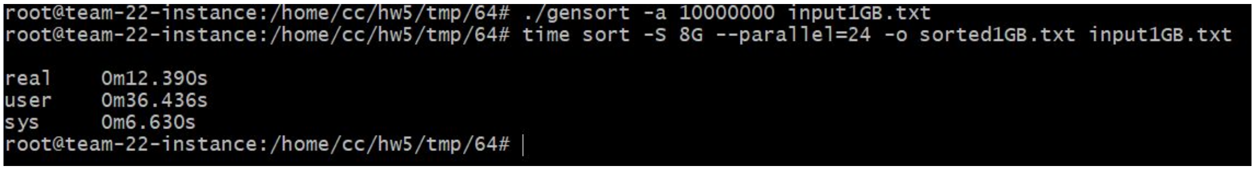
Rev: GD53 **Size:** 240 GB **Vendor:** Samsung

Supported Job Types

Best Effort: No **Deploy:** Yes **Virtual:** ivt

Analysis:

Linux Sort:



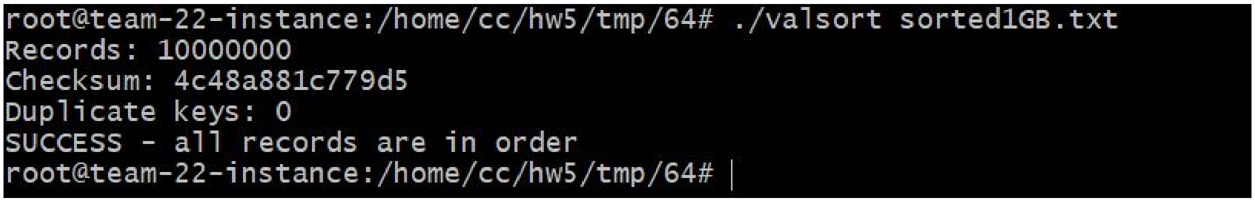
```
root@team-22-instance:/home/cc/hw5/tmp/64# ./gensort -a 10000000 input1GB.txt
root@team-22-instance:/home/cc/hw5/tmp/64# time sort -S 8G --parallel=24 -o sorted1GB.txt input1GB.txt

real    0m12.390s
user    0m36.436s
sys     0m6.630s
root@team-22-instance:/home/cc/hw5/tmp/64# |
```

input1GB.txt is input file.

sorted1GB.txt is sorted output file.

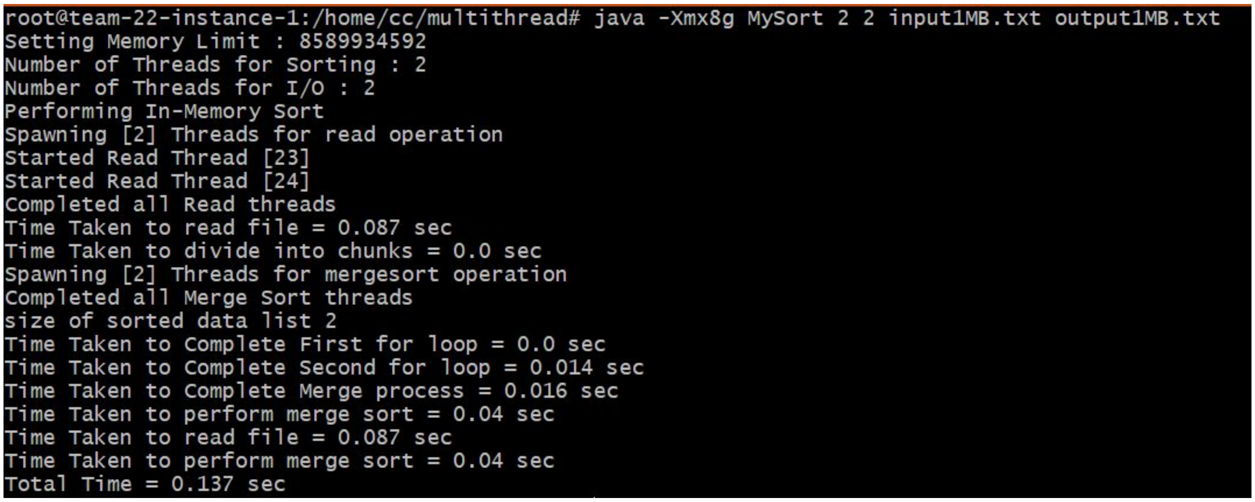
Verifying the Linux sort with Valsort command:



```
root@team-22-instance:/home/cc/hw5/tmp/64# ./valsort sorted1GB.txt
Records: 10000000
Checksum: 4c48a881c779d5
Duplicate keys: 0
SUCCESS - all records are in order
root@team-22-instance:/home/cc/hw5/tmp/64# |
```

Shared-Memory External Sort:

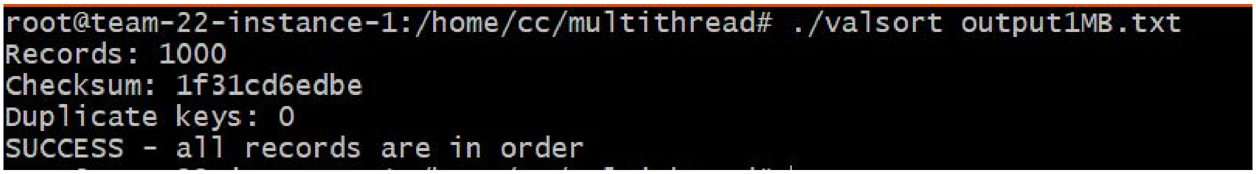
Command : java -Xmx8g MySort 2 2 input1MB.txt output1MB.txt



```
root@team-22-instance-1:/home/cc/multithread# java -Xmx8g MySort 2 2 input1MB.txt output1MB.txt
Setting Memory Limit : 8589934592
Number of Threads for Sorting : 2
Number of Threads for I/O : 2
Performing In-Memory Sort
Spawning [2] Threads for read operation
Started Read Thread [23]
Started Read Thread [24]
Completed all Read threads
Time Taken to read file = 0.087 sec
Time Taken to divide into chunks = 0.0 sec
Spawning [2] Threads for mergesort operation
Completed all Merge Sort threads
size of sorted data list 2
Time Taken to Complete First for loop = 0.0 sec
Time Taken to Complete Second for loop = 0.014 sec
Time Taken to Complete Merge process = 0.016 sec
Time Taken to perform merge sort = 0.04 sec
Time Taken to read file = 0.087 sec
Time Taken to perform merge sort = 0.04 sec
Total Time = 0.137 sec
```

Valsort verification:

Command : ./valsort outpu1MB.txt



```
root@team-22-instance-1:/home/cc/multithread# ./valsort output1MB.txt
Records: 1000
Checksum: 1f31cd6edbe
Duplicate keys: 0
SUCCESS - all records are in order
```

Similarly, we can perform for workloads: 1GB, 4GB, 16GB and 64GB

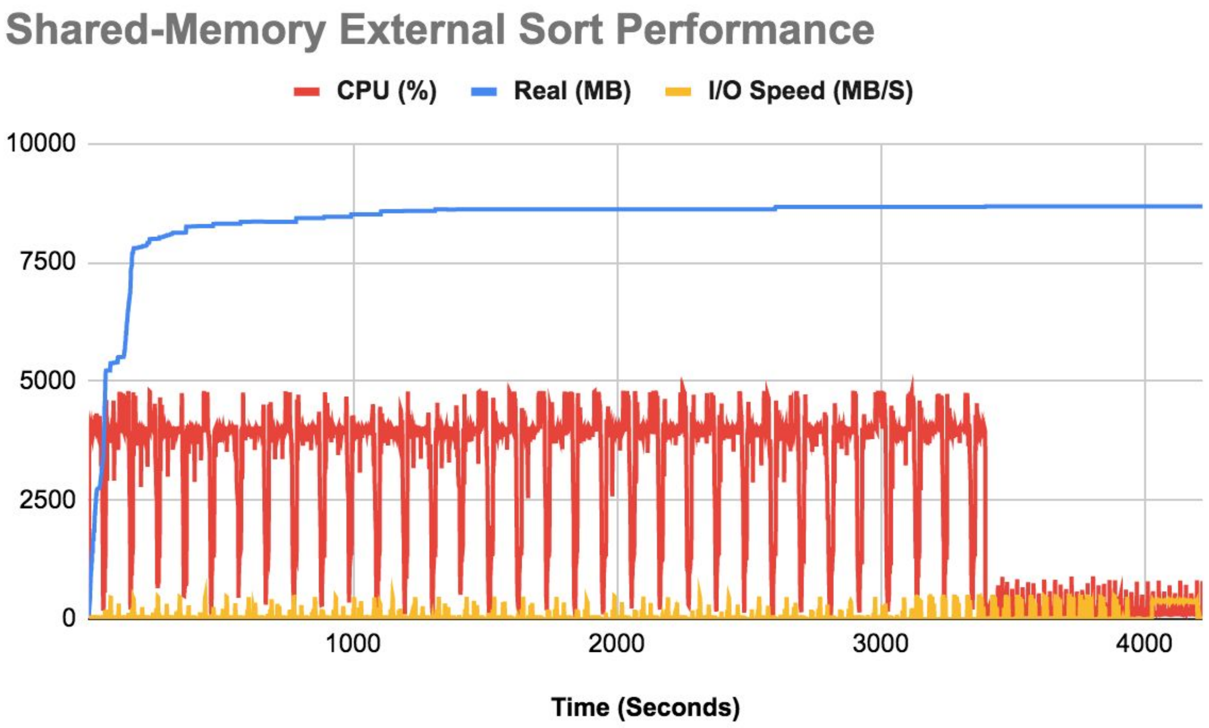
Performance evaluation of Single Node TeraSort:

Experiment	Shared Memory (1GB)	Linux Sort (1GB)	Shared Memory (4GB)	Linux Sort (4GB)	Shared Memory (16GB)	Linux Sort (16GB)	Shared Memory (64GB)	Linux Sort (64GB)
Number of Threads	I/O: 46 Compute: 46	22	I/O: 46 Compute: 46	32	I/O: 5 Compute: 40	24	I/O: 5 Compute: 40	44
Sort Approach (e.g. in-memory / external)	internal	internal	internal	internal	external	external	external	external
Sort Algorithm (e.g. quicksort / mergesort / etc)	mergesort	mergesort	mergesort	mergesort	mergesort	mergesort	mergesort	mergesort
Data Read (GB)	1GB	1GB	4GB	4GB	32GB	16GB	128GB	132 GB
Data Write (GB)	1GB	1GB	4GB	4GB	32GB	31GB	128GB	129 GB
Sort Time (sec)	276.13	11.45	482.36	60.74	927.54	224.07	4345.91	1116.55
Overall I/O Throughput (MB/sec)	7.2429	174.67	16.58	131.7	68.99	206.52	58.911	233.75
Overall CPU Utilization (%)	597.28	353.19	707.54	529.9	463.48	299.7	2885.977	337.49
Average Memory Utilization (GB)	3.003	0.87239	4.2851	4.5357	3.198	7.279	8.403	7.677

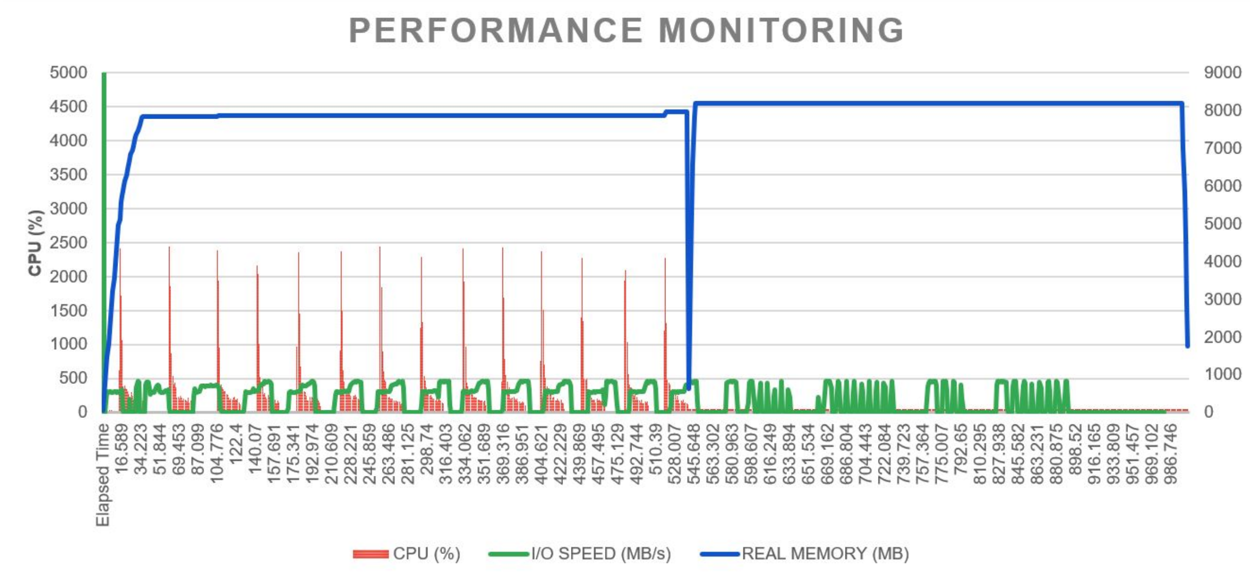
We have limited max memory to 8GB. External sort takes more time compared to internal sort but performance of internal sort degrades as we provide bigger workload size.

Plot for CPU utilization, memory utilization and disk I/O:

Shared-Memory External Sort Plot:



Linux 64GB Plot:


PERFORMANCE MONITORING
CPU (%)
Elapsed Time
CPU (%)
I/O SPEED (MB/s)
REAL MEMORY (MB)