

SCREENSHOTS

Raid Creation for Data Node

```
ubuntu@ip-172-31-38-246:~$ df -h
Filesystem      Size  Used Avail Use% Mounted on
udev            60G   0    60G   0% /dev
tmpfs           12G   0    12G   0% /run
/dev/xvda1      7.7G  2.6G  5.2G  34% /
tmpfs           60G   0    60G   0% /dev/shm
tmpfs           5.0M   0   5.0M   0% /run/lock
tmpfs           60G   0    60G   0% /sys/fs/cgroup
tmpfs           12G   0    12G   0% /run/user/1000

ubuntu@ip-172-31-38-246:~$ lsblk
NAME        MAJ:MIN RM  SIZE RO TYPE MOUNTPOINT
xvda        202:0    0   8G  0 disk
└─xvda1     202:1    0   8G  0 part /
xvdf        202:80   0   3T  0 disk
xvdg        202:96   0   3T  0 disk
nvme0n1     259:1    0  1.7T  0 disk

ubuntu@ip-172-31-38-246:~$ sudo mdadm --create --verbose /dev/md0 --level=0 --name=hadoopterasort --raid-devices=2 /dev/xvdf /dev/xvdg
mdadm: chunk size defaults to 512K
mdadm: /dev/xvdf appears to contain an ext2fs file system
       size=3221225472K  mtime=Sat Dec  2 08:33:26 2017
Continue creating array? yes
mdadm: Defaulting to version 1.2 metadata
mdadm: array /dev/md0 started.

ubuntu@ip-172-31-38-246:~$ sudo mkfs ext4 -L hadoopterasort /dev/md0
mkfs2fs 1.42.13 (17-May-2015)
Creating filesystem with 1610547200 4k blocks and 201318400 inodes
Filesystem UUID: 78504874-3cd7-436a-a3ab-47603819232f
Superblock backups stored on blocks:
    32768, 98304, 163840, 229376, 294912, 819200, 884736, 1605632, 2654208,
    4896000, 7962624, 11239424, 20480000, 23887872, 71663616, 78675968,
    102400000, 214990048, 512000000, 558731776, 644972544

Allocating group tables: done
Writing inode tables: done
Writing superblocks and filesystem accounting information: █
```

Screenshot of TeraSort task running on an instance of i34xlarge for 128 GB dataset

```
17/12/03 05:59:21 INFO mapred.LocalJobRunner: reduce > reduce
17/12/03 05:59:24 INFO mapred.LocalJobRunner: reduce > reduce
17/12/03 05:59:25 INFO mapreduce.Job: map 100% reduce 89%
17/12/03 05:59:27 INFO mapred.LocalJobRunner: reduce > reduce
17/12/03 05:59:30 INFO mapred.LocalJobRunner: reduce > reduce
17/12/03 05:59:33 INFO mapred.LocalJobRunner: reduce > reduce
```

```
-rw-r--r-- 1 hduser supergroup 131072000000 2017-12-03 17:08 /mnt/raid/output/part-r-00000  
ubuntu@ip-172-31-26-250: /usr/local/hadoop/hadoop-2.7.4/bin$ ./hadoop dfs -cat /mnt/raid/output/part-r-00000 | head -5  
DEPRECATED: Use of this script to execute hdfs command is deprecated.  
Instead use the hdfs command for it.
```



```
+!4+ABv      0000000000000000000000000017FEB29    EEEE333344441112222B888333344446666333222DD0DEEEE  
"Oiuve       00000000000000000000000000001228D4    7777888800002224444DDDDDDDEEE00000000CCCC7777DDDD  
%!$Su(       00000000000000000000000000E6C821C   22223337777444455551119999CCCC4444EEEEFFFF1115555  
&$rXl        0000000000000000000000000039BC288   5555CCCCBB8899999999DDDD111100001111EEEE7777DDDD9999  
'ic%So       000000000000000000000000000031F06BD0  EEEBBBBBAAAA8888DDDDDDDD77772222444411166664444AAAA
```

```
ubuntu@ip-172-31-38-246:/mnt/raid/SparkOutput$ ^C  
ubuntu@ip-172-31-38-246:/mnt/raid/SparkOutput$ head -5 part-00000  
I+ABv 000000000000000000000000000017F7E829 EEEE3333444411112222888833334444666633332222DDDDFFFF  
"O!uve 00000000000000000000000000001228D4 77778888000022224444DDDDDDDEEE00000000CCCC7777DDDD  
%!$sU( 00000000000000000000000000002FE6C821 2222333377774444555511119999CCCC4444EEEEFFFF11115555  
.8rX|X 0000000000000000000000000000399BC288 5555CCCB8BBB99999999DDDD111100001111EEEE7777DDDD9999  
'ic%So 000000000000000000000000000031F6B87D EEEEBBBBAAAA8888DDDDDDDD777722224444111166664444AAAA
```

[illegible]

```
ls: cannot access '/mnt/raid/in': No such file or directory
ubuntu@ip-172-31-38-246:/mnt/raid/SparkOutput$ ls -ltrh /mnt/raid/TeraSort/In
total 1.1T
-rwxr-xr-x 1 root root 954M Dec  2 20:59 a.txt
-rwxr-xr-x 1 root root 123G Dec  2 21:52 actualIn.txt
-rwxr-xr-x 1 root root 982G Dec  3 20:48 OneTBInput.txt
ubuntu@ip-172-31-38-246:/mnt/raid/SparkOutputs$
```

```
ubuntu@ip-172-31-38-246:~/mnt/raid/sparkOutput$ /usr/local/hadoop/hadoop-2.7.4/bin/hadoop dfs -ls /mnt/raid/HDFSIn
DEPRECATED: Use of this script to execute hdfs command is deprecated.
Instead use the hdfs command for it.

Found 1 items
-rw-r--r-- 1 hduser supergroup 131072000000 2017-12-03 03:26 /mnt/raid/HDFSIn/actualIn.txt
ubuntu@ip-172-31-38-246:~/mnt/raid/sparkOutput$
```

```
ubuntu@ip-172-31-26-250:/usr/local/hadoop/hadoop-2.7.4/bin$ ./hadoop dfs -cat /mnt/raid/output/part-r-00000 | tail -5  
DEPRECATED: Use of this script to execute hdfs command is deprecated.  
Instead use the hdfs command for it.
```

~~~~~UeTr]s 000000000000000000000083E299FE5 DDD0000CCCC222777D0DD555888000000002222222222

~~~~ZuH~-L 000000000000000000000004320332A 11118888222CCCC6666CCCC888CCCC8888222AAAA0DD7777

~~~~c+I&cP 000000000000000000000000074BDF64 888000055550000DD2227777AAA0000333222AAADDD0

~~~~hb&X\* 00000000000000000000000032CE068 77778888888999EEEEAAAAAAAA000CCCD0444B888444

~~~~tkL\*c1 000000000000000000000000054E700F 99997779999111AAAA22244440000111CCCC9999FFFF0000



```
root@ip-172-31-38-246:/mnt/raid/TeraSort/GenFiles/64# ./valsort /mnt/raid/SparkOutput/part-00488
Records: 3841182
Checksum: 1d4e0a8f651b3b
Duplicate keys: 0
SUCCESS - all records are in order
```

Hadoop Terasort Output on 1 TB dataset for a Single Node Instance & Multi Node Instance (Please note that the output was same for difference instance configurations, hence pasting a single screenshot for all instances to avoid confusion)

```
ubuntu@ip-172-31-26-250:/usr/local/hadoop/hadoop-2.7.4/bin$ ./hadoop dfs -cat /mnt/raid/output/part-r-00000 | head -5
DEPRECATED: Use of this script to execute hdfs command is deprecated.
Instead use the hdfs command for it.
```

```
!"LSR; 00000000000000000000000000000000A68ECBA8 AAAA0000BBBDDDD444AAAAFFFFF1111DDDD2222DDDD33339999
!4+Abv 0000000000000000000000000000000017FE829 EEEE33334444111122228888333344446666333222DDDDEEEE
^Oluev 0000000000000000000000000000000001228D4 77778888000022224444DDDDDDDEEE00000000CCCC7777DDDD
#Eejl= 0000000000000000000000000000000020A68BA17 2222222FFFF7777DDDDEEEE8888EEEEEEEE6666666666668888
Sh# DN 000000000000000000000000000000001BCB770C2 55554444CCCCCCC4444222111199995555222277771111FFFF
```

[illegible]

Spark Terasort Output on 1 TB dataset for a Single Node Instance & Multi Node Instance (Please note that the output was same for difference instance configurations, hence pasting a single screenshot for all instances to avoid confusion)

```
ubuntu@ip-172-31-26-250:/usr/local/hadoop/hadoop-2.7.4/bin$ ./hadoop dfs -cat /mnt/raid/SparkOutput/part-r-00000 | head -5  
DEPRECATED: Use of this script to execute hdfs command is deprecated.  
Instead use the hdfs command for it.
```

```
!L5R; 00000000000000000000A68EC8A8 AAAA000BBBDDDD0444AAAAFFFF1111DDDD2222DD0033339999  
I+ABv 0000000000000000000000F7FE29 EEEE33334444111122228888333344446666333222000EEEE  
"Oluve 000000000000000000000000001228D4 77778888000022224444DDDDDDDDDEEE00000000CCCC7777DDDD  
#Eajl= 00000000000000000000000020A68BA17 22222222FFFF7777DDDDDEEE8888EEEE6666666666668888  
$he_DN 0000000000000000000000001BCB770C2 55554444CCCCCCC444422211119999555522277771111FFFF  
%q/-'7 00000000000000000000000000A674E940 7777FF1111EEEE4444DDDDCCCC8888AAAAACCC1111CCCC1111
```

```
ubuntu@ip-172-31-26-250:/usr/local/hadoop/hadoop-2.7.4/bin$ ./hadoop dfs -cat /mnt/raid/SparkOutput/part-r-01952 | tail -5  
DEPRECATED: Use of this script to execute hdfs command is deprecated.  
Instead use the hdfs command for it.
```



Shared Memory TeraSort Output on 1 TB dataset for a Single Node Instance & Multi Node Instance  
(Please note that the output was same for difference instance configurations, hence pasting a single screenshot for all instances to avoid confusion)

[illegible]

MPI TeraSort Output on 1 TB dataset for a Single Node Instance & Multi Node Instance (Please note that the output was same for difference instance configurations, hence pasting a single screenshot for all instances to avoid confusion)

[illegible]

### Hadoop Map Reduce sample screenshot

```
17/12/03 09:27:47 INFO mapred.LocalJobRunner: reduce > reduce
17/12/03 09:27:47 INFO mapred.Task: Task 'attempt_local1224777188_0001_r_000000_0' done.
17/12/03 09:27:47 INFO mapred.LocalJobRunner: Finishing task: attempt_local1224777188_0001_r_000000_0
17/12/03 09:27:47 INFO mapred.LocalJobRunner: reduce task executor complete.
17/12/03 09:28:04 INFO mapreduce.Job: Job job_local1224777188_0001 completed successfully
17/12/03 09:28:05 INFO mapreduce.Job: Counters: 35
  File System Counters
    FILE: Number of bytes read=33473449786371
    FILE: Number of bytes written=66276002382910
    FILE: Number of read operations=0
    FILE: Number of large read operations=0
    FILE: Number of write operations=0
    HDFS: Number of bytes read=32291281584128
    HDFS: Number of bytes written=131072000000
    HDFS: Number of read operations=242061
    HDFS: Number of large read operations=0
    HDFS: Number of write operations=492
  Map-Reduce Framework
    Map input records=1310720000
    Map output records=1310720000
    Map output bytes=131072000000
    Map output materialized bytes=133693442934
    Input split bytes=76284
    Combine input records=0
    Combine output records=0
    Reduce input groups=1310720000
    Reduce shuffle bytes=133693442934
    Reduce input records=1310720000
    Reduce output records=1310720000
    Spilled Records=6568196172
    Shuffled Maps =489
    Failed Shuffles=0
    Merged Map outputs=489
    GC time elapsed (ms)=81598
    Total committed heap usage (bytes)=262581256192
  Shuffle Errors
    BAD_ID=0
    CONNECTION=0
    IO_ERROR=0
    WRONG_LENGTH=0
    WRONG_MAP=0
    WRONG_REDUCE=0
  File Input Format Counters
    Bytes Read=131073998848
  File Output Format Counters
    Bytes Written=131072000000
Total Time taken for Execution :9601
hduser@ip-172-31-38-246: /mnt/raid/TeraSort$
```

Spark running example on i3 4xlarge with sample dataset:

```
Welcome to
      ____
     / ____ \
    / /  _  \
   / /  | | \
  / /___| |_\
 /_____/_____\
Spark version 1.6.3

Using Scala version 2.10.5 (Java HotSpot(TM) 64-Bit Server VM, Java 1.8.0_151)
Type in expressions to have them evaluated.
Type :help for more information.
17/12/03 13:20:43 WARN SparkConf: In Spark 1.0 and later spark.local.dir will be overridden by the value set by the cluster manager (via SPARK_LOCAL_DIRS in mesos/standalone and LOCAL_DIRS in YARN).
Spark context available as sc.

17/12/03 13:20:45 WARN Connection: BoneCP specified but not present in CLASSPATH (or one of dependencies)
17/12/03 13:20:45 WARN Connection: BoneCP specified but not present in CLASSPATH (or one of dependencies)
17/12/03 13:20:48 WARN ObjectStore: Version information not found in metastore. hive.metastore.schema.validation is not enabled so recording the schema version 1.2.0
17/12/03 13:20:48 WARN ObjectStore: Failed to get database default, returning NoSuchObjectException
17/12/03 13:20:49 WARN Connection: BoneCP specified but not present in CLASSPATH (or one of dependencies)
17/12/03 13:20:49 WARN Connection: BoneCP specified but not present in CLASSPATH (or one of dependencies)
17/12/03 13:20:51 WARN ObjectStore: Version information not found in metastore. hive.metastore.schema.validation is not enabled so recording the schema version 1.2.0
17/12/03 13:20:51 WARN ObjectStore: Failed to get database default, returning NoSuchObjectException
SQL context available as sqlContext.

scala> val start_time = System.currentTimeMillis()
start_time: Long = 1512307272879

scala> val inputFile=sc.textFile("hdfs://ec2-13-59-246-215.us-east-2.compute.amazonaws.com:54310/mnt/raid/HDFSIn/actualIn.txt")
inputFile: org.apache.spark.rdd.RDD[String] = hdfs://ec2-13-59-246-215.us-east-2.compute.amazonaws.com:54310/mnt/raid/HDFSIn/actualIn.txt MapPartitionsRDD[1] at textFile at <console>:27

scala> val sort_file=inputFile.map(line => ((line.take(10), line.drop(10))))
sort_file: org.apache.spark.rdd.RDD[(String, String)] = MapPartitionsRDD[2] at map at <console>:29

scala> val sort = sort_file.sortByKey()
sort: org.apache.spark.rdd.RDD[(String, String)] = ShuffledRDD[5] at sortByKey at <console>:31

scala> val lines=sort.map (case (key,value) => s"$key $value")
lines: org.apache.spark.rdd.RDD[String] = MapPartitionsRDD[6] at map at <console>:33

scala> lines.saveAsTextFile("/mnt/raid/SparkOutput")
Stage 1:##### (399 + 16) / 400█
```

```
to adjust logging levels use sc.setLogLevel(INFO)
Welcome to
      ____
     / ____ \
    / /  _  \
   / /  | | \
  / /___| |_\
 /_____/_____\
Spark version 1.6.3

Using Scala version 2.10.5 (Java HotSpot(TM) 64-Bit Server VM, Java 1.8.0_151)
Type in expressions to have them evaluated.
Type :help for more information.
17/12/03 13:20:43 WARN SparkConf: In Spark 1.0 and later spark.local.dir will be overridden by the value set by the cluster manager (via SPARK_LOCAL_DIRS in mesos/standalone and LOCAL_DIRS in YARN).
Spark context available as sc.

17/12/03 13:20:45 WARN Connection: BoneCP specified but not present in CLASSPATH (or one of dependencies)
17/12/03 13:20:45 WARN Connection: BoneCP specified but not present in CLASSPATH (or one of dependencies)
17/12/03 13:20:48 WARN ObjectStore: Version information not found in metastore. hive.metastore.schema.validation is not enabled so recording the schema version 1.2.0
17/12/03 13:20:48 WARN ObjectStore: Failed to get database default, returning NoSuchObjectException
17/12/03 13:20:49 WARN Connection: BoneCP specified but not present in CLASSPATH (or one of dependencies)
17/12/03 13:20:49 WARN Connection: BoneCP specified but not present in CLASSPATH (or one of dependencies)
17/12/03 13:20:51 WARN ObjectStore: Version information not found in metastore. hive.metastore.schema.validation is not enabled so recording the schema version 1.2.0
17/12/03 13:20:51 WARN ObjectStore: Failed to get database default, returning NoSuchObjectException
SQL context available as sqlContext.

scala> val start_time = System.currentTimeMillis()
start_time: Long = 1512307272879

scala> val inputFile=sc.textFile("hdfs://ec2-13-59-246-215.us-east-2.compute.amazonaws.com:54310/mnt/raid/HDFSIn/actualIn.txt")
inputFile: org.apache.spark.rdd.RDD[String] = hdfs://ec2-13-59-246-215.us-east-2.compute.amazonaws.com:54310/mnt/raid/HDFSIn/actualIn.txt MapPartitionsRDD[1] at textFile at <console>:27

scala> val sort_file=inputFile.map(line => ((line.take(10), line.drop(10))))
sort_file: org.apache.spark.rdd.RDD[(String, String)] = MapPartitionsRDD[2] at map at <console>:29

scala> val sort = sort_file.sortByKey()
sort: org.apache.spark.rdd.RDD[(String, String)] = ShuffledRDD[5] at sortByKey at <console>:31

scala> val lines=sort.map (case (key,value) => s"$key $value")
lines: org.apache.spark.rdd.RDD[String] = MapPartitionsRDD[6] at map at <console>:33

scala> lines.saveAsTextFile("/mnt/raid/SparkOutput")

scala> val end_time = System.currentTimeMillis()
end_time: Long = 1512326608883

scala> println ("Total time : " + (end_time - start_time) + "ms")
Total time :19338804ms
```



### *Hadoop TeraSort on Single Node i3large Instance for 128 GB dataset*

```
17/12/03 17:08:04 INFO mapred.LocalJobRunner: reduce > reduce
17/12/03 17:08:04 INFO mapred.Task: Task 'attempt_local372026054_0001_r_000000_0' done.
17/12/03 17:08:04 INFO mapred.LocalJobRunner: Finishing task: attempt_local372026054_0001_r_000000_0
17/12/03 17:08:04 INFO mapred.LocalJobRunner: reduce task executor complete.
17/12/03 17:08:32 INFO mapreduce.Job: Job job_local372026054_0001 completed successfully
17/12/03 17:08:32 INFO mapreduce.Job: Counters: 35
  File System Counters
    FILE: Number of bytes read=33495978735672
    FILE: Number of bytes written=66298530699298
    FILE: Number of read operations=0
    FILE: Number of large read operations=0
    FILE: Number of write operations=0
    HDFS: Number of bytes read=32291281584128
    HDFS: Number of bytes written=131072000000
    HDFS: Number of read operations=242061
    HDFS: Number of large read operations=0
    HDFS: Number of write operations=492
  Map-Reduce Framework
    Map input records=1310720000
    Map output records=1310720000
    Map output bytes=131072000000
    Map output materialized bytes=133693442934
    Input split bytes=76773
    Combine input records=0
    Combine output records=0
    Reduce input groups=1310720000
    Reduce shuffle bytes=133693442934
    Reduce input records=1310720000
    Reduce output records=1310720000
    Spilled Records=6789068216
    Shuffled Maps =489
    Failed Shuffles=0
    Merged Map outputs=489
    GC time elapsed (ms)=100121
    Total committed heap usage (bytes)=262128795648
  Shuffle Errors
    BAD_ID=0
    CONNECTION=0
    IO_ERROR=0
    WRONG_LENGTH=0
    WRONG_MAP=0
    WRONG_REDUCE=0
  File Input Format Counters
    Bytes Read=131073998848
  File Output Format Counters
    Bytes Written=131072000000
Total Time taken for Execution :16809
```

#### *RAID configuration*

```
ubuntu@ip-172-31-4-151:~$ sudo mkfs ext4 -L hadoopterasort /dev/md0
mkfs2fs 1.42.13 (17-May-2015)
Creating filesystem with 536805376 4k blocks and 134201344 inodes
Filesystem UUID: aa78bb6b-3d0a-4185-8dfd-2c2d111b9999
Superblock backups stored on blocks:
    32768, 98304, 163840, 229376, 294912, 819200, 884736, 1605632, 2654208,
    4096000, 7962624, 11239424, 20480000, 23887872, 71663616, 78675968,
    102400000, 214990848, 512000000

Allocating group tables: done
Writing inode tables: 1754/16382
```

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