

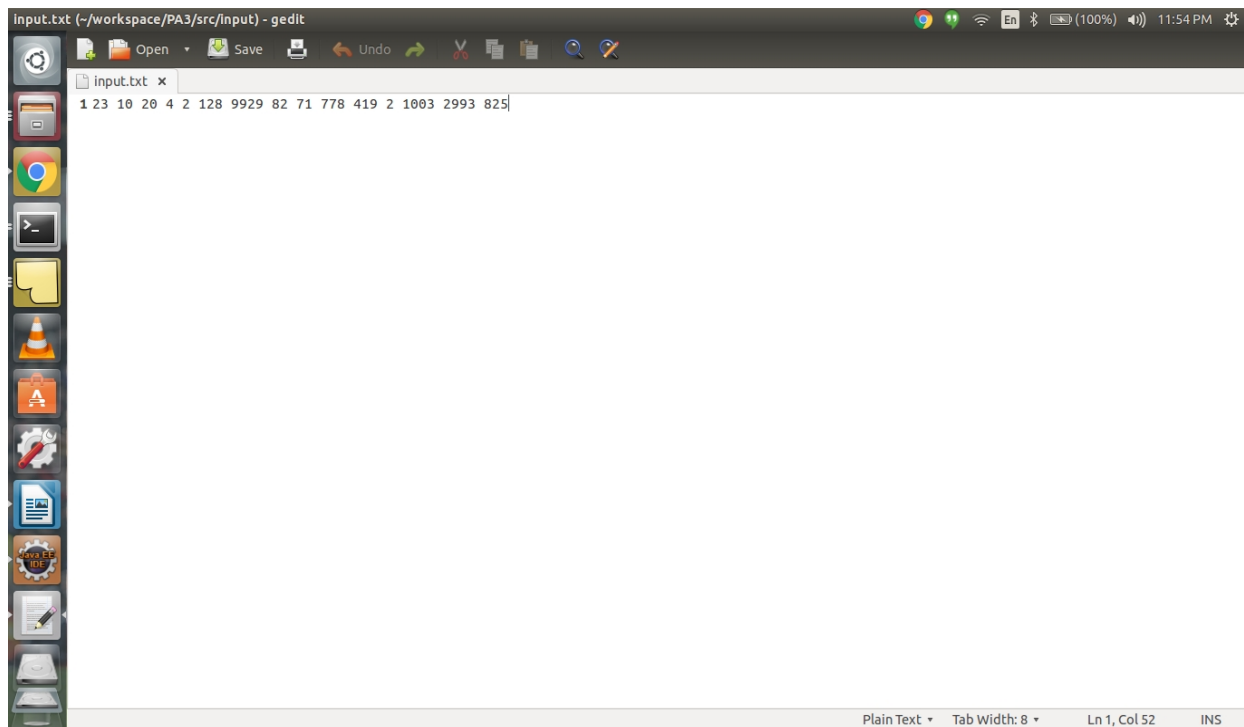
## Test cases

Please have a look at the user document which details how to start all components of the system and how to use the interface. Before running these test cases, PLEASE ENSURE THAT YOU HAVE PLACED THE CODE IN A FOLDER WHERE YOU HAVE WRITE ACCESS, since input, intermediate and output files will be read and written to the file system.

Before running any testcases, please do not forget to copy the input file to the input folder inside the source code folder.

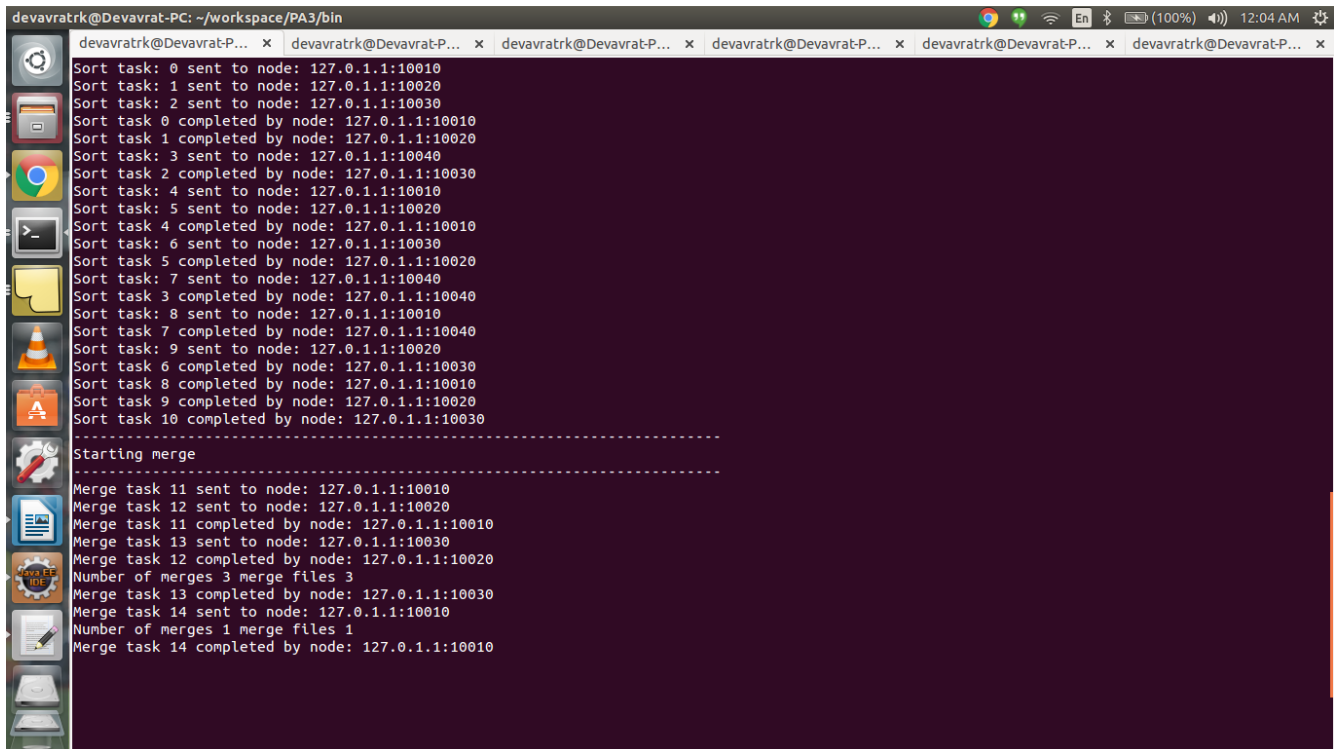
All of these test cases have been run using four compute nodes.

1) **Sorting a small file:** Please have a look at the input.txt file which has been provided in the input folder inside the source code folder. It contains 15 numbers in unsorted order. The size of the file is 52 bytes. The following testcase uses the chunk size parameter as 5 bytes and the number of files to be merged parameter as 4. The failure probability has been set to 0 for simplicity at all compute nodes. Further testcases will have a non zero failure probability at some nodes. Here is how the input file looks like:



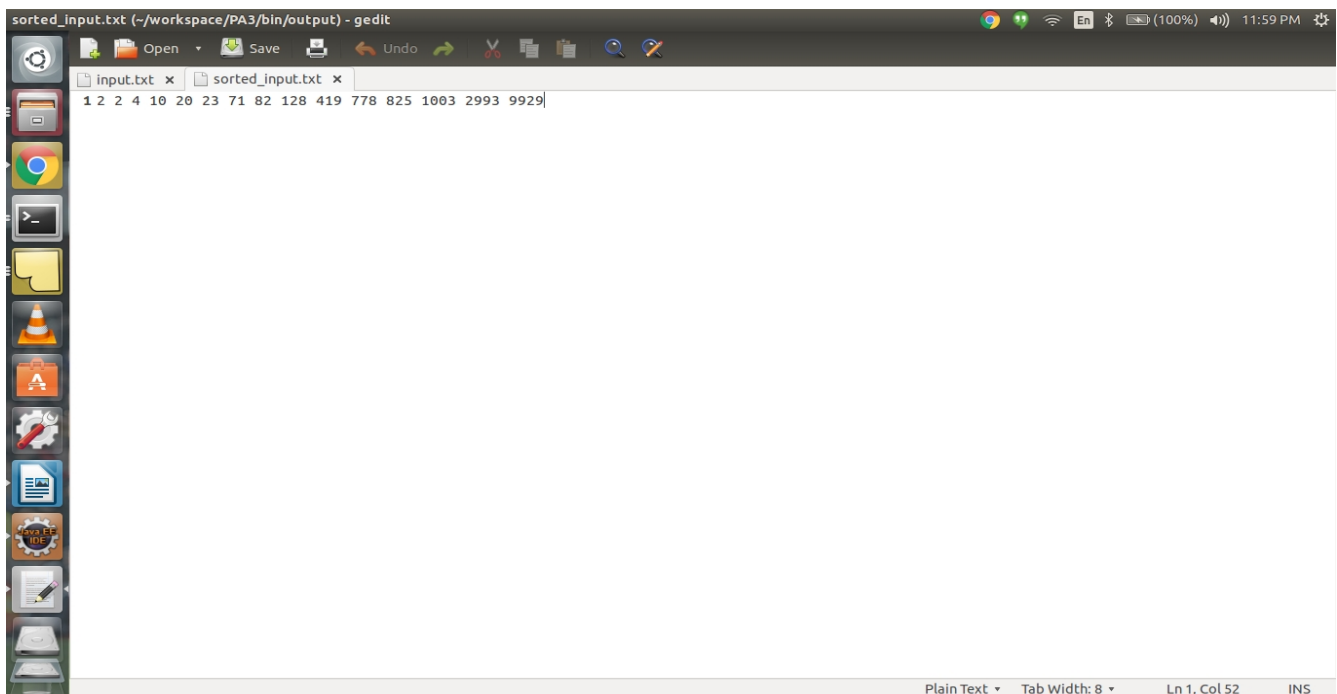
```
input.txt (~/workspace/PA3/src/Input) - gedit
input.txt x
1 23 10 20 4 2 128 9929 82 71 778 419 2 1003 2993 825
Plain Text Tab Width: 8 Ln 1, Col 52 INS
```

The system is then started as mentioned in the user document and the filename input.txt is entered at the client UI. The system starts working on sorting the input file. Here is how the server terminal window looks during execution:



```
devavratrk@Devavrat-PC: ~/workspace/PA3/bin
Sort task: 0 sent to node: 127.0.1.1:10010
Sort task: 1 sent to node: 127.0.1.1:10020
Sort task: 2 sent to node: 127.0.1.1:10030
Sort task 0 completed by node: 127.0.1.1:10010
Sort task 1 completed by node: 127.0.1.1:10020
Sort task 3 sent to node: 127.0.1.1:10040
Sort task 2 completed by node: 127.0.1.1:10030
Sort task: 4 sent to node: 127.0.1.1:10010
Sort task: 5 sent to node: 127.0.1.1:10020
Sort task 4 completed by node: 127.0.1.1:10010
Sort task: 6 sent to node: 127.0.1.1:10030
Sort task 5 completed by node: 127.0.1.1:10020
Sort task: 7 sent to node: 127.0.1.1:10040
Sort task 3 completed by node: 127.0.1.1:10040
Sort task: 8 sent to node: 127.0.1.1:10010
Sort task 7 completed by node: 127.0.1.1:10040
Sort task: 9 sent to node: 127.0.1.1:10020
Sort task 6 completed by node: 127.0.1.1:10030
Sort task 8 completed by node: 127.0.1.1:10010
Sort task 9 completed by node: 127.0.1.1:10020
Sort task 10 completed by node: 127.0.1.1:10030
-----
Starting merge
Merge task 11 sent to node: 127.0.1.1:10010
Merge task 12 sent to node: 127.0.1.1:10020
Merge task 11 completed by node: 127.0.1.1:10010
Merge task 13 sent to node: 127.0.1.1:10030
Merge task 12 completed by node: 127.0.1.1:10020
Number of merges 3 merge files 3
Merge task 13 completed by node: 127.0.1.1:10030
Merge task 14 sent to node: 127.0.1.1:10010
Number of merges 1 merge files 1
Merge task 14 completed by node: 127.0.1.1:10010
```

We see from the above output that there are 11 sort tasks as expected (52/5). There are 3 merge tasks in the first pass (11/4) and these 3 merge tasks produce 3 intermediate files, which are then merged in the second pass to produce the final sorted file, which is then moved to the output folder. Here is how the output file looks like:



```
sorted_input.txt (~/workspace/PA3/bin/output) - gedit
input.txt x sorted_input.txt x
1 2 4 10 20 23 71 82 128 419 778 825 1003 2993 9929
```

We can see that the file is sorted.

2) **Sorting the same file with different parameters:** We start the server and compute nodes once again. The parameters now are 2 bytes as chunk size and 2 files to be merged per merge task. The client is started once again and given the same input.txt file as input to the system. Here is how the server terminal window looks like after execution:

```
devavratrk@Devavrat-PC: ~/workspace/PA3/bin
devavratrk@Devavrat-P... x devavratrk@Devavrat-P... x devavratrk@Devavrat-P... x devavratrk@Devavrat-P... x devavratrk@Devavrat-P... x devavratrk@Devavrat-P... x
Sort task: 0 sent to node: 127.0.1.1:10010
Sort task: 1 sent to node: 127.0.1.1:10020
Sort task 0 completed by node: 127.0.1.1:10010
Sort task: 2 sent to node: 127.0.1.1:10030
Sort task 1 completed by node: 127.0.1.1:10020
Sort task: 3 sent to node: 127.0.1.1:10040
Sort task 2 completed by node: 127.0.1.1:10030
Sort task: 4 sent to node: 127.0.1.1:10010
Sort task: 5 sent to node: 127.0.1.1:10020
Sort task 4 completed by node: 127.0.1.1:10010
Sort task 3 completed by node: 127.0.1.1:10040
Sort task: 6 sent to node: 127.0.1.1:10030
Sort task: 7 sent to node: 127.0.1.1:10040
Sort task 6 completed by node: 127.0.1.1:10030
Sort task: 8 sent to node: 127.0.1.1:10010
Sort task 7 completed by node: 127.0.1.1:10040
Sort task 5 completed by node: 127.0.1.1:10020
Sort task: 9 sent to node: 127.0.1.1:10020
Sort task 8 completed by node: 127.0.1.1:10010
Sort task: 10 sent to node: 127.0.1.1:10030
Sort task 9 completed by node: 127.0.1.1:10020
Sort task: 11 sent to node: 127.0.1.1:10040
Sort task 10 completed by node: 127.0.1.1:10030
Sort task: 12 sent to node: 127.0.1.1:10010
Sort task 11 completed by node: 127.0.1.1:10040
Sort task: 13 sent to node: 127.0.1.1:10020
Sort task 12 completed by node: 127.0.1.1:10010
Sort task: 14 sent to node: 127.0.1.1:10030
Sort task 13 completed by node: 127.0.1.1:10020
Sort task: 15 sent to node: 127.0.1.1:10040
Sort task: 16 sent to node: 127.0.1.1:10010
Sort task 14 completed by node: 127.0.1.1:10030
Sort task 15 completed by node: 127.0.1.1:10040
Sort task: 17 sent to node: 127.0.1.1:10020
Sort task 16 completed by node: 127.0.1.1:10010
Sort task: 18 sent to node: 127.0.1.1:10030
Sort task 17 completed by node: 127.0.1.1:10020
Sort task: 19 sent to node: 127.0.1.1:10040
Sort task 18 completed by node: 127.0.1.1:10030
```

```
devavratrk@Devavrat-PC: ~/workspace/PA3/bin
devavratrk@Devavrat-P... x devavratrk@Devavrat-P... x devavratrk@Devavrat-P... x devavratrk@Devavrat-P... x devavratrk@Devavrat-P... x devavratrk@Devavrat-P... x
Sort task: 20 sent to node: 127.0.1.1:10010
Sort task 19 completed by node: 127.0.1.1:10040
Sort task: 21 sent to node: 127.0.1.1:10020
Sort task 20 completed by node: 127.0.1.1:10010
Sort task: 22 sent to node: 127.0.1.1:10030
Sort task: 23 sent to node: 127.0.1.1:10040
Sort task 21 completed by node: 127.0.1.1:10020
Sort task: 24 sent to node: 127.0.1.1:10010
Sort task 22 completed by node: 127.0.1.1:10030
Sort task 23 completed by node: 127.0.1.1:10040
Sort task: 25 sent to node: 127.0.1.1:10020
Sort task 24 completed by node: 127.0.1.1:10010
Sort task 26 completed by node: 127.0.1.1:10030
Sort task 25 completed by node: 127.0.1.1:10020
-----
Starting merge
-----
Merge task 27 sent to node: 127.0.1.1:10010
Merge task 28 sent to node: 127.0.1.1:10020
Merge task 27 completed by node: 127.0.1.1:10010
Merge task 29 sent to node: 127.0.1.1:10030
Merge task 28 completed by node: 127.0.1.1:10020
Merge task 30 sent to node: 127.0.1.1:10040
Merge task 29 completed by node: 127.0.1.1:10030
Merge task 31 sent to node: 127.0.1.1:10010
Merge task 30 completed by node: 127.0.1.1:10040
Merge task 32 sent to node: 127.0.1.1:10020
Merge task 31 completed by node: 127.0.1.1:10010
Merge task 33 sent to node: 127.0.1.1:10030
Merge task 34 sent to node: 127.0.1.1:10040
Merge task 35 sent to node: 127.0.1.1:10010
Merge task 36 sent to node: 127.0.1.1:10020
Merge task 37 sent to node: 127.0.1.1:10030
Merge task 38 sent to node: 127.0.1.1:10040
Merge task 39 sent to node: 127.0.1.1:10010
Merge task 40 sent to node: 127.0.1.1:10020
Number of merges 14 merge files 14
Merge task 34 completed by node: 127.0.1.1:10040
Merge task 39 completed by node: 127.0.1.1:10010
```

```
devavratrk@Devavrat-PC: ~/workspace/PA3/bin
Merge task 44 completed by node: 127.0.1.1:10040
Merge task 46 sent to node: 127.0.1.1:10020
Merge task 45 completed by node: 127.0.1.1:10010
Merge task 47 sent to node: 127.0.1.1:10030
Number of merges 7 merge files 7
Merge task 47 completed by node: 127.0.1.1:10030
Merge task 46 completed by node: 127.0.1.1:10020
Merge task 48 sent to node: 127.0.1.1:10010
Merge task 49 sent to node: 127.0.1.1:10020
Merge task 50 sent to node: 127.0.1.1:10030
Merge task 48 completed by node: 127.0.1.1:10010
Merge task 49 completed by node: 127.0.1.1:10020
Merge task 51 sent to node: 127.0.1.1:10040
Merge task 50 completed by node: 127.0.1.1:10030
Number of merges 4 merge files 4
Merge task 51 completed by node: 127.0.1.1:10040
Merge task 52 sent to node: 127.0.1.1:10010
Merge task 53 sent to node: 127.0.1.1:10020
Number of merges 2 merge files 2
Merge task 52 completed by node: 127.0.1.1:10010
Merge task 53 completed by node: 127.0.1.1:10020
Merge task 54 sent to node: 127.0.1.1:10010
Number of merges 1 merge files 1
Merge task 54 completed by node: 127.0.1.1:10010

Job completed!!
Total time for job = 30170 ms

Initial number of compute nodes in the system: 4
Number of nodes that failed during job execution: 0
```

Some merges have been skipped from the terminal window output in the last screenshot to show the final few lines of the output. The final lines say that the whole job took about 30 seconds to complete and there were no compute node failures in the system, since the probability of failure at each node was 0. The large time can be attributed to having very small tasks in the system and now the processes of communication and thread creation and the reassign loop dominate to give a larger runtime than expected.

### 3) Sorting a larger file (200,000) with a probability of failure:

We now sort the smallest file out of the given input files, which has a size of 977,556 bytes, with chunk size parameter 5000 (5 kB) and merge list size parameter 20. Three nodes now have a failure probability of 0.5 and one node has a failure probability of 0. For more details on the failure injection logic, please refer to the design document. We now start the server and the compute node again with these parameters. The interesting parts of the output have been shown:

```
devavratrk@Devavrat-PC: ~/workspace/PA3/bin
Merge task 201 sent to node: 127.0.1.1:10020
Merge task 202 sent to node: 127.0.1.1:10030
Merge task 203 sent to node: 127.0.1.1:10040
Merge task 204 sent to node: 127.0.1.1:10010
Merge task 205 sent to node: 127.0.1.1:10020
Number of merges 10 merge files 10
Merge task 196 completed by node: 127.0.1.1:10010
Merge task 198 completed by node: 127.0.1.1:10030
Merge task 200 completed by node: 127.0.1.1:10010
Merge task 202 completed by node: 127.0.1.1:10030
Merge task 204 completed by node: 127.0.1.1:10010
Node 127.0.1.1:10020 is dead. Reassigning merge task: 197 to node: 127.0.1.1:10010
Node 127.0.1.1:10040 is dead. Reassigning merge task: 199 to node: 127.0.1.1:10010
Node 127.0.1.1:10020 is dead. Reassigning merge task: 201 to node: 127.0.1.1:10010
Node 127.0.1.1:10040 is dead. Reassigning merge task: 203 to node: 127.0.1.1:10010
Node 127.0.1.1:10020 is dead. Reassigning merge task: 205 to node: 127.0.1.1:10010
Merge task 199 completed by node: 127.0.1.1:10010
Merge task 201 completed by node: 127.0.1.1:10010
Merge task 197 completed by node: 127.0.1.1:10010
Merge task 203 completed by node: 127.0.1.1:10010
Merge task 205 completed by node: 127.0.1.1:10010
Merge task 206 sent to node: 127.0.1.1:10010
Number of merges 1 merge files 1
Merge task 206 completed by node: 127.0.1.1:10010

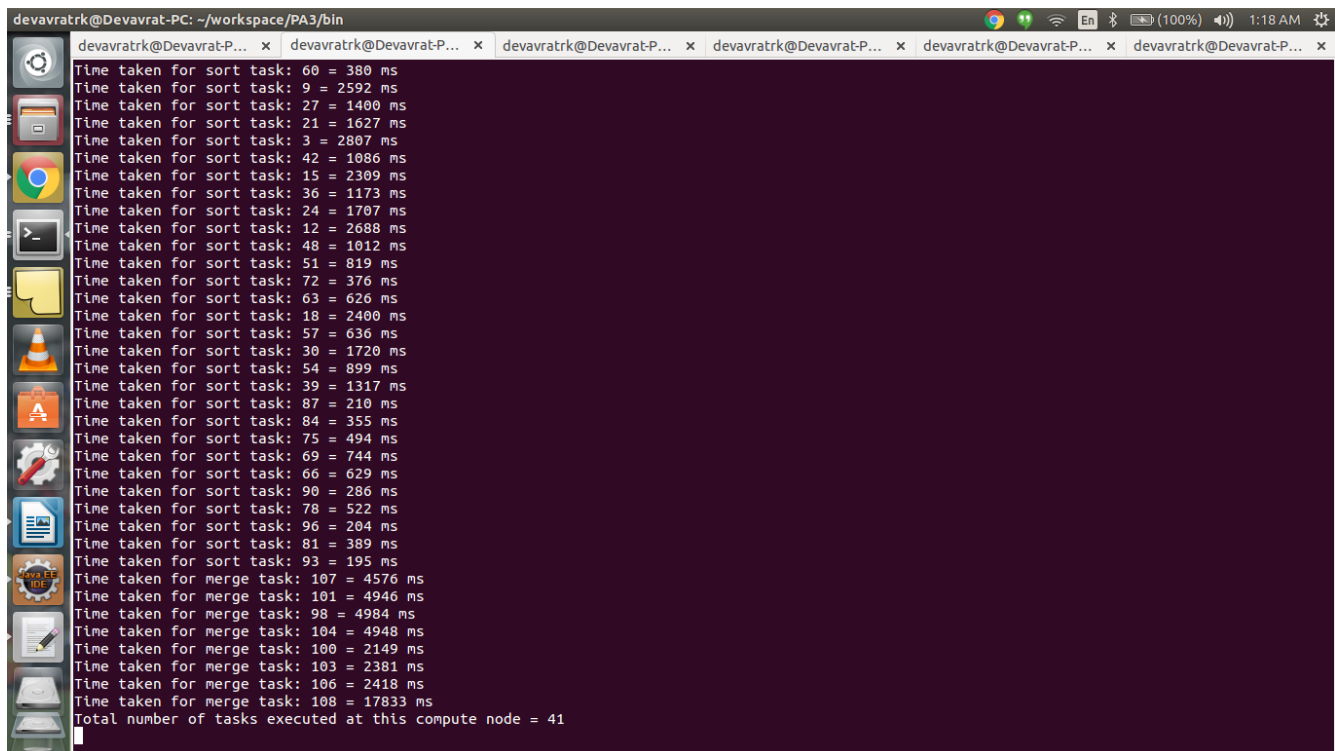
Job completed!!
Total time for job = 20573 ms

Initial number of compute nodes in the system: 4
Number of nodes that failed during job execution: 2
```

We see from the above screenshot that nodes 2 and 4 died while the merge process was going on and their merge tasks were reassigned. The job took 20 seconds to run and 2 nodes failed during execution.

#### 4) Sorting the largest file (20,000,000) with a probability of failure:

We now sort the largest file out of the given input files, which has a size of 97,777,906 bytes, with chunk size parameter 1000000 (1 MB) and merge list size parameter 10. Three nodes now have a failure probability of 0.5 and one node has a failure probability of 0. For more details on the failure injection logic, please refer to the design document. We now start the server and the compute node again with these parameters. The interesting parts of the output have been shown:



```
devavratk@Devavrat-PC: ~/workspace/PA3/bin
Time taken for sort task: 60 = 380 ms
Time taken for sort task: 9 = 2592 ms
Time taken for sort task: 27 = 1400 ms
Time taken for sort task: 21 = 1627 ms
Time taken for sort task: 3 = 2807 ms
Time taken for sort task: 42 = 1086 ms
Time taken for sort task: 15 = 2309 ms
Time taken for sort task: 36 = 1173 ms
Time taken for sort task: 24 = 1707 ms
Time taken for sort task: 12 = 2688 ms
Time taken for sort task: 48 = 1012 ms
Time taken for sort task: 51 = 819 ms
Time taken for sort task: 72 = 376 ms
Time taken for sort task: 63 = 626 ms
Time taken for sort task: 18 = 2400 ms
Time taken for sort task: 57 = 636 ms
Time taken for sort task: 30 = 1720 ms
Time taken for sort task: 54 = 899 ms
Time taken for sort task: 39 = 1317 ms
Time taken for sort task: 87 = 210 ms
Time taken for sort task: 84 = 355 ms
Time taken for sort task: 75 = 494 ms
Time taken for sort task: 69 = 744 ms
Time taken for sort task: 66 = 629 ms
Time taken for sort task: 90 = 286 ms
Time taken for sort task: 78 = 522 ms
Time taken for sort task: 96 = 204 ms
Time taken for sort task: 81 = 389 ms
Time taken for sort task: 93 = 195 ms
Time taken for merge task: 107 = 4576 ms
Time taken for merge task: 101 = 4946 ms
Time taken for merge task: 98 = 4984 ms
Time taken for merge task: 104 = 4948 ms
Time taken for merge task: 100 = 2149 ms
Time taken for merge task: 103 = 2381 ms
Time taken for merge task: 106 = 2418 ms
Time taken for merge task: 108 = 17833 ms
Total number of tasks executed at this compute node = 41
```

The above screenshot is from a compute node. It shows the time each sort and merge task took and the total number of tasks it executed.

```
devavratk@Devavrat-PC: ~/workspace/PA3/bin
devavratk@Devavrat-P... x devavratk@Devavrat-P... x devavratk@Devavrat-P... x devavratk@Devavrat-P... x devavratk@Devavrat-P... x
Sort task 81 completed by node: 127.0.1.1:10010
Sort task 93 completed by node: 127.0.1.1:10010
-----
Starting merge
-----
Merge task 98 sent to node: 127.0.1.1:10010
Merge task 99 sent to node: 127.0.1.1:10020
Merge task 100 sent to node: 127.0.1.1:10030
Merge task 101 sent to node: 127.0.1.1:10010
Merge task 102 sent to node: 127.0.1.1:10020
Merge task 103 sent to node: 127.0.1.1:10030
Merge task 104 sent to node: 127.0.1.1:10010
Merge task 105 sent to node: 127.0.1.1:10020
Merge task 106 sent to node: 127.0.1.1:10030
Merge task 107 sent to node: 127.0.1.1:10010
Number of merges 10 merge files 10
Merge task 99 completed by node: 127.0.1.1:10020
Merge task 102 completed by node: 127.0.1.1:10020
Merge task 105 completed by node: 127.0.1.1:10020
Merge task 107 completed by node: 127.0.1.1:10010
Merge task 101 completed by node: 127.0.1.1:10010
Merge task 98 completed by node: 127.0.1.1:10010
Merge task 104 completed by node: 127.0.1.1:10010
Node 127.0.1.1:10030 is dead. Reassigning merge task: 100 to node: 127.0.1.1:10010
Node 127.0.1.1:10030 is dead. Reassigning merge task: 103 to node: 127.0.1.1:10010
Node 127.0.1.1:10030 is dead. Reassigning merge task: 106 to node: 127.0.1.1:10010
Merge task 100 completed by node: 127.0.1.1:10010
Merge task 103 completed by node: 127.0.1.1:10010
Merge task 106 completed by node: 127.0.1.1:10010
Merge task 108 sent to node: 127.0.1.1:10010
Number of merges 1 merge files 1
Merge task 108 completed by node: 127.0.1.1:10010

Job completed!!
Total time for job = 38169 ms
```

We see from the above screenshot that node 3 died while the merge process was going on and merge tasks were reassigned. The job took 38 seconds to run. We verified the files in the output folder and they had been sorted.