3fs实验

实验结果

BigDataBench-MPI-Sort对比实验

和其他分布式文件系统对比：

benchmark	3FS运行时间	HDFS运行时间	Lustre系统运行时间
MPI-Sort	33s	40s	5s

使用fio工具进行实验

使用fio工具的原因是3fs本身不使用cache，可以通过fio工具进行直接测试（-direct=1参数）。
读取结果：

```
顺序读：
READ: bw=43.8MiB/s (45.9MB/s), 43.8MiB/s-43.8MiB/s (45.9MB/s-45.9MB/s), io=7880MiB (8263MB), run=180073-180073msec
随机读：
READ: bw=40.4MiB/s (42.4MB/s), 40.4MiB/s-40.4MiB/s (42.4MB/s-42.4MB/s), io=7280MiB (7634MB), run=180135-180135msec
```

BigDataBench-MPI-Sort实验

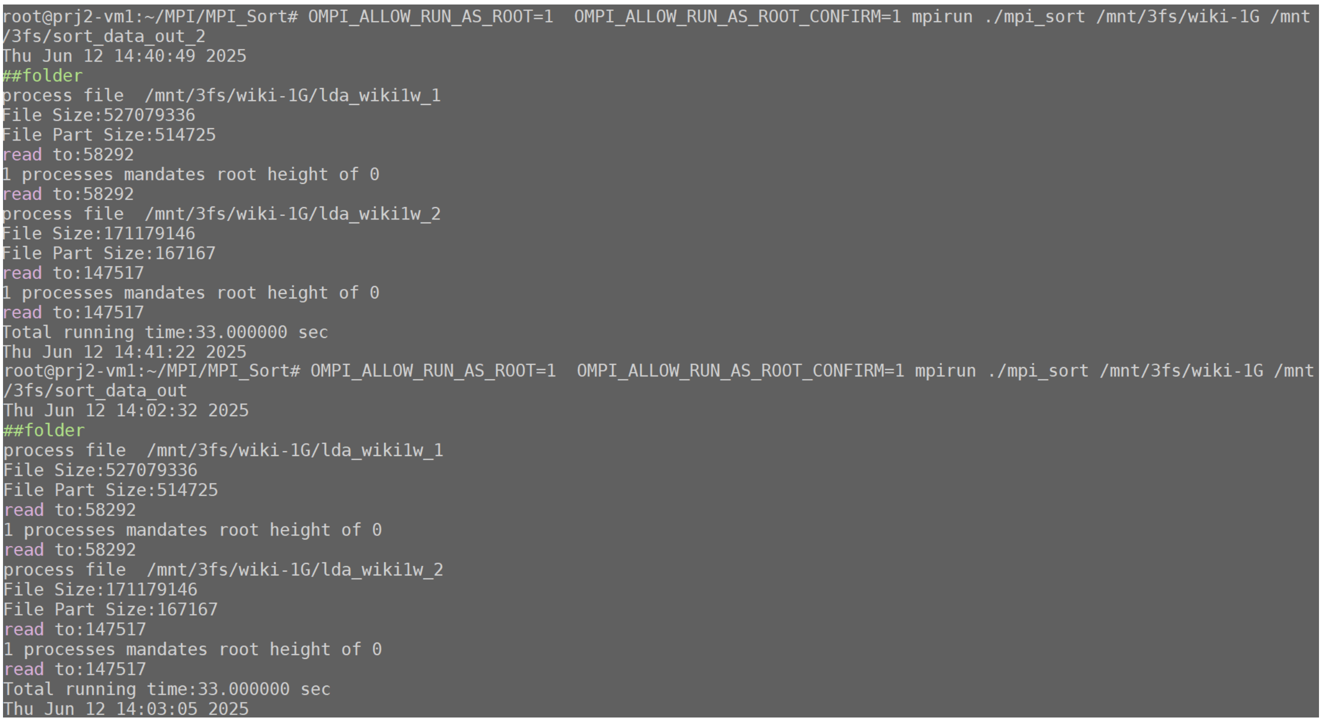
排序时间统计

单机上排序时间：33sec

【五次实验取众数,33sec-36sec之间】

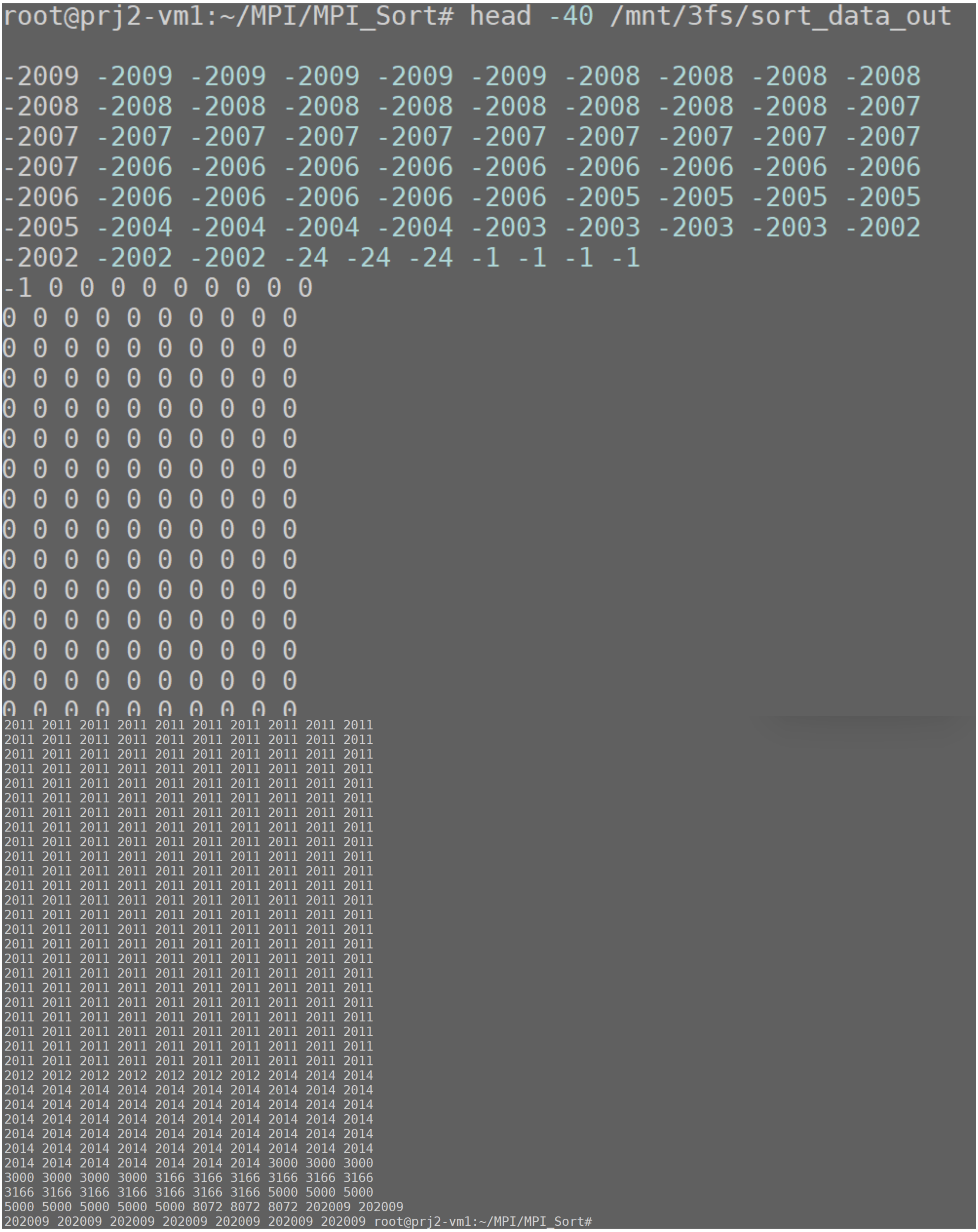
```
 OMPI_ALLOW_RUN_AS_ROOT=1  OMPI_ALLOW_RUN_AS_ROOT_CONFIRM=1 mpirun ./mpi_sort /mnt/3fs/wiki-1G /mnt/3fs/sort_data_out
```

实验结果：



```
root@prj2-vm1:~/MPI/MPI_Sort# OMPI_ALLOW_RUN_AS_ROOT=1  OMPI_ALLOW_RUN_AS_ROOT_CONFIRM=1 mpirun ./mpi_sort /mnt/3fs/wiki-1G /mnt
/3fs/sort_data_out_2
Thu Jun 12 14:40:49 2025
##folder
process file  /mnt/3fs/wiki-1G/lda_wiki1w_1
File Size:527079336
File Part Size:514725
read to:58292
1 processes mandates root height of 0
read to:58292
process file  /mnt/3fs/wiki-1G/lda_wiki1w_2
File Size:171179146
File Part Size:167167
read to:147517
1 processes mandates root height of 0
read to:147517
Total running time:33.000000 sec
Thu Jun 12 14:41:22 2025
root@prj2-vm1:~/MPI/MPI_Sort# OMPI_ALLOW_RUN_AS_ROOT=1  OMPI_ALLOW_RUN_AS_ROOT_CONFIRM=1 mpirun ./mpi_sort /mnt/3fs/wiki-1G /mnt
/3fs/sort_data_out
Thu Jun 12 14:02:32 2025
##folder
process file  /mnt/3fs/wiki-1G/lda_wiki1w_1
File Size:527079336
File Part Size:514725
read to:58292
1 processes mandates root height of 0
read to:58292
process file  /mnt/3fs/wiki-1G/lda_wiki1w_2
File Size:171179146
File Part Size:167167
read to:147517
1 processes mandates root height of 0
read to:147517
Total running time:33.000000 sec
Thu Jun 12 14:03:05 2025
```

排序结果：



```
root@prj2-vm1:~/MPI/MPI_Sort# head -40 /mnt/3fs/sort_data_out

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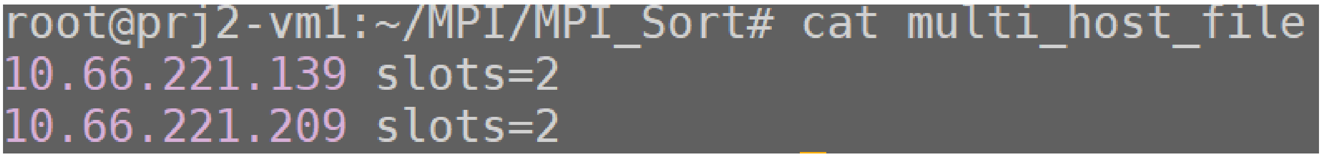
202009 202009 202009 202009 202009 202009 202009 root@prj2-vm1:~/MPI/MPI_Sort#
```

双机上多进程协同排序结果：122sec

【配置略等同lustre，但是对3fs来说没必要】

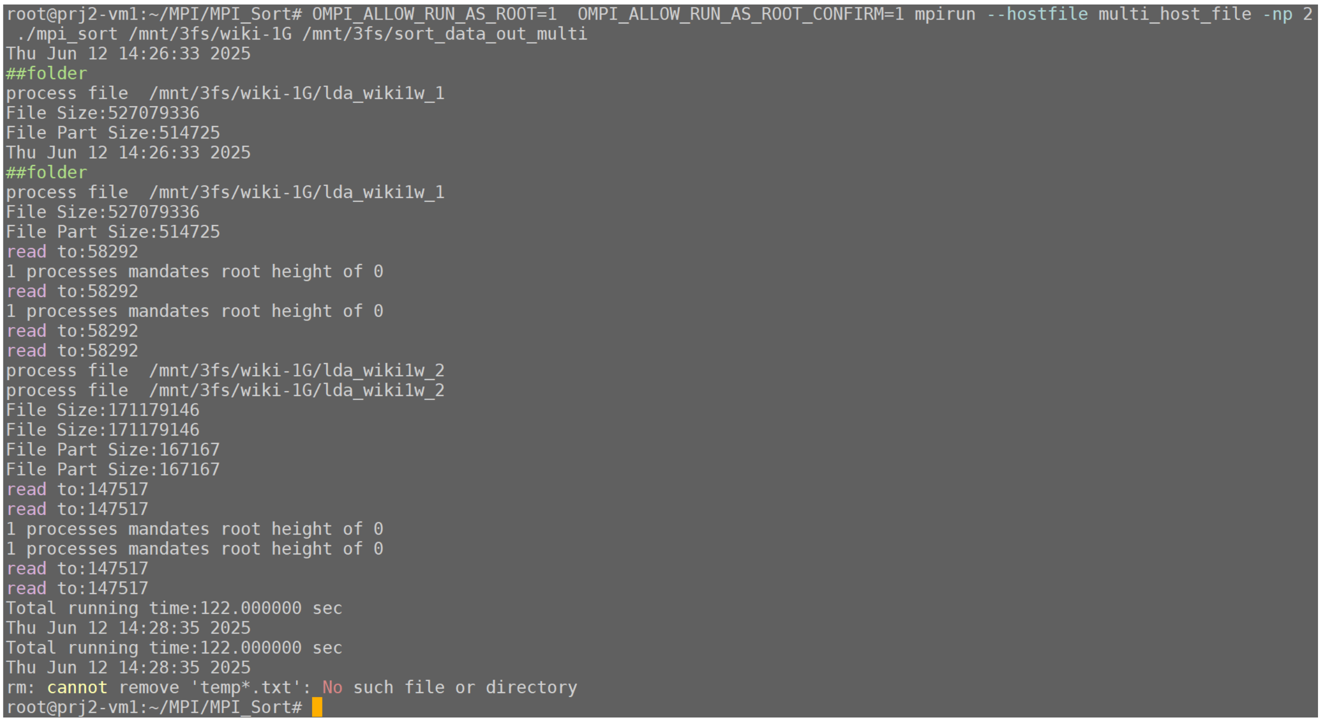
```
OMPI_ALLOW_RUN_AS_ROOT=1  OMPI_ALLOW_RUN_AS_ROOT_CONFIRM=1 mpirun --
hostfile multi_host_file -np 2 ./mpi_sort /mnt/3fs/wiki-1G
/mnt/3fs/sort_data_out_multi
```

multi_host_file内容：



```
root@prj2-vm1:~/MPI/MPI_Sort# cat multi_host_file
10.66.221.139 slots=2
10.66.221.209 slots=2
```

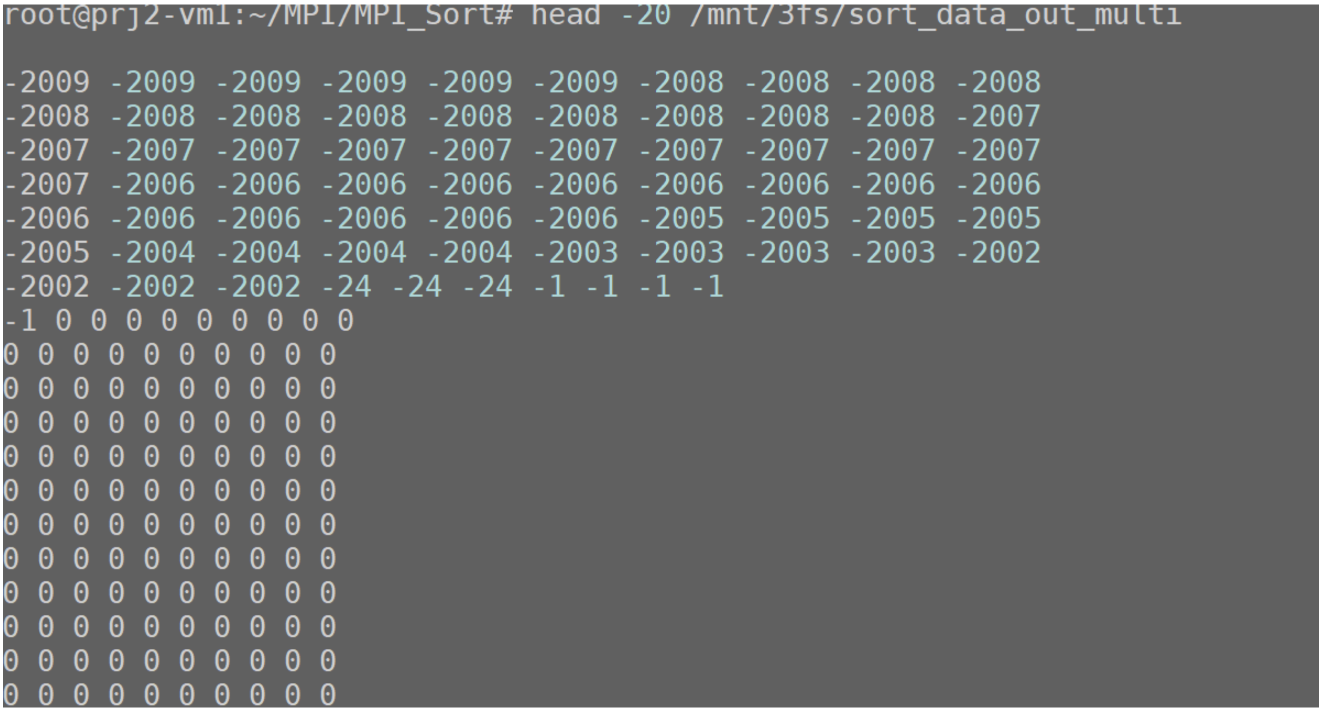
排序时间：



```
root@prj2-vm1:~/MPI/MPI_Sort# OMPI_ALLOW_RUN_AS_ROOT=1  OMPI_ALLOW_RUN_AS_ROOT_CONFIRM=1 mpirun --hostfile multi_host_file -np 2
 ./mpi_sort /mnt/3fs/wiki-1G /mnt/3fs/sort_data_out_multi
Thu Jun 12 14:26:33 2025
##folder
process file  /mnt/3fs/wiki-1G/lda_wiki1w_1
File Size:527079336
File Part Size:514725
Thu Jun 12 14:26:33 2025
##folder
process file  /mnt/3fs/wiki-1G/lda_wiki1w_1
File Size:527079336
File Part Size:514725
read to:58292
1 processes mandates root height of 0
read to:58292
1 processes mandates root height of 0
read to:58292
read to:58292
process file  /mnt/3fs/wiki-1G/lda_wiki1w_2
process file  /mnt/3fs/wiki-1G/lda_wiki1w_2
File Size:171179146
File Size:171179146
File Part Size:167167
File Part Size:167167
read to:147517
read to:147517
1 processes mandates root height of 0
1 processes mandates root height of 0
read to:147517
read to:147517
Total running time:122.000000 sec
Thu Jun 12 14:28:35 2025
Total running time:122.000000 sec
Thu Jun 12 14:28:35 2025
rm: cannot remove 'temp*.txt': No such file or directory
root@prj2-vm1:~/MPI/MPI_Sort# 
```

排序结果：

```
head -20 /mnt/3fs/sort_data_out_multi
```



```
root@prj2-vm1:~/MPI/MPI_Sort# head -20 /mnt/3fs/sort_data_out_multi

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-1 0 0 0 0 0 0 0 0 0
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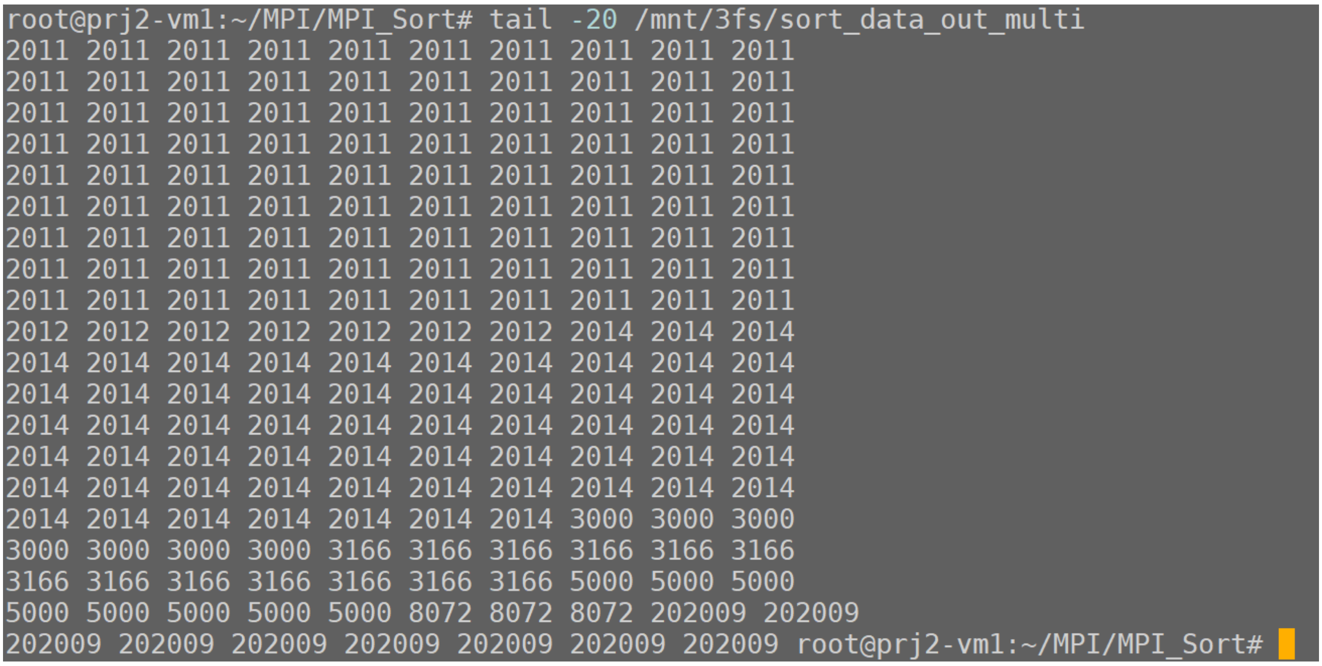
0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0
```

```
tail -20 /mnt/3fs/sort_data_out_multi
```



```
root@prj2-vm1:~/MPI/MPI_Sort# tail -20 /mnt/3fs/sort_data_out_multi
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202009 202009 202009 202009 202009 202009 202009 root@prj2-vm1:~/MPI/MPI_Sort# 
```

猜想：

受网络影响较大。

关于BigBench-MPI-Sort的配置

BigDataBench的MPI-Sort生成的是文本+数据

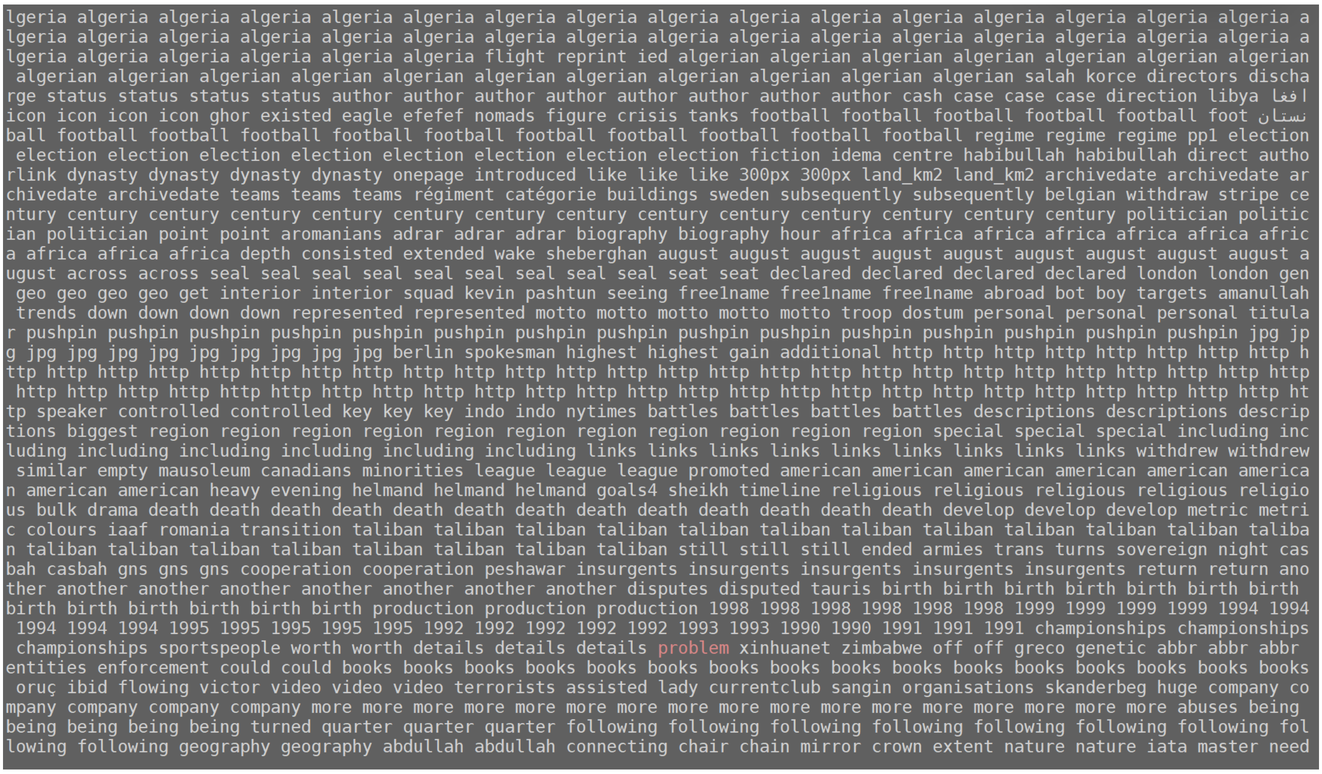
```
echo "Preparing MicroBenchmarks data dir"

WORK_DIR="/mnt/3fs"

echo "WORK_DIR=$WORK_DIR data will be put in $WORK_DIR"

cd ../../BigDataGeneratorSuite/Text_datagen/

echo "print data size GB :"
read GB
a=${GB}
L=$((a * 2))
./gen_text_data.sh lda_wiki1w $L 8000 10000 ${WORK_DIR}/wiki-$a"G"
```



```
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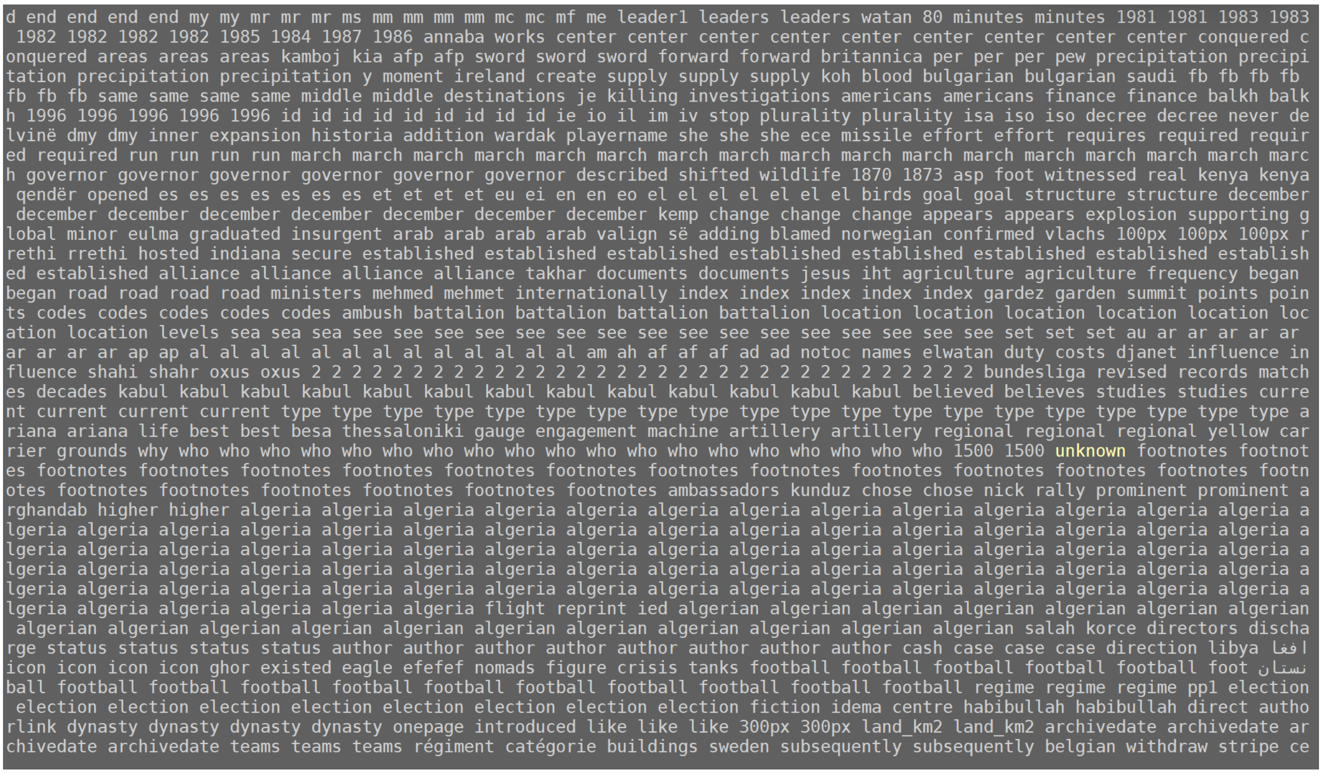
BigDataBench数据生成结果：



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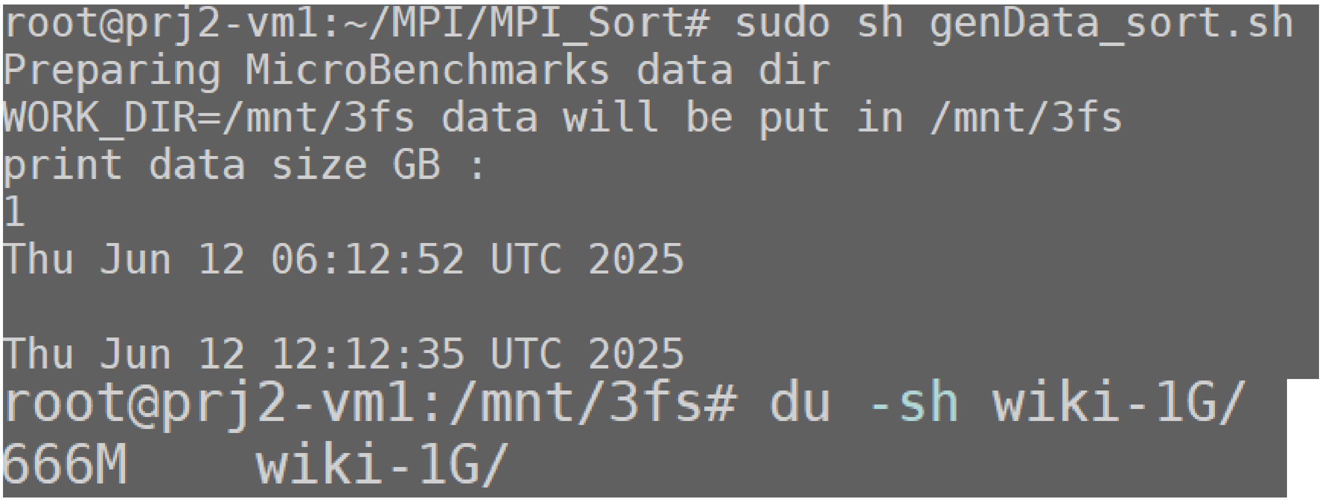
其他问题

排序文本预期生成的是1个G，但是为什么输出的是666M?



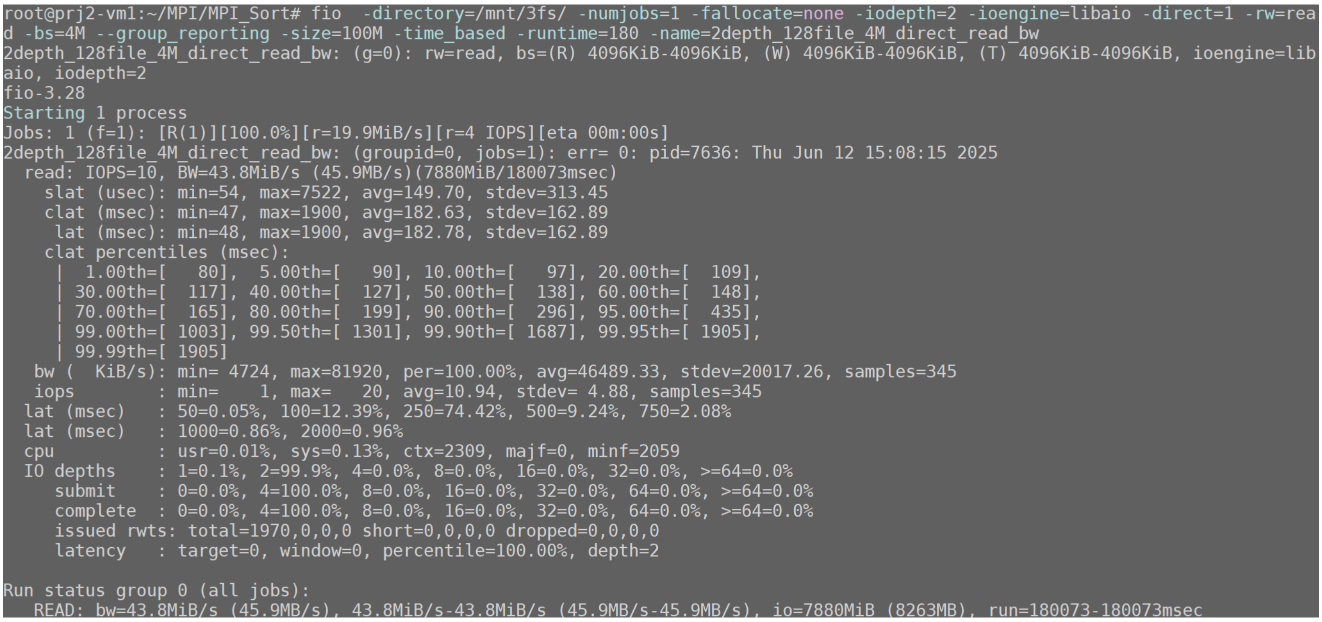
```
root@prj2-vm1:~/MPI/MPI_Sort# sudo sh genData_sort.sh
Preparing MicroBenchmarks data dir
WORK_DIR=/mnt/3fs data will be put in /mnt/3fs
print data size GB :
1
Thu Jun 12 06:12:52 UTC 2025

Thu Jun 12 12:12:35 UTC 2025
root@prj2-vm1:/mnt/3fs# du -sh wiki-1G/
666M    wiki-1G/
```

fio实验

顺序读:

```
fio  -directory=/mnt/3fs/ -numjobs=1 -fallocate=none -iodepth=2 -
ioengine=libaio -direct=1 -rw=read -bs=4M --group_reporting -size=100M -
time_based -runtime=180 -name=2depth_128file_4M_direct_read_bw
```

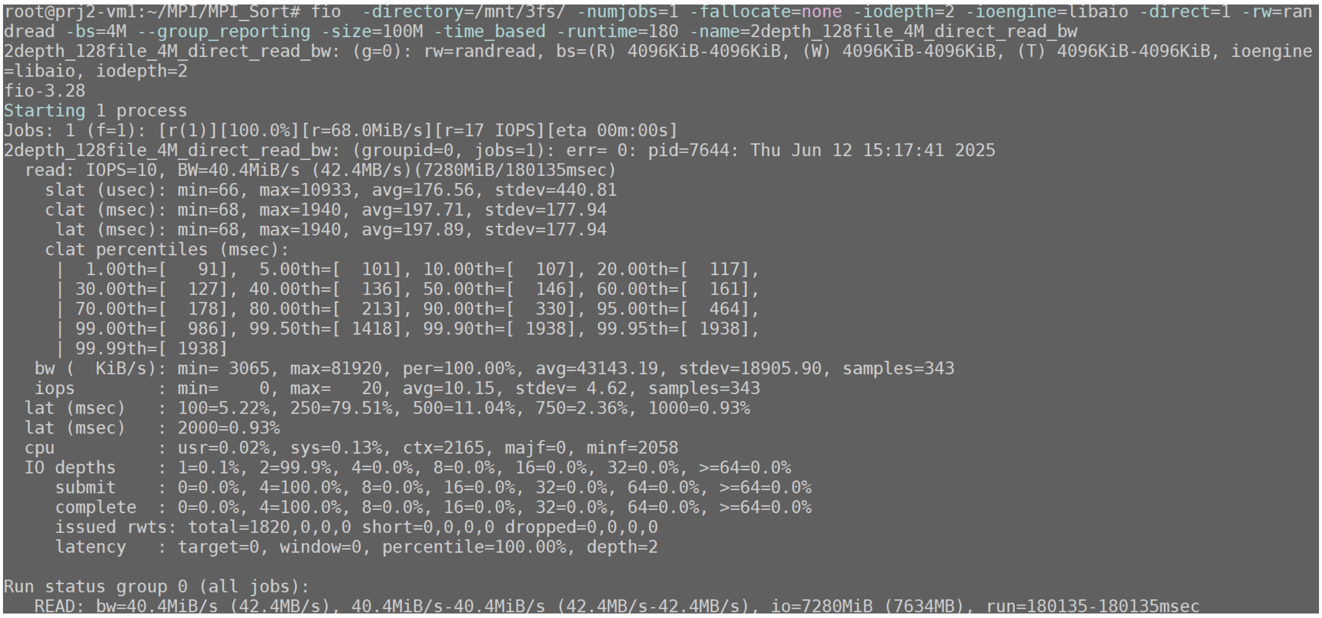


```
root@prj2-vm1:~/MPI/MPI_Sort# fio  -directory=/mnt/3fs/ -numjobs=1 -fallocate=none -iodepth=2 -ioengine=libaio -direct=1 -rw=rea
d -bs=4M --group_reporting -size=100M -time_based -runtime=180 -name=2depth_128file_4M_direct_read_bw
2depth_128file_4M_direct_read_bw: (g=0): rw=read, bs=(R) 4096KiB-4096KiB, (W) 4096KiB-4096KiB, (T) 4096KiB-4096KiB, ioengine=lib
aio, iodepth=2
fio-3.28
Starting 1 process
Jobs: 1 (f=1): [R(1)][100.0%][r=19.9MiB/s][r=4 IOPS][eta 00m:00s]
2depth_128file_4M_direct_read_bw: (groupid=0, jobs=1): err= 0: pid=7636: Thu Jun 12 15:08:15 2025
  read: IOPS=10, BW=43.8MiB/s (45.9MB/s)(7880MiB/180073msec)
    slat (usec): min=54, max=7522, avg=149.70, stdev=313.45
    clat (msec): min=47, max=1900, avg=182.63, stdev=162.89
     lat (msec): min=48, max=1900, avg=182.78, stdev=162.89
    clat percentiles (msec):
     |  1.00th=[   80],  5.00th=[   90], 10.00th=[   97], 20.00th=[  109],
     | 30.00th=[  117], 40.00th=[  127], 50.00th=[  138], 60.00th=[  148],
     | 70.00th=[  165], 80.00th=[  199], 90.00th=[  296], 95.00th=[  435],
     | 99.00th=[ 1003], 99.50th=[ 1301], 99.90th=[ 1687], 99.95th=[ 1905],
     | 99.99th=[ 1905]
   bw (  KiB/s): min= 4724, max=81920, per=100.00%, avg=46489.33, stdev=20017.26, samples=345
   iops        : min=    1, max=   20, avg=10.94, stdev= 4.88, samples=345
  lat (msec)   : 50=0.05%, 100=12.39%, 250=74.42%, 500=9.24%, 750=2.08%
  lat (msec)   : 1000=0.86%, 2000=0.96%
  cpu          : usr=0.01%, sys=0.13%, ctx=2309, majf=0, minf=2059
  IO depths    : 1=0.1%, 2=99.9%, 4=0.0%, 8=0.0%, 16=0.0%, 32=0.0%, >=64=0.0%
     submit    : 0=0.0%, 4=100.0%, 8=0.0%, 16=0.0%, 32=0.0%, 64=0.0%, >=64=0.0%
     complete  : 0=0.0%, 4=100.0%, 8=0.0%, 16=0.0%, 32=0.0%, 64=0.0%, >=64=0.0%
     issued rwts: total=1970,0,0,0 short=0,0,0,0 dropped=0,0,0,0
     latency   : target=0, window=0, percentile=100.00%, depth=2

Run status group 0 (all jobs):
   READ: bw=43.8MiB/s (45.9MB/s), 43.8MiB/s-43.8MiB/s (45.9MB/s-45.9MB/s), io=7880MiB (8263MB), run=180073-180073msec
```

随机读:

```
fio  -directory=/mnt/3fs/ -numjobs=1 -fallocate=none -iodepth=2 -
ioengine=libaio -direct=1 -rw=randread -bs=4M --group_reporting -
size=100M -time_based -runtime=180 -name=2depth_128file_4M_direct_read_bw
```



```
root@prj2-vm1:~/MPI/MPI_Sort# fio  -directory=/mnt/3fs/ -numjobs=1 -fallocate=none -iodepth=2 -ioengine=libaio -direct=1 -rw=ran
dread -bs=4M --group_reporting -size=100M -time_based -runtime=180 -name=2depth_128file_4M_direct_read_bw
2depth_128file_4M_direct_read_bw: (g=0): rw=randread, bs=(R) 4096KiB-4096KiB, (W) 4096KiB-4096KiB, (T) 4096KiB-4096KiB, ioengine
=libaio, iodepth=2
fio-3.28
Starting 1 process
Jobs: 1 (f=1): [r(1)][100.0%][r=68.0MiB/s][r=17 IOPS][eta 00m:00s]
2depth_128file_4M_direct_read_bw: (groupid=0, jobs=1): err= 0: pid=7644: Thu Jun 12 15:17:41 2025
  read: IOPS=10, BW=40.4MiB/s (42.4MB/s)(7280MiB/180135msec)
    slat (usec): min=66, max=10933, avg=176.56, stdev=440.81
    clat (msec): min=68, max=1940, avg=197.71, stdev=177.94
     lat (msec): min=68, max=1940, avg=197.89, stdev=177.94
    clat percentiles (msec):
     |  1.00th=[   91],  5.00th=[  101], 10.00th=[  107], 20.00th=[  117],
     | 30.00th=[  127], 40.00th=[  136], 50.00th=[  146], 60.00th=[  161],
     | 70.00th=[  178], 80.00th=[  213], 90.00th=[  330], 95.00th=[  464],
     | 99.00th=[  986], 99.50th=[ 1418], 99.90th=[ 1938], 99.95th=[ 1938],
     | 99.99th=[ 1938]
   bw (  KiB/s): min= 3065, max=81920, per=100.00%, avg=43143.19, stdev=18905.90, samples=343
   iops        : min=    0, max=   20, avg=10.15, stdev= 4.62, samples=343
  lat (msec)   : 100=5.22%, 250=79.51%, 500=11.04%, 750=2.36%, 1000=0.93%
  lat (msec)   : 2000=0.93%
  cpu          : usr=0.02%, sys=0.13%, ctx=2165, majf=0, minf=2058
  IO depths    : 1=0.1%, 2=99.9%, 4=0.0%, 8=0.0%, 16=0.0%, 32=0.0%, >=64=0.0%
     submit    : 0=0.0%, 4=100.0%, 8=0.0%, 16=0.0%, 32=0.0%, 64=0.0%, >=64=0.0%
     complete  : 0=0.0%, 4=100.0%, 8=0.0%, 16=0.0%, 32=0.0%, 64=0.0%, >=64=0.0%
     issued rwts: total=1820,0,0,0 short=0,0,0,0 dropped=0,0,0,0
     latency   : target=0, window=0, percentile=100.00%, depth=2

Run status group 0 (all jobs):
   READ: bw=40.4MiB/s (42.4MB/s), 40.4MiB/s-40.4MiB/s (42.4MB/s-42.4MB/s), io=7280MiB (7634MB), run=180135-180135msec
```

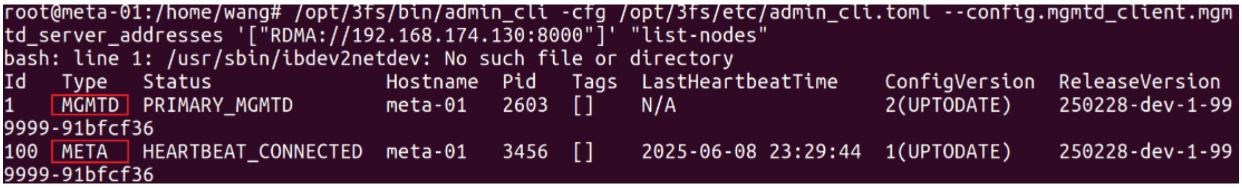
具体部署事项

写在前面

没有真实RDMA设备采用softRoCE方式时，外部必须是**Generic内核的完整Linux**环境，不管是编译部署还是docker部署，否则没有rxe模块。

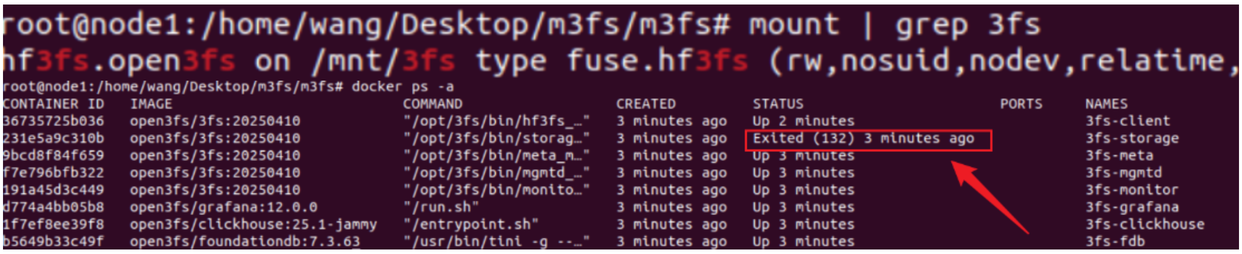
非常容易忽略的点，如果是硬件指令集没有avx512的时候，建议直接换有avx512机器。根据实践，使用虚拟机上是无法正常运行的（无论使用哪一种部署方式），哪怕给4G内存，128G的磁盘。在本地虚拟机上硬部署的结果（这个也有可能是本地的硬件带不动，但是由于之前服务器上的lxc容器是没有内核的，所以所有的尝试都在本地，大失败）：

1. 按照官方文件编译配置，编译成功，但是无法正常使用，尤其是Storage节点无法启动，直接卡死挂掉。



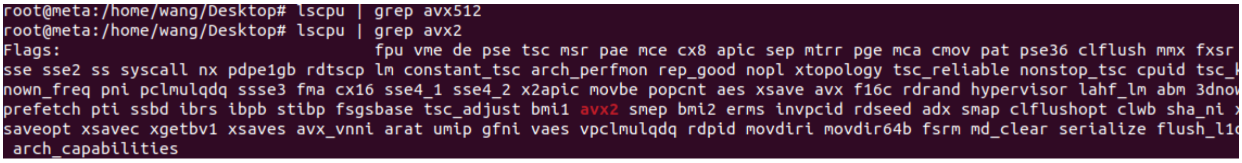
```
root@meta-01:/home/wang# /opt/3fs/bin/admin_cli -cfg /opt/3fs/etc/admin_cli.toml --config.mgmtd_client.mgm
td_server_addresses '["RDMA://192.168.174.130:8000"]' "list-nodes"
bash: line 1: /usr/sbin/ibdev2netdev: No such file or directory
Id   Type    Status               Hostname  Pid   Tags  LastHeartbeatTime    ConfigVersion  ReleaseVersion
1    MGMTD   PRIMARY_MGMTD        meta-01   2603  []    N/A                  2(UPTODATE)    250228-dev-1-99
9999-91bfcf36
100  META    HEARTBEAT_CONNECTED  meta-01   3456  []    2025-06-08 23:29:44  1(UPTODATE)    250228-dev-1-99
9999-91bfcf36
```

2. 按照docker方式部署，部署成功，挂载成功，但是storage异常退出，退出码351，为指令不兼容。使用-avx2版本的结果：通官方编译结果，直接卡死，挂掉，而且难以收集异常退出信息。



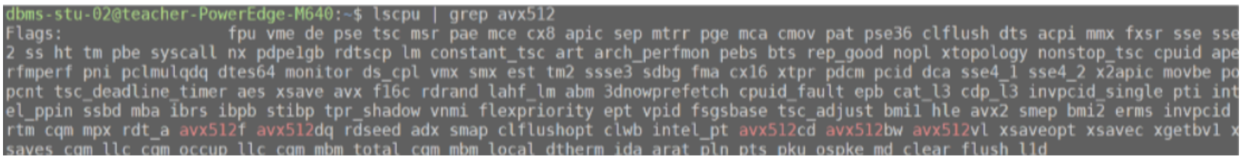
```
root@node1:/home/wang/Desktop/m3fs/m3fs# mount | grep 3fs
hf3fs.open3fs on /mnt/3fs type fuse.hf3fs (rw,nosuid,nodev,relatime,
root@node1:/home/wang/Desktop/m3fs/m3fs# docker ps -a
CONTAINER ID   IMAGE                             COMMAND                  CREATED         STATUS                       PORTS     NAMES
36735725b036   open3fs/3fs:20250410              "/opt/3fs/bin/hf3fs_…"   3 minutes ago   Up 2 minutes                           3fs-client
231e5a9c310b   open3fs/3fs:20250410              "/opt/3fs/bin/storag…"   3 minutes ago   Exited (132) 3 minutes ago             3fs-storage
9bcd8f84f659   open3fs/3fs:20250410              "/opt/3fs/bin/meta_m…"   3 minutes ago   Up 3 minutes                           3fs-meta
f7e796bfb322   open3fs/3fs:20250410              "/opt/3fs/bin/mgmtd_…"   3 minutes ago   Up 3 minutes                           3fs-mgmtd
191a45d3c449   open3fs/3fs:20250410              "/opt/3fs/bin/monito…"   3 minutes ago   Up 3 minutes                           3fs-monitor
d774a4bb05b8   open3fs/grafana:12.0.0            "/run.sh"                3 minutes ago   Up 3 minutes                           3fs-grafana
1f7ef8ee39f8   open3fs/clickhouse:25.1-jammy     "/entrypoint.sh"         3 minutes ago   Up 3 minutes                           3fs-clickhouse
b5649b33c49f   open3fs/foundationdb:7.3.63       "/usr/bin/tini -g --…"   3 minutes ago   Up 3 minutes                           3fs-fdb
```

完全没成功的lscpu，只有avx2：



```
root@meta:/home/wang/Desktop# lscpu | grep avx512
root@meta:/home/wang/Desktop# lscpu | grep avx2
Flags:                              fpu vme de pse tsc msr pae mce cx8 apic sep mtrr pge mca cmov pat pse36 clflush mmx fxsr
sse sse2 ss syscall nx pdpe1gb rdtscp lm constant_tsc arch_perfmon rep_good nopl xtopology tsc_reliable nonstop_tsc cpuid tsc_k
nown_freq pni pclmulqdq ssse3 fma cx16 sse4_1 sse4_2 x2apic movbe popcnt aes xsave avx f16c rdrand hypervisor lahf_lm abm 3dnow
prefetch pti ssbd ibrs ibpb stibp fsgsbase tsc_adjust bmi1 avx2 smep bmi2 erms invpcid rdseed adx smap clflushopt clwb sha_ni x
saveopt xsavec xgetbv1 xsaves avx_vnni arat umip gfni vaes vpclmulqdq rdpid movdiri movdir64b fsrm md_clear serialize flush_l1d
 arch_capabilities
```

成功的lscpu，有avx512：

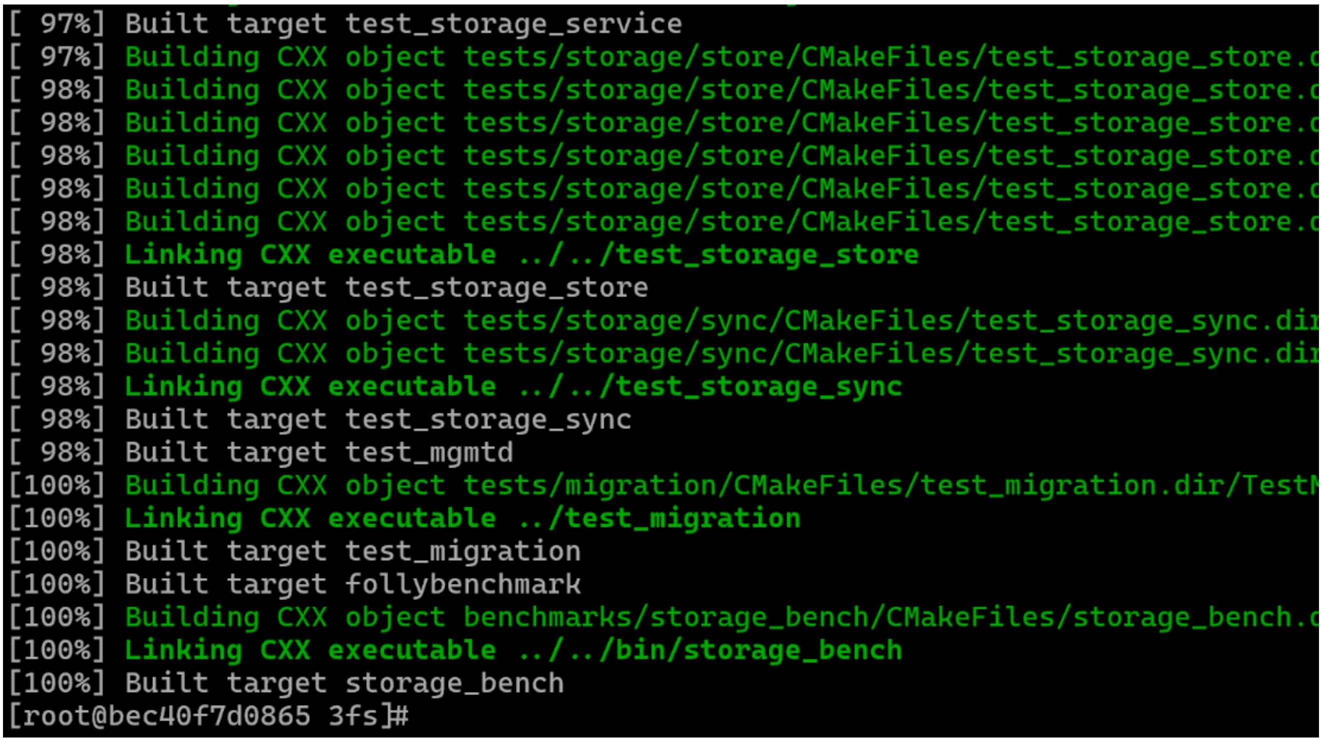


```
dbms-stu-02@teacher-PowerEdge-M640:~$ lscpu | grep avx512
Flags:                  fpu vme de pse tsc msr pae mce cx8 apic sep mtrr pge mca cmov pat pse36 clflush dts acpi mmx fxsr sse sse
2 ss ht tm pbe syscall nx pdpe1gb rdtscp lm constant_tsc art arch_perfmon pebs bts rep_good nopl xtopology nonstop_tsc cpuid ape
rfmperf pni pclmulqdq dtes64 monitor ds_cpl vmx smx est tm2 ssse3 sdbg fma cx16 xtpr pdcm pcid dca sse4_1 sse4_2 x2apic movbe po
pcnt tsc_deadline_timer aes xsave avx f16c rdrand lahf_lm abm 3dnowprefetch cpuid_fault epb cat_l3 cdp_l3 invpcid_single pti int
el_ppin ssbd mba ibrs ibpb stibp tpr_shadow vnmi flexpriority ept vpid fsgsbase tsc_adjust bmi1 hle avx2 smep bmi2 erms invpcid
rtm cqm mpx rdt_a avx512f avx512dq rdseed adx smap clflushopt clwb intel_pt avx512cd avx512bw avx512vl xsaveopt xsavec xgetbv1 x
saves cqm_llc cqm_occup_llc cqm_mbm_total cqm_mbm_local dtherm ida arat pln pts pku ospke md_clear flush_l1d
```

部署方式一：编译文件

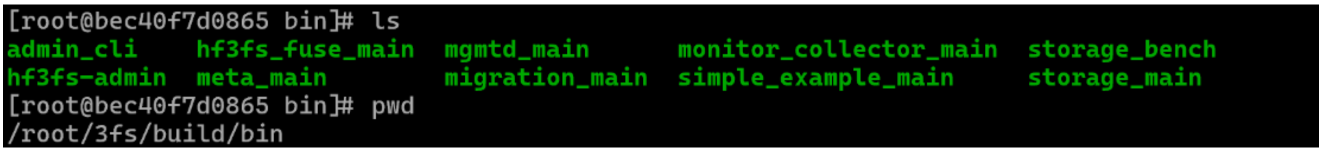
按照官方文件进行，编译安装。问题是编译安装时间过长，而且配置文件的修改需要自己手动修改，有些冗余。好处是知道各种结构，搭配配置文件可塑性强。

编译结果：



```
[ 97%] Built target test_storage_service
[ 97%] Building CXX object tests/storage/store/CMakeFiles/test_storage_store.d
[ 98%] Building CXX object tests/storage/store/CMakeFiles/test_storage_store.d
[ 98%] Building CXX object tests/storage/store/CMakeFiles/test_storage_store.d
[ 98%] Building CXX object tests/storage/store/CMakeFiles/test_storage_store.d
[ 98%] Building CXX object tests/storage/store/CMakeFiles/test_storage_store.d
[ 98%] Building CXX object tests/storage/store/CMakeFiles/test_storage_store.d
[ 98%] Linking CXX executable ../../test_storage_store
[ 98%] Built target test_storage_store
[ 98%] Building CXX object tests/storage/sync/CMakeFiles/test_storage_sync.dir
[ 98%] Building CXX object tests/storage/sync/CMakeFiles/test_storage_sync.dir
[ 98%] Linking CXX executable ../../test_storage_sync
[ 98%] Built target test_storage_sync
[ 98%] Built target test_mgmtd
[100%] Building CXX object tests/migration/CMakeFiles/test_migration.dir/TestM
[100%] Linking CXX executable ../test_migration
[100%] Built target test_migration
[100%] Built target follybenchmark
[100%] Building CXX object benchmarks/storage_bench/CMakeFiles/storage_bench.d
[100%] Linking CXX executable ../../bin/storage_bench
[100%] Built target storage_bench
[root@bec40f7d0865 3fs]#
```

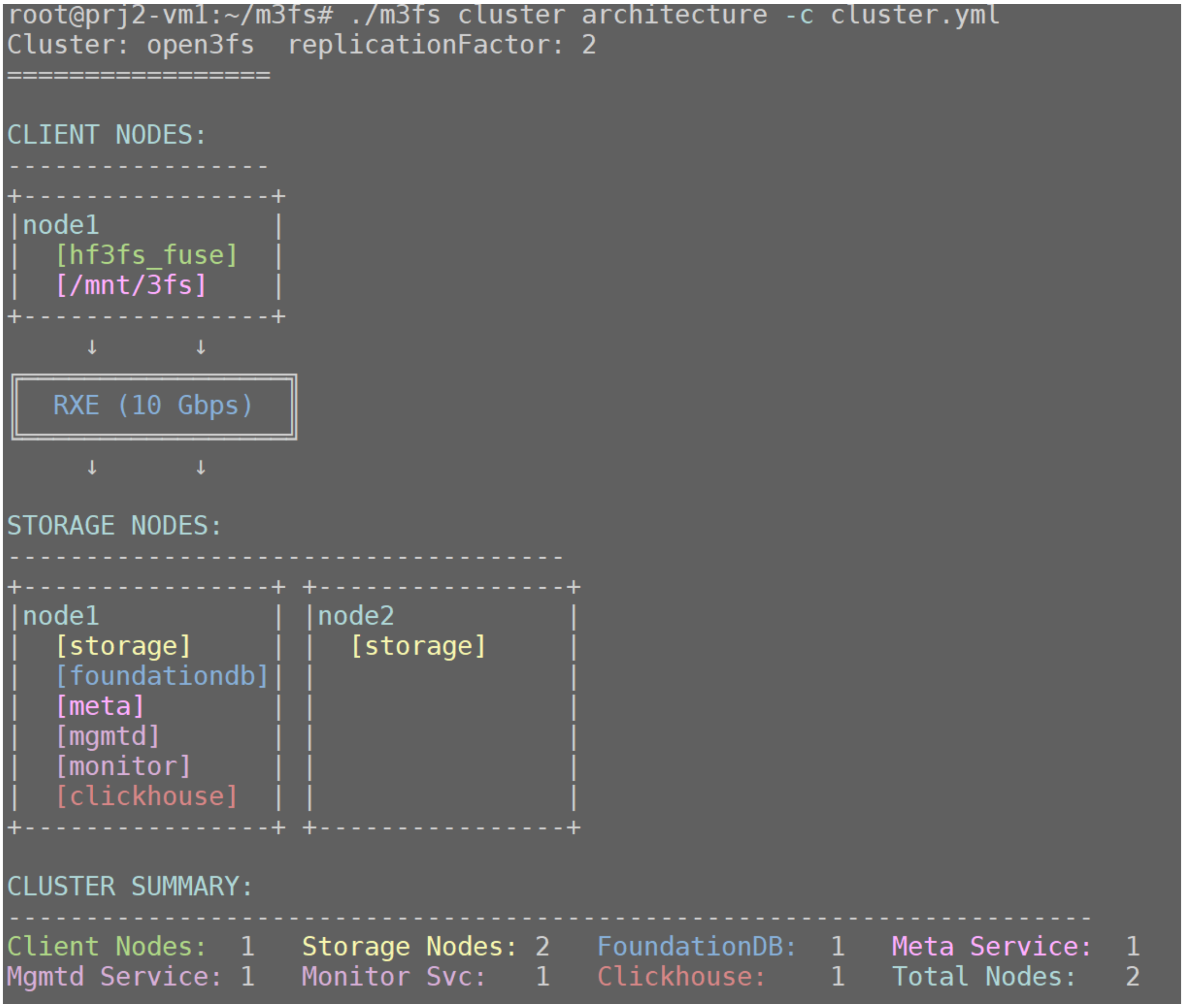
可执行文件：



```
[root@bec40f7d0865 bin]# ls
admin_cli     hf3fs_fuse_main  mgmtd_main      monitor_collector_main  storage_bench
hf3fs-admin   meta_main        migration_main  simple_example_main     storage_main
[root@bec40f7d0865 bin]# pwd
/root/3fs/build/bin
```

部署方式二：docker部署

集群结构：



```
root@prj2-vm1:~/m3fs# ./m3fs cluster architecture -c cluster.yml
Cluster: open3fs  replicationFactor: 2
=================

CLIENT NODES:
-----------------
+-----------------+
|node1            |
|  [hf3fs_fuse]   |
|  [/mnt/3fs]     |
+-----------------+
     ↓      ↓
╔══════════════════╗
║  RXE (10 Gbps)   ║
╚══════════════════╝
     ↓      ↓

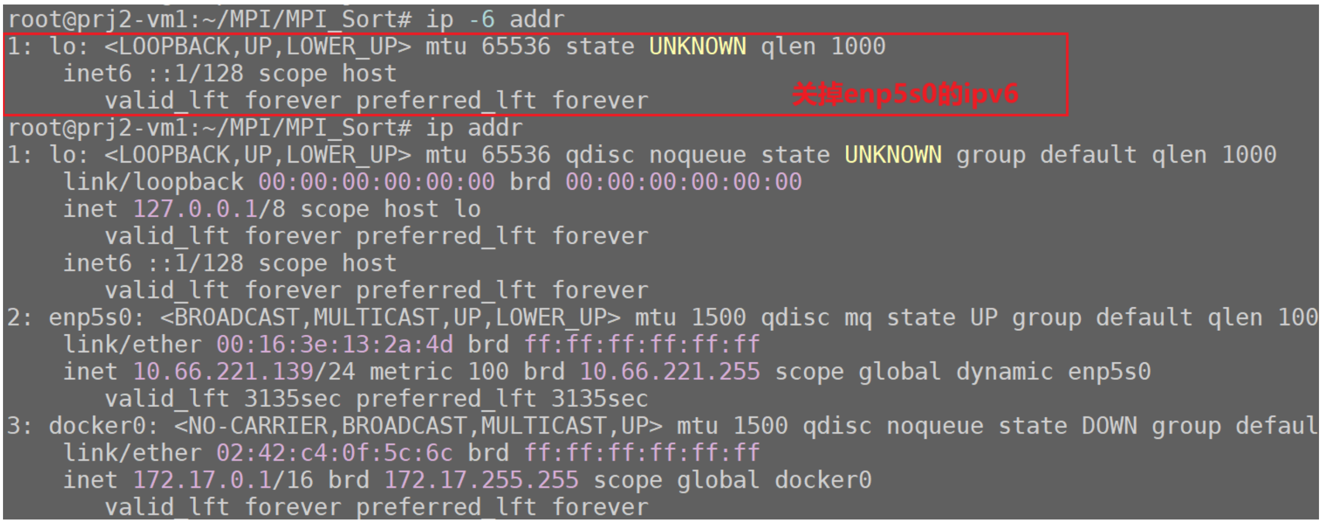
STORAGE NODES:
------------------------------------
+-----------------+ +-----------------+
|node1            | |node2            |
|  [storage]      | |  [storage]      |
|  [foundationdb]| |                 |
|  [meta]         | |                 |
|  [mgmtd]        | |                 |
|  [monitor]      | |                 |
|  [clickhouse]   | |                 |
+-----------------+ +-----------------+

CLUSTER SUMMARY:
-----------------------------------------------------------------------
Client Nodes:   1   Storage Nodes: 2   FoundationDB:   1   Meta Service:   1
Mgmtd Service: 1   Monitor Svc:    1   Clickhouse:     1   Total Nodes:    2
```

来自：https://github.com/open3fs/m3fs

这里的主要问题就是在lxc的Ubuntu容器里对网络的要求有些奇怪：foundationDB的docker中需要ipv4，否则挂掉（无法解析）；同时clickhouse的docker中又要求不能完全直接关闭ipv6。但是在直接的Ubuntu虚拟机中没有这些奇怪的毛病。

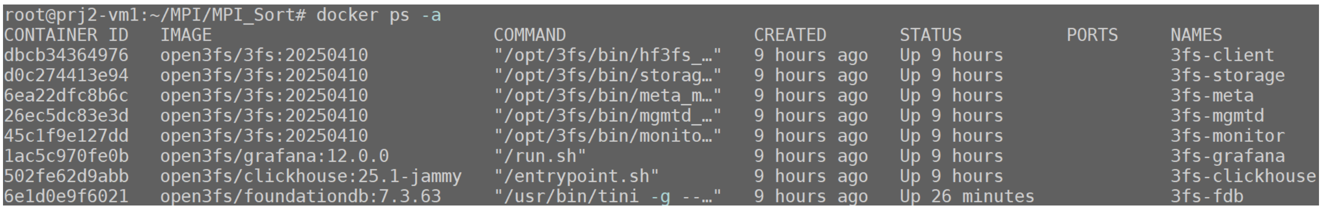
其他的就是保证端口没有被占用即可。



```
root@prj2-vm1:~/MPI/MPI_Sort# ip -6 addr
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 state UNKNOWN qlen 1000
    inet6 ::1/128 scope host
       valid_lft forever preferred_lft forever
root@prj2-vm1:~/MPI/MPI_Sort# ip addr
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN group default qlen 1000
    link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
    inet 127.0.0.1/8 scope host lo
       valid_lft forever preferred_lft forever
    inet6 ::1/128 scope host
       valid_lft forever preferred_lft forever
2: enp5s0: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc mq state UP group default qlen 100
    link/ether 00:16:3e:13:2a:4d brd ff:ff:ff:ff:ff:ff
    inet 10.66.221.139/24 metric 100 brd 10.66.221.255 scope global dynamic enp5s0
       valid_lft 3135sec preferred_lft 3135sec
3: docker0: <NO-CARRIER,BROADCAST,MULTICAST,UP> mtu 1500 qdisc noqueue state DOWN group defaul
    link/ether 02:42:c4:0f:5c:6c brd ff:ff:ff:ff:ff:ff
    inet 172.17.0.1/16 brd 172.17.255.255 scope global docker0
       valid_lft forever preferred_lft forever
```

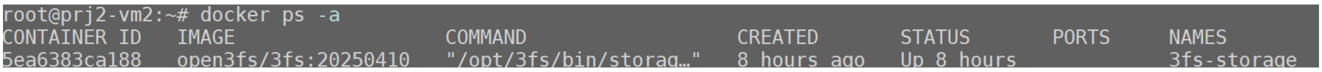
关掉enp5s0的ipv6

部署成功界面



```
root@prj2-vm1:~/MPI/MPI_Sort# docker ps -a
CONTAINER ID   IMAGE                          COMMAND                  CREATED       STATUS          PORTS     NAMES
dbcb34364976   open3fs/3fs:20250410           "/opt/3fs/bin/hf3fs_…"   9 hours ago   Up 9 hours                3fs-client
d0c274413e94   open3fs/3fs:20250410           "/opt/3fs/bin/storag…"   9 hours ago   Up 9 hours                3fs-storage
6ea22dfc8b6c   open3fs/3fs:20250410           "/opt/3fs/bin/meta_m…"   9 hours ago   Up 9 hours                3fs-meta
26ec5dc83e3d   open3fs/3fs:20250410           "/opt/3fs/bin/mgmtd_…"   9 hours ago   Up 9 hours                3fs-mgmtd
45c1f9e127dd   open3fs/3fs:20250410           "/opt/3fs/bin/monito…"   9 hours ago   Up 9 hours                3fs-monitor
1ac5c970fe0b   open3fs/grafana:12.0.0         "/run.sh"                9 hours ago   Up 9 hours                3fs-grafana
502fe62d9abb   open3fs/clickhouse:25.1-jammy  "/entrypoint.sh"         9 hours ago   Up 9 hours                3fs-clickhouse
6e1d0e9f6021   open3fs/foundationdb:7.3.63    "/usr/bin/tini -g --…"   9 hours ago   Up 26 minutes             3fs-fdb
```

另一个storage节点的部署：

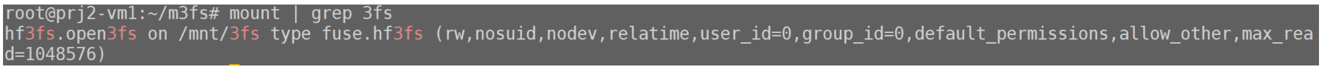


```
root@prj2-vm2:~# docker ps -a
CONTAINER ID   IMAGE                  COMMAND                  CREATED       STATUS       PORTS     NAMES
5ea6383ca188   open3fs/3fs:20250410   "/opt/3fs/bin/storag…"   8 hours ago   Up 8 hours             3fs-storage
```

挂载目录

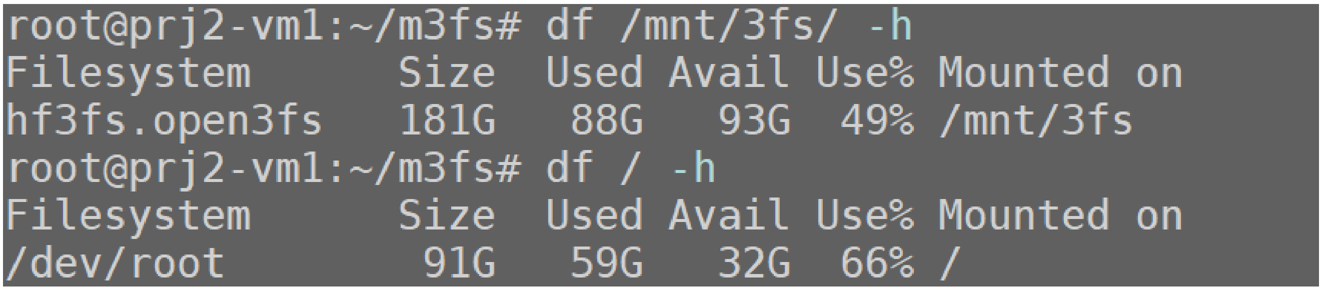
```
mount | grep 3fs
```

读写方式就和直接读写本地文件系统一样【fuse的方式，便捷，性能会差点：https://github.com/deepseek-ai/3FS/blob/main/docs/design_notes.md#limitations-of-fuse】。当然还有别的方式：https://github.com/deepseek-ai/3FS/blob/main/docs/design_notes.md#asynchronous-zero-copy-api



```
root@prj2-vm1:~/m3fs# mount | grep 3fs
hf3fs.open3fs on /mnt/3fs type fuse.hf3fs (rw,nosuid,nodev,relatime,user_id=0,group_id=0,default_permissions,allow_other,max_read=1048576)
```

挂载大小以及FileSystem：



```
root@prj2-vm1:~/m3fs# df /mnt/3fs/ -h
Filesystem       Size  Used Avail Use% Mounted on
hf3fs.open3fs    181G   88G   93G  49% /mnt/3fs
root@prj2-vm1:~/m3fs# df / -h
Filesystem       Size  Used Avail Use% Mounted on
/dev/root         91G   59G   32G  66% /
```