Assignment：<https://hackmd.io/@R0WpJazmReaVJZtOM8krSg/BJ51EDHhke>

the type of drive used for the following experiments: SSD（XPG GAMMIX S70 PRO）

Q0. (10%) Example

**Question :** Please run q0.fio on your own device and write down your output q0 in report.

* q0.fio output

job1: (g=0): rw=read, bs=(R) 4096B-4096B, (W) 4096B-4096B, (T) 4096B-4096B, ioengine=psync, iodepth=1

fio-3.37

Starting 1 process

job1: (groupid=0, jobs=1): err= 0: pid=31235: Sun Mar 23 15:00:00 2025

read: IOPS=10.1k, BW=39.5MiB/s (41.4MB/s)(1024MiB/25937msec)

clat (usec): min=24, max=4294, avg=98.27, stdev=58.35

lat (usec): min=24, max=4294, avg=98.34, stdev=58.36

clat percentiles (usec):

| 1.00th=[ 36], 5.00th=[ 40], 10.00th=[ 56], 20.00th=[ 82],

| 30.00th=[ 87], 40.00th=[ 91], 50.00th=[ 95], 60.00th=[ 101],

| 70.00th=[ 109], 80.00th=[ 117], 90.00th=[ 129], 95.00th=[ 139],

| 99.00th=[ 196], 99.50th=[ 231], 99.90th=[ 742], 99.95th=[ 1205],

| 99.99th=[ 2671]

bw ( KiB/s): min=32376, max=86224, per=100.00%, avg=40466.35, stdev=10173.34, samples=51

iops : min= 8094, max=21556, avg=10116.59, stdev=2543.34, samples=51

lat (usec) : 50=9.04%, 100=49.23%, 250=41.37%, 500=0.22%, 750=0.04%

lat (usec) : 1000=0.04%

lat (msec) : 2=0.04%, 4=0.02%, 10=0.01%

cpu : usr=1.04%, sys=18.12%, ctx=262176, majf=0, minf=10

IO depths : 1=100.0%, 2=0.0%, 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=262144,0,0,0 short=0,0,0,0 dropped=0,0,0,0

latency : target=0, window=0, percentile=100.00%, depth=1

Run status group 0 (all jobs):

READ: bw=39.5MiB/s (41.4MB/s), 39.5MiB/s-39.5MiB/s (41.4MB/s-41.4MB/s), io=1024MiB (1074MB), run=25937-25937msec

Disk stats (read/write):

sda: ios=261370/148, sectors=2091912/3512, merge=119/144, ticks=21356/135, in\_queue=21503, util=72.78%

Q1. (10%) Read vs. Randread

**Question :** Is there any significant difference between read and randread? Why or why not? Please justify your answer in brief.

read和randread在SSD中差異較小，因為沒有HDD磁頭移動的問題。但相較於sequential read（IOPS=14.7k、bw=57.6MiB/s (60.4MB/s)、run=1111msec），random read（IOPS=11.8k、bw=46.2MiB/s (48.4MB/s)、run=1386msec）還是慢一些。因為跳轉到不同的地址（或page）就會有比較高的延遲（可能受page大小和地址對齊影響）。加上Sequential Read時，SSD controller可以預測接下來的數據存放位置，可能提前讀取資料進DRAM緩存（雖然設置direct=1可以讓IO繞過Page Cache等緩存區，但SSD內部的DRAM Cache還是有用的），使存取速度加快，從而提高IOPS。相較之下，Random Read可能無法預測下一個數據的位置，每次讀取時都需要重新定位Flash Page。

* q1.fio output

Sequential Read: (g=0): rw=read, bs=(R) 4096B-4096B, (W) 4096B-4096B, (T) 4096B-4096B, ioengine=psync, iodepth=1

Random Read: (g=1): rw=randread, bs=(R) 4096B-4096B, (W) 4096B-4096B, (T) 4096B-4096B, ioengine=psync, iodepth=1

fio-3.37

Starting 2 processes

Sequential Read: (groupid=0, jobs=1): err= 0: pid=31405: Sun Mar 23 15:10:58 2025

read: IOPS=14.7k, BW=57.6MiB/s (60.4MB/s)(64.0MiB/1111msec)

clat (usec): min=25, max=1222, avg=66.96, stdev=38.43

lat (usec): min=26, max=1222, avg=67.02, stdev=38.45

clat percentiles (usec):

| 1.00th=[ 28], 5.00th=[ 30], 10.00th=[ 37], 20.00th=[ 39],

| 30.00th=[ 41], 40.00th=[ 46], 50.00th=[ 53], 60.00th=[ 68],

| 70.00th=[ 85], 80.00th=[ 97], 90.00th=[ 116], 95.00th=[ 128],

| 99.00th=[ 163], 99.50th=[ 198], 99.90th=[ 281], 99.95th=[ 314],

| 99.99th=[ 1057]

bw ( KiB/s): min=44608, max=68470, per=95.85%, avg=56539.00, stdev=16872.98, samples=2

iops : min=11152, max=17117, avg=14134.50, stdev=4217.89, samples=2

lat (usec) : 50=46.45%, 100=35.71%, 250=17.71%, 500=0.10%, 750=0.01%

lat (usec) : 1000=0.02%

lat (msec) : 2=0.01%

cpu : usr=1.44%, sys=22.61%, ctx=16381, majf=0, minf=11

IO depths : 1=100.0%, 2=0.0%, 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=16384,0,0,0 short=0,0,0,0 dropped=0,0,0,0

latency : target=0, window=0, percentile=100.00%, depth=1

Random Read: (groupid=1, jobs=1): err= 0: pid=31407: Sun Mar 23 15:10:58 2025

read: IOPS=11.8k, BW=46.2MiB/s (48.4MB/s)(64.0MiB/1386msec)

clat (usec): min=24, max=315, avg=83.72, stdev=45.73

lat (usec): min=24, max=315, avg=83.78, stdev=45.73

clat percentiles (usec):

| 1.00th=[ 28], 5.00th=[ 34], 10.00th=[ 40], 20.00th=[ 45],

| 30.00th=[ 48], 40.00th=[ 53], 50.00th=[ 60], 60.00th=[ 74],

| 70.00th=[ 126], 80.00th=[ 137], 90.00th=[ 149], 95.00th=[ 159],

| 99.00th=[ 178], 99.50th=[ 186], 99.90th=[ 227], 99.95th=[ 260],

| 99.99th=[ 302]

bw ( KiB/s): min=45280, max=50546, per=100.00%, avg=47913.00, stdev=3723.62, samples=2

iops : min=11320, max=12636, avg=11978.00, stdev=930.55, samples=2

lat (usec) : 50=34.42%, 100=27.88%, 250=37.63%, 500=0.06%

cpu : usr=2.09%, sys=19.42%, ctx=16384, majf=0, minf=9

IO depths : 1=100.0%, 2=0.0%, 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=16384,0,0,0 short=0,0,0,0 dropped=0,0,0,0

latency : target=0, window=0, percentile=100.00%, depth=1

Run status group 0 (all jobs):

READ: bw=57.6MiB/s (60.4MB/s), 57.6MiB/s-57.6MiB/s (60.4MB/s-60.4MB/s), io=64.0MiB (67.1MB), run=1111-1111msec

Run status group 1 (all jobs):

READ: bw=46.2MiB/s (48.4MB/s), 46.2MiB/s-46.2MiB/s (48.4MB/s-48.4MB/s), io=64.0MiB (67.1MB), run=1386-1386msec

Disk stats (read/write):

sda: ios=29913/100, sectors=239776/2680, merge=59/28, ticks=1970/23, in\_queue=1997, util=56.15%

Q2. (10%) Write vs. Randwrite

**Question :** Is there any significant difference between write and randwrite? Why or why not? Please justify your answer in brief.

sequential write（bw=4571MiB/s (4793MB/s)、IOPS=1170k、run=14-14msec）較random write（bw=3765MiB/s (3948MB/s)、IOPS=964k、run=17-17msec）較有效率。因為NAND Flash在寫入時會有Read-modify-write的限制，每次寫入都需要讀取整個 page、修改數據，然後再寫入新的page。所以如果是sequential write，修改的bytes在鄰近的page中，會使得被修改到的page數量較random write少，因此效能較高。

* q2.fio output

Sequential Write: (g=0): rw=write, bs=(R) 4096B-4096B, (W) 4096B-4096B, (T) 4096B-4096B, ioengine=psync, iodepth=1

Random Write: (g=1): rw=randwrite, bs=(R) 4096B-4096B, (W) 4096B-4096B, (T) 4096B-4096B, ioengine=psync, iodepth=1

fio-3.37

Starting 2 processes

Sequential Write: (groupid=0, jobs=1): err= 0: pid=23556: Sat Mar 22 15:06:57 2025

write: IOPS=1170k, BW=4571MiB/s (4793MB/s)(64.0MiB/14msec); 0 zone resets

clat (nsec): min=511, max=53130, avg=714.05, stdev=889.67

lat (nsec): min=531, max=84231, avg=740.62, stdev=1103.53

clat percentiles (nsec):

| 1.00th=[ 532], 5.00th=[ 548], 10.00th=[ 548], 20.00th=[ 572],

| 30.00th=[ 588], 40.00th=[ 620], 50.00th=[ 660], 60.00th=[ 700],

| 70.00th=[ 740], 80.00th=[ 780], 90.00th=[ 860], 95.00th=[ 924],

| 99.00th=[ 1096], 99.50th=[ 1192], 99.90th=[10048], 99.95th=[17280],

| 99.99th=[49408]

lat (nsec) : 750=72.43%, 1000=25.12%

lat (usec) : 2=2.26%, 4=0.02%, 10=0.07%, 20=0.06%, 50=0.04%

lat (usec) : 100=0.01%

cpu : usr=23.08%, sys=69.23%, ctx=1, majf=0, minf=8

IO depths : 1=100.0%, 2=0.0%, 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=0,16384,0,0 short=0,0,0,0 dropped=0,0,0,0

latency : target=0, window=0, percentile=100.00%, depth=1

Random Write: (groupid=1, jobs=1): err= 0: pid=23557: Sat Mar 22 15:06:57 2025

write: IOPS=964k, BW=3765MiB/s (3948MB/s)(64.0MiB/17msec); 0 zone resets

clat (nsec): min=551, max=24113, avg=832.70, stdev=519.14

lat (nsec): min=571, max=24143, avg=856.14, stdev=519.99

clat percentiles (nsec):

| 1.00th=[ 620], 5.00th=[ 652], 10.00th=[ 700], 20.00th=[ 724],

| 30.00th=[ 740], 40.00th=[ 764], 50.00th=[ 780], 60.00th=[ 812],

| 70.00th=[ 860], 80.00th=[ 900], 90.00th=[ 972], 95.00th=[ 1048],

| 99.00th=[ 1240], 99.50th=[ 1320], 99.90th=[ 9792], 99.95th=[15040],

| 99.99th=[23424]

lat (nsec) : 750=32.12%, 1000=60.19%

lat (usec) : 2=7.54%, 4=0.01%, 10=0.05%, 20=0.07%, 50=0.02%

cpu : usr=37.50%, sys=56.25%, ctx=0, majf=0, minf=6

IO depths : 1=100.0%, 2=0.0%, 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=0,16384,0,0 short=0,0,0,0 dropped=0,0,0,0

latency : target=0, window=0, percentile=100.00%, depth=1

Run status group 0 (all jobs):

WRITE: bw=4571MiB/s (4793MB/s), 4571MiB/s-4571MiB/s (4793MB/s-4793MB/s), io=64.0MiB (67.1MB), run=14-14msec

Run status group 1 (all jobs):

WRITE: bw=3765MiB/s (3948MB/s), 3765MiB/s-3765MiB/s (3948MB/s-3948MB/s), io=64.0MiB (67.1MB), run=17-17msec

Q3. (10%) Forward write vs. Backward write

**Question :** Is there any significant difference between forward and backward write? Why or why not? Please justify your answer in brief.

Forward write（BW=80.1MiB/s (84.0MB/s)、run=799msec）和Backward write（BW=80.7MiB/s (84.6MB/s)、run=793msec）在SSD中並沒有明顯差異。現代的 SSD 設計通常能夠應對不同的寫入順序，controller會進行最佳化處理，所以Forward write和Backward write的差異並不大。

* q3.fio output

forward\_write: (g=0): rw=write, bs=(R) 4096B-4096B, (W) 4096B-4096B, (T) 4096B-4096B, ioengine=psync, iodepth=1

backward\_write: (g=1): rw=write, bs=(R) 4096B-4096B, (W) 4096B-4096B, (T) 4096B-4096B, ioengine=psync, iodepth=1

fio-3.37

Starting 2 processes

forward\_write: (groupid=0, jobs=1): err= 0: pid=32782: Sun Mar 23 15:55:14 2025

write: IOPS=20.5k, BW=80.1MiB/s (84.0MB/s)(64.0MiB/799msec); 0 zone resets

clat (usec): min=28, max=781, avg=48.29, stdev=16.13

lat (usec): min=28, max=781, avg=48.36, stdev=16.15

clat percentiles (usec):

| 1.00th=[ 32], 5.00th=[ 34], 10.00th=[ 35], 20.00th=[ 37],

| 30.00th=[ 43], 40.00th=[ 44], 50.00th=[ 45], 60.00th=[ 48],

| 70.00th=[ 51], 80.00th=[ 57], 90.00th=[ 65], 95.00th=[ 73],

| 99.00th=[ 104], 99.50th=[ 120], 99.90th=[ 190], 99.95th=[ 206],

| 99.99th=[ 461]

bw ( KiB/s): min=79433, max=79433, per=96.84%, avg=79433.00, stdev= 0.00, samples=1

iops : min=19858, max=19858, avg=19858.00, stdev= 0.00, samples=1

lat (usec) : 50=68.45%, 100=30.41%, 250=1.11%, 500=0.02%, 1000=0.01%

cpu : usr=5.51%, sys=30.70%, ctx=16380, majf=0, minf=7

IO depths : 1=100.0%, 2=0.0%, 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=0,16384,0,0 short=0,0,0,0 dropped=0,0,0,0

latency : target=0, window=0, percentile=100.00%, depth=1

backward\_write: (groupid=1, jobs=1): err= 0: pid=32790: Sun Mar 23 15:55:14 2025

write: IOPS=20.7k, BW=80.7MiB/s (84.6MB/s)(64.0MiB/793msec); 0 zone resets

clat (usec): min=28, max=942, avg=47.92, stdev=13.72

lat (usec): min=28, max=942, avg=47.98, stdev=13.74

clat percentiles (usec):

| 1.00th=[ 31], 5.00th=[ 40], 10.00th=[ 41], 20.00th=[ 42],

| 30.00th=[ 42], 40.00th=[ 42], 50.00th=[ 45], 60.00th=[ 47],

| 70.00th=[ 50], 80.00th=[ 56], 90.00th=[ 62], 95.00th=[ 68],

| 99.00th=[ 80], 99.50th=[ 87], 99.90th=[ 126], 99.95th=[ 147],

| 99.99th=[ 783]

bw ( KiB/s): min=82192, max=82192, per=99.45%, avg=82192.00, stdev= 0.00, samples=1

iops : min=20548, max=20548, avg=20548.00, stdev= 0.00, samples=1

lat (usec) : 50=71.21%, 100=28.52%, 250=0.25%, 500=0.01%, 1000=0.01%

cpu : usr=2.40%, sys=33.84%, ctx=16376, majf=0, minf=8

IO depths : 1=100.0%, 2=0.0%, 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=0,16384,0,0 short=0,0,0,0 dropped=0,0,0,0

latency : target=0, window=0, percentile=100.00%, depth=1

Run status group 0 (all jobs):

WRITE: bw=80.1MiB/s (84.0MB/s), 80.1MiB/s-80.1MiB/s (84.0MB/s-84.0MB/s), io=64.0MiB (67.1MB), run=799-799msec

Run status group 1 (all jobs):

WRITE: bw=80.7MiB/s (84.6MB/s), 80.7MiB/s-80.7MiB/s (84.6MB/s-84.6MB/s), io=64.0MiB (67.1MB), run=793-793msec

Disk stats (read/write):

sda: ios=1/28076, sectors=64/224912, merge=0/38, ticks=0/989, in\_queue=996, util=43.03%

Q4. (15%) Buffered read vs. Nonbuffered read

**Question :**

1. (10%) Is there any significant difference between buffered and nonbuffered sequential read? Why or why not? Please justify your answer in brief.

在會read相同資料的情況下（用了loops=5），buffered sequential read（IOPS=359k、bw=1404MiB/s (1472MB/s)、run=228-228msec）較nonbuffered sequential read（IOPS=14.4k、bw=56.3MiB/s (59.0MB/s)、run=5683-5683msec）效率高很多。因為sequential有locality的性質，可以有效的利用到buffer的資訊，所以省下很多access time。

1. (5%) Replace **sequential read** with **random read**. Is there any significant difference between buffered and nonbuffered random read? Why or why not? Please justify your answer in brief.

buffered random read（IOPS=11.1k、bw=43.3MiB/s (45.4MB/s)、run=7398-7398msec）和nonbuffered random read（IOPS=11.3k、bw=44.0MiB/s (46.1MB/s)、run=7280-7280msec）的差異不大，因為沒有辦法有效的利用buffer的資料。

* q4.fio output

buffered\_read: (g=0): rw=read, bs=(R) 4096B-4096B, (W) 4096B-4096B, (T) 4096B-4096B, ioengine=psync, iodepth=1

nonbuffered\_read: (g=1): rw=read, bs=(R) 4096B-4096B, (W) 4096B-4096B, (T) 4096B-4096B, ioengine=psync, iodepth=1

buffered\_randread: (g=2): rw=randread, bs=(R) 4096B-4096B, (W) 4096B-4096B, (T) 4096B-4096B, ioengine=psync, iodepth=1

nonbuffered\_randread: (g=3): rw=randread, bs=(R) 4096B-4096B, (W) 4096B-4096B, (T) 4096B-4096B, ioengine=psync, iodepth=1

fio-3.37

Starting 4 processes

buffered\_read: (groupid=0, jobs=1): err= 0: pid=28572: Sat Mar 22 21:32:29 2025

read: IOPS=359k, BW=1404MiB/s (1472MB/s)(320MiB/228msec)

clat (nsec): min=371, max=634183, avg=2169.92, stdev=17219.78

lat (nsec): min=390, max=634193, avg=2183.70, stdev=17219.96

clat percentiles (nsec):

| 1.00th=[ 390], 5.00th=[ 402], 10.00th=[ 402], 20.00th=[ 410],

| 30.00th=[ 410], 40.00th=[ 422], 50.00th=[ 430], 60.00th=[ 442],

| 70.00th=[ 470], 80.00th=[ 510], 90.00th=[ 540], 95.00th=[ 564],

| 99.00th=[ 54528], 99.50th=[140288], 99.90th=[252928], 99.95th=[309248],

| 99.99th=[477184]

lat (nsec) : 500=74.85%, 750=22.58%, 1000=0.59%

lat (usec) : 2=0.33%, 4=0.01%, 10=0.02%, 20=0.03%, 50=0.40%

lat (usec) : 100=0.60%, 250=0.48%, 500=0.10%, 750=0.01%

cpu : usr=6.61%, sys=62.56%, ctx=508, majf=0, minf=10

IO depths : 1=100.0%, 2=0.0%, 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=81920,0,0,0 short=0,0,0,0 dropped=0,0,0,0

latency : target=0, window=0, percentile=100.00%, depth=1

nonbuffered\_read: (groupid=1, jobs=1): err= 0: pid=28574: Sat Mar 22 21:32:29 2025

read: IOPS=14.4k, BW=56.3MiB/s (59.0MB/s)(320MiB/5683msec)

clat (usec): min=25, max=3762, avg=68.58, stdev=48.56

lat (usec): min=25, max=3762, avg=68.65, stdev=48.58

clat percentiles (usec):

| 1.00th=[ 29], 5.00th=[ 36], 10.00th=[ 37], 20.00th=[ 39],

| 30.00th=[ 40], 40.00th=[ 44], 50.00th=[ 52], 60.00th=[ 69],

| 70.00th=[ 86], 80.00th=[ 98], 90.00th=[ 119], 95.00th=[ 133],

| 99.00th=[ 188], 99.50th=[ 219], 99.90th=[ 400], 99.95th=[ 725],

| 99.99th=[ 1516]

bw ( KiB/s): min=41606, max=76218, per=99.54%, avg=57393.09, stdev=13605.13, samples=11

iops : min=10401, max=19054, avg=14347.91, stdev=3401.28, samples=11

lat (usec) : 50=47.69%, 100=33.67%, 250=18.35%, 500=0.21%, 750=0.04%

lat (usec) : 1000=0.03%

lat (msec) : 2=0.02%, 4=0.01%

cpu : usr=1.14%, sys=22.12%, ctx=81931, majf=0, minf=10

IO depths : 1=100.0%, 2=0.0%, 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=81920,0,0,0 short=0,0,0,0 dropped=0,0,0,0

latency : target=0, window=0, percentile=100.00%, depth=1

buffered\_randread: (groupid=2, jobs=1): err= 0: pid=28585: Sat Mar 22 21:32:29 2025

read: IOPS=11.1k, BW=43.3MiB/s (45.4MB/s)(320MiB/7398msec)

clat (nsec): min=801, max=3752.9k, avg=89108.17, stdev=72910.81

lat (nsec): min=821, max=3753.0k, avg=89187.32, stdev=72919.19

clat percentiles (usec):

| 1.00th=[ 31], 5.00th=[ 39], 10.00th=[ 41], 20.00th=[ 45],

| 30.00th=[ 50], 40.00th=[ 55], 50.00th=[ 62], 60.00th=[ 79],

| 70.00th=[ 128], 80.00th=[ 139], 90.00th=[ 155], 95.00th=[ 165],

| 99.00th=[ 221], 99.50th=[ 265], 99.90th=[ 922], 99.95th=[ 1188],

| 99.99th=[ 2769]

bw ( KiB/s): min=41875, max=47840, per=100.00%, avg=44394.21, stdev=1550.90, samples=14

iops : min=10468, max=11960, avg=11098.29, stdev=387.88, samples=14

lat (nsec) : 1000=0.03%

lat (usec) : 2=0.06%, 50=31.30%, 100=29.96%, 250=38.05%, 500=0.40%

lat (usec) : 750=0.06%, 1000=0.08%

lat (msec) : 2=0.06%, 4=0.01%

cpu : usr=1.42%, sys=20.41%, ctx=81843, majf=0, minf=9

IO depths : 1=100.0%, 2=0.0%, 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=81920,0,0,0 short=0,0,0,0 dropped=0,0,0,0

latency : target=0, window=0, percentile=100.00%, depth=1

nonbuffered\_randread: (groupid=3, jobs=1): err= 0: pid=28601: Sat Mar 22 21:32:29 2025

read: IOPS=11.3k, BW=44.0MiB/s (46.1MB/s)(320MiB/7280msec)

clat (usec): min=24, max=3821, avg=87.89, stdev=75.84

lat (usec): min=24, max=3821, avg=87.97, stdev=75.85

clat percentiles (usec):

| 1.00th=[ 30], 5.00th=[ 37], 10.00th=[ 40], 20.00th=[ 44],

| 30.00th=[ 49], 40.00th=[ 55], 50.00th=[ 61], 60.00th=[ 78],

| 70.00th=[ 127], 80.00th=[ 139], 90.00th=[ 155], 95.00th=[ 165],

| 99.00th=[ 202], 99.50th=[ 237], 99.90th=[ 807], 99.95th=[ 1418],

| 99.99th=[ 2900]

bw ( KiB/s): min=38368, max=49738, per=99.88%, avg=44959.79, stdev=3259.33, samples=14

iops : min= 9592, max=12434, avg=11239.86, stdev=814.78, samples=14

lat (usec) : 50=32.86%, 100=28.59%, 250=38.15%, 500=0.24%, 750=0.05%

lat (usec) : 1000=0.04%

lat (msec) : 2=0.05%, 4=0.03%

cpu : usr=1.46%, sys=19.30%, ctx=81907, majf=0, minf=9

IO depths : 1=100.0%, 2=0.0%, 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=81920,0,0,0 short=0,0,0,0 dropped=0,0,0,0

latency : target=0, window=0, percentile=100.00%, depth=1

Run status group 0 (all jobs):

READ: bw=1404MiB/s (1472MB/s), 1404MiB/s-1404MiB/s (1472MB/s-1472MB/s), io=320MiB (336MB), run=228-228msec

Run status group 1 (all jobs):

READ: bw=56.3MiB/s (59.0MB/s), 56.3MiB/s-56.3MiB/s (59.0MB/s-59.0MB/s), io=320MiB (336MB), run=5683-5683msec

Run status group 2 (all jobs):

READ: bw=43.3MiB/s (45.4MB/s), 43.3MiB/s-43.3MiB/s (45.4MB/s-45.4MB/s), io=320MiB (336MB), run=7398-7398msec

Run status group 3 (all jobs):

READ: bw=44.0MiB/s (46.1MB/s), 44.0MiB/s-44.0MiB/s (46.1MB/s-46.1MB/s), io=320MiB (336MB), run=7280-7280msec

Disk stats (read/write):

sda: ios=244997/486, sectors=2612248/7080, merge=614/206, ticks=16725/115, in\_queue=16868, util=69.14%

Q5. (10%) LBA

**Question :** Is there any bandwidth trend between these jobs? Why or why not? Please justify your answer in brief. You can also experiment with the size of the file.

理論上在SSD當中offset應該不會有太大的影響，但實驗結果出來速度是不均勻的。offset=60%（bw=6244MiB/s (6547MB/s)、run=164-164msec）、offset=40%（bw=5596MiB/s (5867MB/s)、run=183-183msec）、offset=20%（bw=6649MiB/s (6972MB/s)、run=154-154msec）都保持著較穩定的高速運作，而offset=80%（bw=3459MiB/s (3628MB/s)、run=296-296msec）和offset=0（bw=1900MiB/s (1992MB/s)、run=539-539msec）與他們相比慢了不少，可能和SSD內部的機制有關，如Wear Leveling影響到部分區域的效能，有些地方可能已經被讀寫很多次導致NAND Flash存取速度變慢，也可能與SSD內部控制器的 Garbage Collection 運作有關，導致效能下降，再者XPG GAMMIX S70 PRO 的SLC快取演算法也可能導致每個區塊存取速度不一，使部分區塊的速度比其他區塊還高。

* q5.fio output

job1: (g=0): rw=read, bs=(R) 1024KiB-1024KiB, (W) 1024KiB-1024KiB, (T) 1024KiB-1024KiB, ioengine=psync, iodepth=1

job2: (g=1): rw=read, bs=(R) 1024KiB-1024KiB, (W) 1024KiB-1024KiB, (T) 1024KiB-1024KiB, ioengine=psync, iodepth=1

job3: (g=2): rw=read, bs=(R) 1024KiB-1024KiB, (W) 1024KiB-1024KiB, (T) 1024KiB-1024KiB, ioengine=psync, iodepth=1

job4: (g=3): rw=read, bs=(R) 1024KiB-1024KiB, (W) 1024KiB-1024KiB, (T) 1024KiB-1024KiB, ioengine=psync, iodepth=1

job5: (g=4): rw=read, bs=(R) 1024KiB-1024KiB, (W) 1024KiB-1024KiB, (T) 1024KiB-1024KiB, ioengine=psync, iodepth=1

fio-3.37

Starting 5 processes

job1: (groupid=0, jobs=1): err= 0: pid=28828: Sat Mar 22 21:54:12 2025

read: IOPS=3459, BW=3459MiB/s (3628MB/s)(1024MiB/296msec)

clat (usec): min=125, max=743, avg=280.74, stdev=190.90

lat (usec): min=125, max=743, avg=280.84, stdev=190.93

clat percentiles (usec):

| 1.00th=[ 127], 5.00th=[ 129], 10.00th=[ 131], 20.00th=[ 137],

| 30.00th=[ 147], 40.00th=[ 153], 50.00th=[ 161], 60.00th=[ 178],

| 70.00th=[ 433], 80.00th=[ 537], 90.00th=[ 594], 95.00th=[ 619],

| 99.00th=[ 676], 99.50th=[ 693], 99.90th=[ 709], 99.95th=[ 742],

| 99.99th=[ 742]

lat (usec) : 250=66.41%, 500=12.01%, 750=21.58%

cpu : usr=0.00%, sys=22.71%, ctx=1030, majf=0, minf=265

IO depths : 1=100.0%, 2=0.0%, 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=1024,0,0,0 short=0,0,0,0 dropped=0,0,0,0

latency : target=0, window=0, percentile=100.00%, depth=1

job2: (groupid=1, jobs=1): err= 0: pid=28832: Sat Mar 22 21:54:12 2025

read: IOPS=6243, BW=6244MiB/s (6547MB/s)(1024MiB/164msec)

clat (usec): min=125, max=718, avg=156.02, stdev=35.00

lat (usec): min=125, max=718, avg=156.11, stdev=35.02

clat percentiles (usec):

| 1.00th=[ 128], 5.00th=[ 129], 10.00th=[ 131], 20.00th=[ 135],

| 30.00th=[ 139], 40.00th=[ 145], 50.00th=[ 151], 60.00th=[ 157],

| 70.00th=[ 163], 80.00th=[ 172], 90.00th=[ 184], 95.00th=[ 194],

| 99.00th=[ 262], 99.50th=[ 285], 99.90th=[ 627], 99.95th=[ 717],

| 99.99th=[ 717]

lat (usec) : 250=98.54%, 500=1.27%, 750=0.20%

cpu : usr=1.84%, sys=35.58%, ctx=1029, majf=0, minf=264

IO depths : 1=100.0%, 2=0.0%, 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=1024,0,0,0 short=0,0,0,0 dropped=0,0,0,0

latency : target=0, window=0, percentile=100.00%, depth=1

job3: (groupid=2, jobs=1): err= 0: pid=28833: Sat Mar 22 21:54:12 2025

read: IOPS=5595, BW=5596MiB/s (5867MB/s)(1024MiB/183msec)

clat (usec): min=125, max=2776, avg=174.60, stdev=119.58

lat (usec): min=125, max=2776, avg=174.71, stdev=119.59

clat percentiles (usec):

| 1.00th=[ 128], 5.00th=[ 133], 10.00th=[ 141], 20.00th=[ 149],

| 30.00th=[ 153], 40.00th=[ 155], 50.00th=[ 159], 60.00th=[ 163],

| 70.00th=[ 167], 80.00th=[ 174], 90.00th=[ 184], 95.00th=[ 204],

| 99.00th=[ 693], 99.50th=[ 922], 99.90th=[ 1270], 99.95th=[ 2769],

| 99.99th=[ 2769]

lat (usec) : 250=97.36%, 500=0.78%, 750=1.07%, 1000=0.49%

lat (msec) : 2=0.20%, 4=0.10%

cpu : usr=0.00%, sys=35.71%, ctx=1030, majf=0, minf=264

IO depths : 1=100.0%, 2=0.0%, 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=1024,0,0,0 short=0,0,0,0 dropped=0,0,0,0

latency : target=0, window=0, percentile=100.00%, depth=1

job4: (groupid=3, jobs=1): err= 0: pid=28834: Sat Mar 22 21:54:12 2025

read: IOPS=6649, BW=6649MiB/s (6972MB/s)(1024MiB/154msec)

clat (usec): min=123, max=961, avg=146.47, stdev=32.24

lat (usec): min=123, max=962, avg=146.55, stdev=32.26

clat percentiles (usec):

| 1.00th=[ 126], 5.00th=[ 127], 10.00th=[ 128], 20.00th=[ 129],

| 30.00th=[ 133], 40.00th=[ 135], 50.00th=[ 139], 60.00th=[ 147],

| 70.00th=[ 153], 80.00th=[ 163], 90.00th=[ 174], 95.00th=[ 182],

| 99.00th=[ 208], 99.50th=[ 231], 99.90th=[ 277], 99.95th=[ 963],

| 99.99th=[ 963]

lat (usec) : 250=99.61%, 500=0.29%, 1000=0.10%

cpu : usr=0.00%, sys=38.56%, ctx=1030, majf=0, minf=265

IO depths : 1=100.0%, 2=0.0%, 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=1024,0,0,0 short=0,0,0,0 dropped=0,0,0,0

latency : target=0, window=0, percentile=100.00%, depth=1

job5: (groupid=4, jobs=1): err= 0: pid=28835: Sat Mar 22 21:54:12 2025

read: IOPS=1899, BW=1900MiB/s (1992MB/s)(1024MiB/539msec)

clat (usec): min=126, max=3495, avg=523.21, stdev=295.74

lat (usec): min=126, max=3495, avg=523.35, stdev=295.75

clat percentiles (usec):

| 1.00th=[ 143], 5.00th=[ 159], 10.00th=[ 184], 20.00th=[ 433],

| 30.00th=[ 449], 40.00th=[ 469], 50.00th=[ 490], 60.00th=[ 529],

| 70.00th=[ 594], 80.00th=[ 619], 90.00th=[ 660], 95.00th=[ 709],

| 99.00th=[ 1778], 99.50th=[ 2999], 99.90th=[ 3458], 99.95th=[ 3490],

| 99.99th=[ 3490]

bw ( MiB/s): min= 1930, max= 1930, per=100.00%, avg=1930.00, stdev= 0.00, samples=1

iops : min= 1930, max= 1930, avg=1930.00, stdev= 0.00, samples=1

lat (usec) : 250=11.72%, 500=41.89%, 750=42.87%, 1000=1.56%

lat (msec) : 2=0.98%, 4=0.98%

cpu : usr=0.37%, sys=13.38%, ctx=1032, majf=0, minf=265

IO depths : 1=100.0%, 2=0.0%, 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=1024,0,0,0 short=0,0,0,0 dropped=0,0,0,0

latency : target=0, window=0, percentile=100.00%, depth=1

Run status group 0 (all jobs):

READ: bw=3459MiB/s (3628MB/s), 3459MiB/s-3459MiB/s (3628MB/s-3628MB/s), io=1024MiB (1074MB), run=296-296msec

Run status group 1 (all jobs):

READ: bw=6244MiB/s (6547MB/s), 6244MiB/s-6244MiB/s (6547MB/s-6547MB/s), io=1024MiB (1074MB), run=164-164msec

Run status group 2 (all jobs):

READ: bw=5596MiB/s (5867MB/s), 5596MiB/s-5596MiB/s (5867MB/s-5867MB/s), io=1024MiB (1074MB), run=183-183msec

Run status group 3 (all jobs):

READ: bw=6649MiB/s (6972MB/s), 6649MiB/s-6649MiB/s (6972MB/s-6972MB/s), io=1024MiB (1074MB), run=154-154msec

Run status group 4 (all jobs):

READ: bw=1900MiB/s (1992MB/s), 1900MiB/s-1900MiB/s (1992MB/s-1992MB/s), io=1024MiB (1074MB), run=539-539msec

Disk stats (read/write):

sda: ios=9929/163, sectors=10148944/2360, merge=119/65, ticks=1798/53, in\_queue=1863, util=44.18%

Q6. (15%) Blocksize

**Question :**

1. (10%) Is there any significant difference between 4k and 1k read? Why or why not? Please justify your answer in brief.

4K block size（bw=61.9MiB/s (64.9MB/s)、run=1034-1034msec）比1K block size（bw=14.0MiB/s (14.7MB/s)、run=4575-4575msec）效能好很多，因為相同的資料量1K block size所需要的I/O request是4K block size的4倍。而且一個page為4K，即使block size小於4K，實際上SSD還是需要讀取 4K，然後取其中的1K數據，效能很差。

1. (5%) If you want to achieve the best performance in the condition above, how would you modify blocksize? Explain it briefly.

如果以4K和1K來選，一定會選擇4K，因為Page size就是4K，一次I/O最少就會搬到4K的量。如果Block size再設定更大，一次可以抓的資料越多，在資料量大的情況下效率也就越高（以size 64MB的檔案來看，block size設置到1MB，read的效率仍是提升的）。其實如果知道檔案大小，能一次將它全部搬進來是最有效率的做法，但在檔案大小會變動且無法事先得知的情況下，block size太大，反而會增加I/O request的時間，當所需要的資料量不多（或最後一次搬運資料剩餘的不多時），很容易搬運到太多不需要的資料，加上如果使用buffer，buffer容易存到太多不會被利用到的資料導致空間浪費。

* q6.fio output

bs=4k: (g=0): rw=read, bs=(R) 4096B-4096B, (W) 4096B-4096B, (T) 4096B-4096B, ioengine=psync, iodepth=1

bs=1k: (g=1): rw=read, bs=(R) 1024B-1024B, (W) 1024B-1024B, (T) 1024B-1024B, ioengine=psync, iodepth=1

fio-3.37

Starting 2 processes

bs=4k: (groupid=0, jobs=1): err= 0: pid=29172: Sat Mar 22 22:45:26 2025

read: IOPS=15.8k, BW=61.9MiB/s (64.9MB/s)(64.0MiB/1034msec)

clat (usec): min=25, max=956, avg=62.08, stdev=36.61

lat (usec): min=25, max=956, avg=62.14, stdev=36.64

clat percentiles (usec):

| 1.00th=[ 28], 5.00th=[ 29], 10.00th=[ 29], 20.00th=[ 30],

| 30.00th=[ 36], 40.00th=[ 40], 50.00th=[ 45], 60.00th=[ 63],

| 70.00th=[ 82], 80.00th=[ 96], 90.00th=[ 117], 95.00th=[ 129],

| 99.00th=[ 155], 99.50th=[ 167], 99.90th=[ 208], 99.95th=[ 221],

| 99.99th=[ 873]

bw ( KiB/s): min=73517, max=73517, per=100.00%, avg=73517.00, stdev= 0.00, samples=1

iops : min=18379, max=18379, avg=18379.00, stdev= 0.00, samples=1

lat (usec) : 50=54.61%, 100=27.40%, 250=17.96%, 500=0.01%, 1000=0.01%

cpu : usr=1.45%, sys=24.01%, ctx=16366, majf=0, minf=11

IO depths : 1=100.0%, 2=0.0%, 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=16384,0,0,0 short=0,0,0,0 dropped=0,0,0,0

latency : target=0, window=0, percentile=100.00%, depth=1

bs=1k: (groupid=1, jobs=1): err= 0: pid=29175: Sat Mar 22 22:45:26 2025

read: IOPS=14.3k, BW=14.0MiB/s (14.7MB/s)(64.0MiB/4575msec)

clat (usec): min=26, max=3462, avg=69.23, stdev=36.31

lat (usec): min=26, max=3462, avg=69.30, stdev=36.33

clat percentiles (usec):

| 1.00th=[ 38], 5.00th=[ 39], 10.00th=[ 39], 20.00th=[ 40],

| 30.00th=[ 43], 40.00th=[ 47], 50.00th=[ 56], 60.00th=[ 72],

| 70.00th=[ 88], 80.00th=[ 99], 90.00th=[ 118], 95.00th=[ 131],

| 99.00th=[ 155], 99.50th=[ 165], 99.90th=[ 196], 99.95th=[ 235],

| 99.99th=[ 701]

bw ( KiB/s): min= 9360, max=21160, per=99.54%, avg=14259.78, stdev=5239.02, samples=9

iops : min= 9360, max=21160, avg=14259.78, stdev=5239.02, samples=9

lat (usec) : 50=44.32%, 100=36.17%, 250=19.48%, 500=0.02%, 750=0.01%

lat (usec) : 1000=0.01%

lat (msec) : 2=0.01%, 4=0.01%

cpu : usr=1.29%, sys=23.26%, ctx=65538, majf=0, minf=11

IO depths : 1=100.0%, 2=0.0%, 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=65536,0,0,0 short=0,0,0,0 dropped=0,0,0,0

latency : target=0, window=0, percentile=100.00%, depth=1

Run status group 0 (all jobs):

READ: bw=61.9MiB/s (64.9MB/s), 61.9MiB/s-61.9MiB/s (64.9MB/s-64.9MB/s), io=64.0MiB (67.1MB), run=1034-1034msec

Run status group 1 (all jobs):

READ: bw=14.0MiB/s (14.7MB/s), 14.0MiB/s-14.0MiB/s (14.7MB/s-14.7MB/s), io=64.0MiB (67.1MB), run=4575-4575msec

Disk stats (read/write):

sda: ios=77383/173, sectors=253892/3008, merge=90/67, ticks=4591/50, in\_queue=4650, util=62.84%

Q7. (20%) Fastest nonbuffered read

**Question :** Please explain how you achieve the fastest 1G nonbuffered read in brief.

測試了從4K到1G的block size，可以發現從1G到32M左右，頻寬是呈現增加的趨勢（block size太大會導致最後搬運太多沒有必要的資訊），而32M到4M的效能並沒有明顯差異，4M直至 4K頻寬則是呈現減少的趨勢（block size小所需的I/O request就會很多（其實1G到4M的最大時間差（424 – 226 = 198msec）與4M到4K的（23996 – 265 = 23731msec）相比差距甚少，可以得知I/O request的數量對效能的影響較大））。所以，在這個size=1g的例子中，可以選擇block size 32M到4M（這次實驗中是8M）以達到最好的效能。

* q7.fio output

bs=1g: (g=0): rw=read, bs=(R) 1024MiB-1024MiB, (W) 1024MiB-1024MiB, (T) 1024MiB-1024MiB, ioengine=psync, iodepth=1

bs=512m: (g=1): rw=read, bs=(R) 512MiB-512MiB, (W) 512MiB-512MiB, (T) 512MiB-512MiB, ioengine=psync, iodepth=1

bs=256m: (g=2): rw=read, bs=(R) 256MiB-256MiB, (W) 256MiB-256MiB, (T) 256MiB-256MiB, ioengine=psync, iodepth=1

bs=128m: (g=3): rw=read, bs=(R) 128MiB-128MiB, (W) 128MiB-128MiB, (T) 128MiB-128MiB, ioengine=psync, iodepth=1

bs=64m: (g=4): rw=read, bs=(R) 64.0MiB-64.0MiB, (W) 64.0MiB-64.0MiB, (T) 64.0MiB-64.0MiB, ioengine=psync, iodepth=1

bs=32m: (g=5): rw=read, bs=(R) 32.0MiB-32.0MiB, (W) 32.0MiB-32.0MiB, (T) 32.0MiB-32.0MiB, ioengine=psync, iodepth=1

bs=16m: (g=6): rw=read, bs=(R) 16.0MiB-16.0MiB, (W) 16.0MiB-16.0MiB, (T) 16.0MiB-16.0MiB, ioengine=psync, iodepth=1

bs=8m: (g=7): rw=read, bs=(R) 8192KiB-8192KiB, (W) 8192KiB-8192KiB, (T) 8192KiB-8192KiB, ioengine=psync, iodepth=1

bs=4m: (g=8): rw=read, bs=(R) 4096KiB-4096KiB, (W) 4096KiB-4096KiB, (T) 4096KiB-4096KiB, ioengine=psync, iodepth=1

bs=2m: (g=9): rw=read, bs=(R) 2048KiB-2048KiB, (W) 2048KiB-2048KiB, (T) 2048KiB-2048KiB, ioengine=psync, iodepth=1

bs=1m: (g=10): rw=read, bs=(R) 1024KiB-1024KiB, (W) 1024KiB-1024KiB, (T) 1024KiB-1024KiB, ioengine=psync, iodepth=1

bs=512k: (g=11): rw=read, bs=(R) 512KiB-512KiB, (W) 512KiB-512KiB, (T) 512KiB-512KiB, ioengine=psync, iodepth=1

bs=256k: (g=12): rw=read, bs=(R) 256KiB-256KiB, (W) 256KiB-256KiB, (T) 256KiB-256KiB, ioengine=psync, iodepth=1

bs=128k: (g=13): rw=read, bs=(R) 128KiB-128KiB, (W) 128KiB-128KiB, (T) 128KiB-128KiB, ioengine=psync, iodepth=1

bs=64k: (g=14): rw=read, bs=(R) 64.0KiB-64.0KiB, (W) 64.0KiB-64.0KiB, (T) 64.0KiB-64.0KiB, ioengine=psync, iodepth=1

bs=32k: (g=15): rw=read, bs=(R) 32.0KiB-32.0KiB, (W) 32.0KiB-32.0KiB, (T) 32.0KiB-32.0KiB, ioengine=psync, iodepth=1

bs=16k: (g=16): rw=read, bs=(R) 16.0KiB-16.0KiB, (W) 16.0KiB-16.0KiB, (T) 16.0KiB-16.0KiB, ioengine=psync, iodepth=1

bs=8k: (g=17): rw=read, bs=(R) 8192B-8192B, (W) 8192B-8192B, (T) 8192B-8192B, ioengine=psync, iodepth=1

bs=4k: (g=18): rw=read, bs=(R) 4096B-4096B, (W) 4096B-4096B, (T) 4096B-4096B, ioengine=psync, iodepth=1

fio-3.37

Starting 19 processes

bs=1g: (groupid=0, jobs=1): err= 0: pid=31055: Sun Mar 23 14:23:25 2025

read: IOPS=2, BW=2415MiB/s (2532MB/s)(1024MiB/424msec)

clat (nsec): min=415913k, max=415913k, avg=415913054.00, stdev= 0.00

lat (nsec): min=415914k, max=415914k, avg=415913655.00, stdev= 0.00

clat percentiles (msec):

| 1.00th=[ 418], 5.00th=[ 418], 10.00th=[ 418], 20.00th=[ 418],

| 30.00th=[ 418], 40.00th=[ 418], 50.00th=[ 418], 60.00th=[ 418],

| 70.00th=[ 418], 80.00th=[ 418], 90.00th=[ 418], 95.00th=[ 418],

| 99.00th=[ 418], 99.50th=[ 418], 99.90th=[ 418], 99.95th=[ 418],

| 99.99th=[ 418]

bw ( MiB/s): min= 2015, max= 2015, per=83.46%, avg=2015.75, stdev= 0.00, samples=1

iops : min= 1, max= 1, avg= 1.00, stdev= 0.00, samples=1

lat (msec) : 500=100.00%

cpu : usr=0.00%, sys=82.98%, ctx=229, majf=0, minf=262152

IO depths : 1=100.0%, 2=0.0%, 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=1,0,0,0 short=0,0,0,0 dropped=0,0,0,0

latency : target=0, window=0, percentile=100.00%, depth=1

bs=512m: (groupid=1, jobs=1): err= 0: pid=31056: Sun Mar 23 14:23:25 2025

read: IOPS=6, BW=3160MiB/s (3314MB/s)(1024MiB/324msec)

clat (msec): min=113, max=207, avg=160.26, stdev=66.51

lat (msec): min=113, max=207, avg=160.26, stdev=66.51

clat percentiles (msec):

| 1.00th=[ 113], 5.00th=[ 113], 10.00th=[ 113], 20.00th=[ 113],

| 30.00th=[ 113], 40.00th=[ 113], 50.00th=[ 113], 60.00th=[ 207],

| 70.00th=[ 207], 80.00th=[ 207], 90.00th=[ 207], 95.00th=[ 207],

| 99.00th=[ 207], 99.50th=[ 207], 99.90th=[ 207], 99.95th=[ 207],

| 99.99th=[ 207]

lat (msec) : 250=100.00%

cpu : usr=0.00%, sys=56.97%, ctx=410, majf=0, minf=131080

IO depths : 1=100.0%, 2=0.0%, 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=2,0,0,0 short=0,0,0,0 dropped=0,0,0,0

latency : target=0, window=0, percentile=100.00%, depth=1

bs=256m: (groupid=2, jobs=1): err= 0: pid=31057: Sun Mar 23 14:23:25 2025

read: IOPS=14, BW=3765MiB/s (3948MB/s)(1024MiB/272msec)

clat (usec): min=61316, max=84725, avg=67703.83, stdev=11379.45

lat (usec): min=61316, max=84726, avg=67704.28, stdev=11379.36

clat percentiles (usec):

| 1.00th=[61080], 5.00th=[61080], 10.00th=[61080], 20.00th=[61080],

| 30.00th=[61604], 40.00th=[61604], 50.00th=[61604], 60.00th=[63177],

| 70.00th=[63177], 80.00th=[84411], 90.00th=[84411], 95.00th=[84411],

| 99.00th=[84411], 99.50th=[84411], 99.90th=[84411], 99.95th=[84411],

| 99.99th=[84411]

lat (msec) : 100=100.00%

cpu : usr=0.00%, sys=41.33%, ctx=315, majf=0, minf=65544

IO depths : 1=100.0%, 2=0.0%, 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=4,0,0,0 short=0,0,0,0 dropped=0,0,0,0

latency : target=0, window=0, percentile=100.00%, depth=1

bs=128m: (groupid=3, jobs=1): err= 0: pid=31058: Sun Mar 23 14:23:25 2025

read: IOPS=27, BW=3568MiB/s (3741MB/s)(1024MiB/287msec)

clat (usec): min=32465, max=45362, avg=35612.23, stdev=4626.55

lat (usec): min=32465, max=45363, avg=35612.56, stdev=4626.60

clat percentiles (usec):

| 1.00th=[32375], 5.00th=[32375], 10.00th=[32375], 20.00th=[32375],

| 30.00th=[32637], 40.00th=[33162], 50.00th=[33162], 60.00th=[33424],

| 70.00th=[35914], 80.00th=[39584], 90.00th=[45351], 95.00th=[45351],

| 99.00th=[45351], 99.50th=[45351], 99.90th=[45351], 99.95th=[45351],

| 99.99th=[45351]

lat (msec) : 50=100.00%

cpu : usr=0.00%, sys=30.42%, ctx=232, majf=0, minf=32776

IO depths : 1=100.0%, 2=0.0%, 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=8,0,0,0 short=0,0,0,0 dropped=0,0,0,0

latency : target=0, window=0, percentile=100.00%, depth=1

bs=64m: (groupid=4, jobs=1): err= 0: pid=31059: Sun Mar 23 14:23:25 2025

read: IOPS=62, BW=4000MiB/s (4194MB/s)(1024MiB/256msec)

clat (usec): min=6135, max=24895, avg=15865.15, stdev=3961.22

lat (usec): min=6136, max=24895, avg=15865.37, stdev=3961.20

clat percentiles (usec):

| 1.00th=[ 6128], 5.00th=[ 6128], 10.00th=[14222], 20.00th=[14615],

| 30.00th=[14877], 40.00th=[15139], 50.00th=[15401], 60.00th=[15795],

| 70.00th=[15926], 80.00th=[16057], 90.00th=[22938], 95.00th=[24773],

| 99.00th=[24773], 99.50th=[24773], 99.90th=[24773], 99.95th=[24773],

| 99.99th=[24773]

lat (msec) : 10=6.25%, 20=81.25%, 50=12.50%

cpu : usr=0.00%, sys=30.20%, ctx=327, majf=0, minf=16392

IO depths : 1=100.0%, 2=0.0%, 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=16,0,0,0 short=0,0,0,0 dropped=0,0,0,0

latency : target=0, window=0, percentile=100.00%, depth=1

bs=32m: (groupid=5, jobs=1): err= 0: pid=31063: Sun Mar 23 14:23:25 2025

read: IOPS=127, BW=4080MiB/s (4278MB/s)(1024MiB/251msec)

clat (usec): min=2891, max=13484, avg=7722.28, stdev=1699.37

lat (usec): min=2891, max=13484, avg=7722.43, stdev=1699.40

clat percentiles (usec):

| 1.00th=[ 2900], 5.00th=[ 2933], 10.00th=[ 7308], 20.00th=[ 7439],

| 30.00th=[ 7504], 40.00th=[ 7504], 50.00th=[ 7635], 60.00th=[ 7832],

| 70.00th=[ 7963], 80.00th=[ 8160], 90.00th=[ 8455], 95.00th=[10159],

| 99.00th=[13435], 99.50th=[13435], 99.90th=[13435], 99.95th=[13435],

| 99.99th=[13435]

lat (msec) : 4=6.25%, 10=87.50%, 20=6.25%

cpu : usr=0.00%, sys=24.40%, ctx=39, majf=0, minf=8200

IO depths : 1=100.0%, 2=0.0%, 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=32,0,0,0 short=0,0,0,0 dropped=0,0,0,0

latency : target=0, window=0, percentile=100.00%, depth=1

bs=16m: (groupid=6, jobs=1): err= 0: pid=31064: Sun Mar 23 14:23:25 2025

read: IOPS=257, BW=4112MiB/s (4312MB/s)(1024MiB/249msec)

clat (usec): min=1023, max=11992, avg=3844.81, stdev=1319.69

lat (usec): min=1023, max=11992, avg=3844.95, stdev=1319.70

clat percentiles (usec):

| 1.00th=[ 1020], 5.00th=[ 1139], 10.00th=[ 3294], 20.00th=[ 3785],

| 30.00th=[ 3818], 40.00th=[ 3884], 50.00th=[ 3916], 60.00th=[ 3949],

| 70.00th=[ 3982], 80.00th=[ 4047], 90.00th=[ 4146], 95.00th=[ 4490],

| 99.00th=[11994], 99.50th=[11994], 99.90th=[11994], 99.95th=[11994],

| 99.99th=[11994]

lat (msec) : 2=7.81%, 4=64.06%, 10=26.56%, 20=1.56%

cpu : usr=0.00%, sys=18.55%, ctx=69, majf=0, minf=4105

IO depths : 1=100.0%, 2=0.0%, 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=64,0,0,0 short=0,0,0,0 dropped=0,0,0,0

latency : target=0, window=0, percentile=100.00%, depth=1

bs=8m: (groupid=7, jobs=1): err= 0: pid=31065: Sun Mar 23 14:23:25 2025

read: IOPS=566, BW=4531MiB/s (4751MB/s)(1024MiB/226msec)

clat (usec): min=531, max=3449, avg=1745.91, stdev=407.09

lat (usec): min=531, max=3449, avg=1746.04, stdev=407.10

clat percentiles (usec):

| 1.00th=[ 537], 5.00th=[ 619], 10.00th=[ 1500], 20.00th=[ 1745],

| 30.00th=[ 1762], 40.00th=[ 1795], 50.00th=[ 1811], 60.00th=[ 1827],

| 70.00th=[ 1860], 80.00th=[ 1876], 90.00th=[ 2008], 95.00th=[ 2089],

| 99.00th=[ 2474], 99.50th=[ 3458], 99.90th=[ 3458], 99.95th=[ 3458],

| 99.99th=[ 3458]

lat (usec) : 750=7.81%, 1000=0.78%

lat (msec) : 2=81.25%, 4=10.16%

cpu : usr=0.00%, sys=15.11%, ctx=133, majf=0, minf=2057

IO depths : 1=100.0%, 2=0.0%, 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=128,0,0,0 short=0,0,0,0 dropped=0,0,0,0

latency : target=0, window=0, percentile=100.00%, depth=1

bs=4m: (groupid=8, jobs=1): err= 0: pid=31066: Sun Mar 23 14:23:25 2025

read: IOPS=966, BW=3864MiB/s (4052MB/s)(1024MiB/265msec)

clat (usec): min=300, max=2376, avg=1028.94, stdev=290.31

lat (usec): min=300, max=2376, avg=1029.07, stdev=290.33

clat percentiles (usec):

| 1.00th=[ 302], 5.00th=[ 326], 10.00th=[ 553], 20.00th=[ 947],

| 30.00th=[ 979], 40.00th=[ 1012], 50.00th=[ 1090], 60.00th=[ 1123],

| 70.00th=[ 1156], 80.00th=[ 1188], 90.00th=[ 1237], 95.00th=[ 1319],

| 99.00th=[ 1942], 99.50th=[ 2278], 99.90th=[ 2376], 99.95th=[ 2376],

| 99.99th=[ 2376]

lat (usec) : 500=9.38%, 750=1.95%, 1000=24.22%

lat (msec) : 2=63.67%, 4=0.78%

cpu : usr=0.00%, sys=17.80%, ctx=261, majf=0, minf=1033

IO depths : 1=100.0%, 2=0.0%, 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=256,0,0,0 short=0,0,0,0 dropped=0,0,0,0

latency : target=0, window=0, percentile=100.00%, depth=1

bs=2m: (groupid=9, jobs=1): err= 0: pid=31067: Sun Mar 23 14:23:25 2025

read: IOPS=1372, BW=2745MiB/s (2879MB/s)(1024MiB/373msec)

clat (usec): min=192, max=3427, avg=722.36, stdev=236.06

lat (usec): min=192, max=3427, avg=722.48, stdev=236.07

clat percentiles (usec):

| 1.00th=[ 215], 5.00th=[ 231], 10.00th=[ 265], 20.00th=[ 709],

| 30.00th=[ 725], 40.00th=[ 742], 50.00th=[ 750], 60.00th=[ 766],

| 70.00th=[ 775], 80.00th=[ 799], 90.00th=[ 832], 95.00th=[ 898],

| 99.00th=[ 1418], 99.50th=[ 1729], 99.90th=[ 3425], 99.95th=[ 3425],

| 99.99th=[ 3425]

lat (usec) : 250=8.59%, 500=2.15%, 750=37.70%, 1000=49.22%

lat (msec) : 2=1.95%, 4=0.39%

cpu : usr=0.00%, sys=15.59%, ctx=517, majf=0, minf=521

IO depths : 1=100.0%, 2=0.0%, 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=512,0,0,0 short=0,0,0,0 dropped=0,0,0,0

latency : target=0, window=0, percentile=100.00%, depth=1

bs=1m: (groupid=10, jobs=1): err= 0: pid=31068: Sun Mar 23 14:23:25 2025

read: IOPS=1980, BW=1981MiB/s (2077MB/s)(1024MiB/517msec)

clat (usec): min=111, max=2301, avg=501.78, stdev=180.47

lat (usec): min=112, max=2301, avg=501.89, stdev=180.48

clat percentiles (usec):

| 1.00th=[ 120], 5.00th=[ 133], 10.00th=[ 153], 20.00th=[ 416],

| 30.00th=[ 453], 40.00th=[ 529], 50.00th=[ 545], 60.00th=[ 562],

| 70.00th=[ 578], 80.00th=[ 594], 90.00th=[ 619], 95.00th=[ 668],

| 99.00th=[ 971], 99.50th=[ 1156], 99.90th=[ 2180], 99.95th=[ 2311],

| 99.99th=[ 2311]

lat (usec) : 250=11.82%, 500=23.93%, 750=62.01%, 1000=1.46%

lat (msec) : 2=0.59%, 4=0.20%

cpu : usr=0.00%, sys=14.34%, ctx=1029, majf=0, minf=264

IO depths : 1=100.0%, 2=0.0%, 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=1024,0,0,0 short=0,0,0,0 dropped=0,0,0,0

latency : target=0, window=0, percentile=100.00%, depth=1

bs=512k: (groupid=11, jobs=1): err= 0: pid=31069: Sun Mar 23 14:23:25 2025

read: IOPS=3459, BW=1730MiB/s (1814MB/s)(1024MiB/592msec)

clat (usec): min=84, max=979, avg=286.58, stdev=87.79

lat (usec): min=84, max=979, avg=286.69, stdev=87.79

clat percentiles (usec):

| 1.00th=[ 86], 5.00th=[ 94], 10.00th=[ 112], 20.00th=[ 269],

| 30.00th=[ 277], 40.00th=[ 285], 50.00th=[ 293], 60.00th=[ 306],

| 70.00th=[ 318], 80.00th=[ 330], 90.00th=[ 359], 95.00th=[ 379],

| 99.00th=[ 562], 99.50th=[ 668], 99.90th=[ 840], 99.95th=[ 930],

| 99.99th=[ 979]

bw ( MiB/s): min= 1700, max= 1700, per=98.34%, avg=1701.00, stdev= 0.00, samples=1

iops : min= 3401, max= 3401, avg=3401.00, stdev= 0.00, samples=1

lat (usec) : 100=6.74%, 250=7.03%, 500=84.86%, 750=1.12%, 1000=0.24%

cpu : usr=1.52%, sys=12.69%, ctx=2054, majf=0, minf=137

IO depths : 1=100.0%, 2=0.0%, 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=2048,0,0,0 short=0,0,0,0 dropped=0,0,0,0

latency : target=0, window=0, percentile=100.00%, depth=1

bs=256k: (groupid=12, jobs=1): err= 0: pid=31070: Sun Mar 23 14:23:25 2025

read: IOPS=5224, BW=1306MiB/s (1370MB/s)(1024MiB/784msec)

clat (usec): min=56, max=1014, avg=190.10, stdev=72.44

lat (usec): min=56, max=1014, avg=190.18, stdev=72.44

clat percentiles (usec):

| 1.00th=[ 67], 5.00th=[ 71], 10.00th=[ 85], 20.00th=[ 153],

| 30.00th=[ 157], 40.00th=[ 163], 50.00th=[ 172], 60.00th=[ 182],

| 70.00th=[ 227], 80.00th=[ 249], 90.00th=[ 297], 95.00th=[ 322],

| 99.00th=[ 371], 99.50th=[ 408], 99.90th=[ 474], 99.95th=[ 562],

| 99.99th=[ 1012]

bw ( MiB/s): min= 1344, max= 1344, per=100.00%, avg=1344.89, stdev= 0.00, samples=1

iops : min= 5379, max= 5379, avg=5379.00, stdev= 0.00, samples=1

lat (usec) : 100=11.43%, 250=68.97%, 500=19.51%, 750=0.05%, 1000=0.02%

lat (msec) : 2=0.02%

cpu : usr=0.00%, sys=17.11%, ctx=4102, majf=0, minf=72

IO depths : 1=100.0%, 2=0.0%, 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=4096,0,0,0 short=0,0,0,0 dropped=0,0,0,0

latency : target=0, window=0, percentile=100.00%, depth=1

bs=128k: (groupid=13, jobs=1): err= 0: pid=31071: Sun Mar 23 14:23:25 2025

read: IOPS=7198, BW=900MiB/s (944MB/s)(1024MiB/1138msec)

clat (usec): min=46, max=831, avg=137.90, stdev=56.35

lat (usec): min=46, max=831, avg=137.98, stdev=56.37

clat percentiles (usec):

| 1.00th=[ 50], 5.00th=[ 55], 10.00th=[ 67], 20.00th=[ 111],

| 30.00th=[ 116], 40.00th=[ 121], 50.00th=[ 125], 60.00th=[ 133],

| 70.00th=[ 141], 80.00th=[ 159], 90.00th=[ 219], 95.00th=[ 265],

| 99.00th=[ 306], 99.50th=[ 322], 99.90th=[ 416], 99.95th=[ 469],

| 99.99th=[ 832]

bw ( KiB/s): min=910051, max=957207, per=100.00%, avg=933629.00, stdev=33344.33, samples=2

iops : min= 7109, max= 7478, avg=7293.50, stdev=260.92, samples=2

lat (usec) : 50=1.32%, 100=10.90%, 250=81.69%, 500=6.05%, 750=0.02%

lat (usec) : 1000=0.01%

cpu : usr=0.00%, sys=17.50%, ctx=8197, majf=0, minf=39

IO depths : 1=100.0%, 2=0.0%, 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=8192,0,0,0 short=0,0,0,0 dropped=0,0,0,0

latency : target=0, window=0, percentile=100.00%, depth=1

bs=64k: (groupid=14, jobs=1): err= 0: pid=31072: Sun Mar 23 14:23:25 2025

read: IOPS=8591, BW=537MiB/s (563MB/s)(1024MiB/1907msec)

clat (usec): min=34, max=986, avg=115.59, stdev=44.50

lat (usec): min=34, max=986, avg=115.66, stdev=44.52

clat percentiles (usec):

| 1.00th=[ 43], 5.00th=[ 48], 10.00th=[ 64], 20.00th=[ 96],

| 30.00th=[ 100], 40.00th=[ 103], 50.00th=[ 108], 60.00th=[ 113],

| 70.00th=[ 121], 80.00th=[ 133], 90.00th=[ 174], 95.00th=[ 202],

| 99.00th=[ 269], 99.50th=[ 281], 99.90th=[ 322], 99.95th=[ 429],

| 99.99th=[ 922]

bw ( KiB/s): min=527647, max=607512, per=100.00%, avg=556434.33, stdev=44353.68, samples=3

iops : min= 8244, max= 9492, avg=8694.00, stdev=692.97, samples=3

lat (usec) : 50=6.32%, 100=23.37%, 250=68.23%, 500=2.05%, 750=0.01%

lat (usec) : 1000=0.02%

cpu : usr=1.21%, sys=17.42%, ctx=16390, majf=0, minf=26

IO depths : 1=100.0%, 2=0.0%, 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=16384,0,0,0 short=0,0,0,0 dropped=0,0,0,0

latency : target=0, window=0, percentile=100.00%, depth=1

bs=32k: (groupid=15, jobs=1): err= 0: pid=31073: Sun Mar 23 14:23:25 2025

read: IOPS=9855, BW=308MiB/s (323MB/s)(1024MiB/3325msec)

clat (usec): min=27, max=593, avg=100.84, stdev=34.02

lat (usec): min=27, max=593, avg=100.90, stdev=34.04

clat percentiles (usec):

| 1.00th=[ 30], 5.00th=[ 36], 10.00th=[ 48], 20.00th=[ 86],

| 30.00th=[ 91], 40.00th=[ 95], 50.00th=[ 98], 60.00th=[ 103],

| 70.00th=[ 111], 80.00th=[ 121], 90.00th=[ 139], 95.00th=[ 157],

| 99.00th=[ 215], 99.50th=[ 233], 99.90th=[ 265], 99.95th=[ 277],

| 99.99th=[ 343]

bw ( KiB/s): min=288125, max=385030, per=98.54%, avg=310750.33, stdev=36853.58, samples=6

iops : min= 9003, max=12032, avg=9710.50, stdev=1151.85, samples=6

lat (usec) : 50=10.49%, 100=44.47%, 250=44.81%, 500=0.22%, 750=0.01%

cpu : usr=0.84%, sys=18.29%, ctx=32772, majf=0, minf=16

IO depths : 1=100.0%, 2=0.0%, 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=32768,0,0,0 short=0,0,0,0 dropped=0,0,0,0

latency : target=0, window=0, percentile=100.00%, depth=1

bs=16k: (groupid=16, jobs=1): err= 0: pid=31074: Sun Mar 23 14:23:25 2025

read: IOPS=10.1k, BW=157MiB/s (165MB/s)(1024MiB/6514msec)

clat (usec): min=25, max=2488, avg=98.77, stdev=30.16

lat (usec): min=25, max=2488, avg=98.83, stdev=30.18

clat percentiles (usec):

| 1.00th=[ 39], 5.00th=[ 42], 10.00th=[ 55], 20.00th=[ 87],

| 30.00th=[ 92], 40.00th=[ 95], 50.00th=[ 97], 60.00th=[ 102],

| 70.00th=[ 109], 80.00th=[ 116], 90.00th=[ 129], 95.00th=[ 143],

| 99.00th=[ 178], 99.50th=[ 206], 99.90th=[ 241], 99.95th=[ 258],

| 99.99th=[ 490]

bw ( KiB/s): min=149056, max=241513, per=99.25%, avg=159768.42, stdev=26046.46, samples=12

iops : min= 9316, max=15094, avg=9985.33, stdev=1627.80, samples=12

lat (usec) : 50=9.01%, 100=47.37%, 250=43.57%, 500=0.05%, 1000=0.01%

lat (msec) : 2=0.01%, 4=0.01%

cpu : usr=2.63%, sys=16.72%, ctx=65541, majf=0, minf=13

IO depths : 1=100.0%, 2=0.0%, 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=65536,0,0,0 short=0,0,0,0 dropped=0,0,0,0

latency : target=0, window=0, percentile=100.00%, depth=1

bs=8k: (groupid=17, jobs=1): err= 0: pid=31075: Sun Mar 23 14:23:25 2025

read: IOPS=10.7k, BW=83.6MiB/s (87.6MB/s)(1024MiB/12253msec)

clat (usec): min=27, max=1334, avg=92.89, stdev=27.04

lat (usec): min=27, max=1334, avg=92.95, stdev=27.06

clat percentiles (usec):

| 1.00th=[ 39], 5.00th=[ 40], 10.00th=[ 53], 20.00th=[ 81],

| 30.00th=[ 86], 40.00th=[ 90], 50.00th=[ 93], 60.00th=[ 97],

| 70.00th=[ 102], 80.00th=[ 110], 90.00th=[ 122], 95.00th=[ 133],

| 99.00th=[ 159], 99.50th=[ 178], 99.90th=[ 227], 99.95th=[ 247],

| 99.99th=[ 717]

bw ( KiB/s): min=72916, max=132059, per=99.35%, avg=85023.58, stdev=14263.26, samples=24

iops : min= 9114, max=16507, avg=10627.62, stdev=1782.94, samples=24

lat (usec) : 50=9.45%, 100=57.71%, 250=32.79%, 500=0.03%, 750=0.01%

lat (usec) : 1000=0.01%

lat (msec) : 2=0.01%

cpu : usr=1.05%, sys=18.32%, ctx=131081, majf=0, minf=10

IO depths : 1=100.0%, 2=0.0%, 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=131072,0,0,0 short=0,0,0,0 dropped=0,0,0,0

latency : target=0, window=0, percentile=100.00%, depth=1

bs=4k: (groupid=18, jobs=1): err= 0: pid=31076: Sun Mar 23 14:23:25 2025

read: IOPS=10.9k, BW=42.7MiB/s (44.7MB/s)(1024MiB/23996msec)

clat (usec): min=24, max=3679, avg=90.95, stdev=29.05

lat (usec): min=24, max=3679, avg=91.02, stdev=29.06

clat percentiles (usec):

| 1.00th=[ 39], 5.00th=[ 41], 10.00th=[ 57], 20.00th=[ 78],

| 30.00th=[ 83], 40.00th=[ 87], 50.00th=[ 91], 60.00th=[ 95],

| 70.00th=[ 100], 80.00th=[ 109], 90.00th=[ 120], 95.00th=[ 130],

| 99.00th=[ 149], 99.50th=[ 161], 99.90th=[ 208], 99.95th=[ 227],

| 99.99th=[ 914]

bw ( KiB/s): min=38424, max=86136, per=100.00%, avg=43763.02, stdev=9291.91, samples=47

iops : min= 9606, max=21534, avg=10940.70, stdev=2322.99, samples=47

lat (usec) : 50=8.43%, 100=61.46%, 250=30.09%, 500=0.01%, 750=0.01%

lat (usec) : 1000=0.01%

lat (msec) : 2=0.01%, 4=0.01%

cpu : usr=0.85%, sys=19.01%, ctx=262147, majf=0, minf=10

IO depths : 1=100.0%, 2=0.0%, 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=262144,0,0,0 short=0,0,0,0 dropped=0,0,0,0

latency : target=0, window=0, percentile=100.00%, depth=1

Run status group 0 (all jobs):

READ: bw=2415MiB/s (2532MB/s), 2415MiB/s-2415MiB/s (2532MB/s-2532MB/s), io=1024MiB (1074MB), run=424-424msec

Run status group 1 (all jobs):

READ: bw=3160MiB/s (3314MB/s), 3160MiB/s-3160MiB/s (3314MB/s-3314MB/s), io=1024MiB (1074MB), run=324-324msec

Run status group 2 (all jobs):

READ: bw=3765MiB/s (3948MB/s), 3765MiB/s-3765MiB/s (3948MB/s-3948MB/s), io=1024MiB (1074MB), run=272-272msec

Run status group 3 (all jobs):

READ: bw=3568MiB/s (3741MB/s), 3568MiB/s-3568MiB/s (3741MB/s-3741MB/s), io=1024MiB (1074MB), run=287-287msec

Run status group 4 (all jobs):

READ: bw=4000MiB/s (4194MB/s), 4000MiB/s-4000MiB/s (4194MB/s-4194MB/s), io=1024MiB (1074MB), run=256-256msec

Run status group 5 (all jobs):

READ: bw=4080MiB/s (4278MB/s), 4080MiB/s-4080MiB/s (4278MB/s-4278MB/s), io=1024MiB (1074MB), run=251-251msec

Run status group 6 (all jobs):

READ: bw=4112MiB/s (4312MB/s), 4112MiB/s-4112MiB/s (4312MB/s-4312MB/s), io=1024MiB (1074MB), run=249-249msec

Run status group 7 (all jobs):

READ: bw=4531MiB/s (4751MB/s), 4531MiB/s-4531MiB/s (4751MB/s-4751MB/s), io=1024MiB (1074MB), run=226-226msec

Run status group 8 (all jobs):

READ: bw=3864MiB/s (4052MB/s), 3864MiB/s-3864MiB/s (4052MB/s-4052MB/s), io=1024MiB (1074MB), run=265-265msec

Run status group 9 (all jobs):

READ: bw=2745MiB/s (2879MB/s), 2745MiB/s-2745MiB/s (2879MB/s-2879MB/s), io=1024MiB (1074MB), run=373-373msec

Run status group 10 (all jobs):

READ: bw=1981MiB/s (2077MB/s), 1981MiB/s-1981MiB/s (2077MB/s-2077MB/s), io=1024MiB (1074MB), run=517-517msec

Run status group 11 (all jobs):

READ: bw=1730MiB/s (1814MB/s), 1730MiB/s-1730MiB/s (1814MB/s-1814MB/s), io=1024MiB (1074MB), run=592-592msec

Run status group 12 (all jobs):

READ: bw=1306MiB/s (1370MB/s), 1306MiB/s-1306MiB/s (1370MB/s-1370MB/s), io=1024MiB (1074MB), run=784-784msec

Run status group 13 (all jobs):

READ: bw=900MiB/s (944MB/s), 900MiB/s-900MiB/s (944MB/s-944MB/s), io=1024MiB (1074MB), run=1138-1138msec

Run status group 14 (all jobs):

READ: bw=537MiB/s (563MB/s), 537MiB/s-537MiB/s (563MB/s-563MB/s), io=1024MiB (1074MB), run=1907-1907msec

Run status group 15 (all jobs):

READ: bw=308MiB/s (323MB/s), 308MiB/s-308MiB/s (323MB/s-323MB/s), io=1024MiB (1074MB), run=3325-3325msec

Run status group 16 (all jobs):

READ: bw=157MiB/s (165MB/s), 157MiB/s-157MiB/s (165MB/s-165MB/s), io=1024MiB (1074MB), run=6514-6514msec

Run status group 17 (all jobs):

READ: bw=83.6MiB/s (87.6MB/s), 83.6MiB/s-83.6MiB/s (87.6MB/s-87.6MB/s), io=1024MiB (1074MB), run=12253-12253msec

Run status group 18 (all jobs):

READ: bw=42.7MiB/s (44.7MB/s), 42.7MiB/s-42.7MiB/s (44.7MB/s-44.7MB/s), io=1024MiB (1074MB), run=23996-23996msec

Disk stats (read/write):

sda: ios=534119/420, sectors=39827424/7464, merge=398/128, ticks=190291/221, in\_queue=190555, util=66.70%

Bonus (10%)

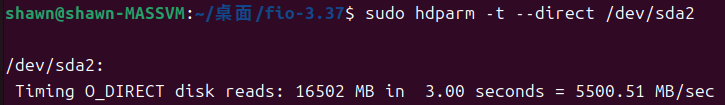
**Question :**

1. (5%) Compare with multiple kinds of storage devices  
   Is there any significant difference between read/randread on storage devices? Why or why not? Please justify your answer in brief.

HDD的read和random read差異蠻大的。因為讀取資料需要物理上的移動（尤其是移動磁頭），如果是random的話磁頭移動距離可能會變得很大，大幅影響效能。而SSD使用flash memory來儲存資料，因為都是通過電子的方式存取，所以存取時間差異較小。

1. (5%) Find the specs of your own hardware that you tested on  
   Is your hardware running to spec? If not, could you come up with a possible theory?

XPG GAMMIX S70 PRO的Read可達7400MB/s，Write可達6800MB/s。



使用hdparm工具及fio工具測試得出的結果（Read最高5500MB/s、Write最高5711MB/s），都難以達到官方的最高速率，推測原因是在VM中測試，多了一些虛擬化的開銷，資源也較受限，而影響到磁碟存取的效能。

所以我在本機上又做了測試，發現其實與官方數值十分接近。



bonus\_q2.fio output

bs=1g: (g=0): rw=write, bs=(R) 1024MiB-1024MiB, (W) 1024MiB-1024MiB, (T) 1024MiB-1024MiB, ioengine=psync, iodepth=1

bs=512m: (g=1): rw=write, bs=(R) 512MiB-512MiB, (W) 512MiB-512MiB, (T) 512MiB-512MiB, ioengine=psync, iodepth=1

bs=256m: (g=2): rw=write, bs=(R) 256MiB-256MiB, (W) 256MiB-256MiB, (T) 256MiB-256MiB, ioengine=psync, iodepth=1

bs=128m: (g=3): rw=write, bs=(R) 128MiB-128MiB, (W) 128MiB-128MiB, (T) 128MiB-128MiB, ioengine=psync, iodepth=1

bs=64m: (g=4): rw=write, bs=(R) 64.0MiB-64.0MiB, (W) 64.0MiB-64.0MiB, (T) 64.0MiB-64.0MiB, ioengine=psync, iodepth=1

bs=32m: (g=5): rw=write, bs=(R) 32.0MiB-32.0MiB, (W) 32.0MiB-32.0MiB, (T) 32.0MiB-32.0MiB, ioengine=psync, iodepth=1

bs=16m: (g=6): rw=write, bs=(R) 16.0MiB-16.0MiB, (W) 16.0MiB-16.0MiB, (T) 16.0MiB-16.0MiB, ioengine=psync, iodepth=1

bs=8m: (g=7): rw=write, bs=(R) 8192KiB-8192KiB, (W) 8192KiB-8192KiB, (T) 8192KiB-8192KiB, ioengine=psync, iodepth=1

bs=4m: (g=8): rw=write, bs=(R) 4096KiB-4096KiB, (W) 4096KiB-4096KiB, (T) 4096KiB-4096KiB, ioengine=psync, iodepth=1

bs=2m: (g=9): rw=write, bs=(R) 2048KiB-2048KiB, (W) 2048KiB-2048KiB, (T) 2048KiB-2048KiB, ioengine=psync, iodepth=1

bs=1m: (g=10): rw=write, bs=(R) 1024KiB-1024KiB, (W) 1024KiB-1024KiB, (T) 1024KiB-1024KiB, ioengine=psync, iodepth=1

bs=512k: (g=11): rw=write, bs=(R) 512KiB-512KiB, (W) 512KiB-512KiB, (T) 512KiB-512KiB, ioengine=psync, iodepth=1

bs=256k: (g=12): rw=write, bs=(R) 256KiB-256KiB, (W) 256KiB-256KiB, (T) 256KiB-256KiB, ioengine=psync, iodepth=1

bs=128k: (g=13): rw=write, bs=(R) 128KiB-128KiB, (W) 128KiB-128KiB, (T) 128KiB-128KiB, ioengine=psync, iodepth=1

bs=64k: (g=14): rw=write, bs=(R) 64.0KiB-64.0KiB, (W) 64.0KiB-64.0KiB, (T) 64.0KiB-64.0KiB, ioengine=psync, iodepth=1

bs=32k: (g=15): rw=write, bs=(R) 32.0KiB-32.0KiB, (W) 32.0KiB-32.0KiB, (T) 32.0KiB-32.0KiB, ioengine=psync, iodepth=1

bs=16k: (g=16): rw=write, bs=(R) 16.0KiB-16.0KiB, (W) 16.0KiB-16.0KiB, (T) 16.0KiB-16.0KiB, ioengine=psync, iodepth=1

bs=8k: (g=17): rw=write, bs=(R) 8192B-8192B, (W) 8192B-8192B, (T) 8192B-8192B, ioengine=psync, iodepth=1

bs=4k: (g=18): rw=write, bs=(R) 4096B-4096B, (W) 4096B-4096B, (T) 4096B-4096B, ioengine=psync, iodepth=1

fio-3.37

Starting 19 processes

bs=1g: Laying out IO file (1 file / 1024MiB)

bs=1g: (groupid=0, jobs=1): err= 0: pid=33254: Sun Mar 23 16:50:16 2025

write: IOPS=1, BW=1105MiB/s (1158MB/s)(1024MiB/927msec); 0 zone resets

clat (nsec): min=900754k, max=900754k, avg=900754457.00, stdev= 0.00

lat (nsec): min=925901k, max=925901k, avg=925901465.00, stdev= 0.00

clat percentiles (msec):

| 1.00th=[ 902], 5.00th=[ 902], 10.00th=[ 902], 20.00th=[ 902],

| 30.00th=[ 902], 40.00th=[ 902], 50.00th=[ 902], 60.00th=[ 902],

| 70.00th=[ 902], 80.00th=[ 902], 90.00th=[ 902], 95.00th=[ 902],

| 99.00th=[ 902], 99.50th=[ 902], 99.90th=[ 902], 99.95th=[ 902],

| 99.99th=[ 902]

bw ( MiB/s): min= 2052, max= 2052, per=100.00%, avg=2052.10, stdev= 0.00, samples=1

iops : min= 2, max= 2, avg= 2.00, stdev= 0.00, samples=1

lat (msec) : 1000=100.00%

cpu : usr=2.38%, sys=4.75%, ctx=658, majf=0, minf=10

IO depths : 1=100.0%, 2=0.0%, 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=0,1,0,0 short=0,0,0,0 dropped=0,0,0,0

latency : target=0, window=0, percentile=100.00%, depth=1

bs=512m: (groupid=1, jobs=1): err= 0: pid=33256: Sun Mar 23 16:50:16 2025

write: IOPS=7, BW=3938MiB/s (4130MB/s)(1024MiB/260msec); 0 zone resets

clat (msec): min=113, max=118, avg=115.90, stdev= 3.50

lat (msec): min=128, max=130, avg=129.61, stdev= 1.67

clat percentiles (msec):

| 1.00th=[ 114], 5.00th=[ 114], 10.00th=[ 114], 20.00th=[ 114],

| 30.00th=[ 114], 40.00th=[ 114], 50.00th=[ 114], 60.00th=[ 118],

| 70.00th=[ 118], 80.00th=[ 118], 90.00th=[ 118], 95.00th=[ 118],

| 99.00th=[ 118], 99.50th=[ 118], 99.90th=[ 118], 99.95th=[ 118],

| 99.99th=[ 118]

lat (msec) : 250=100.00%

cpu : usr=10.81%, sys=31.27%, ctx=402, majf=0, minf=10

IO depths : 1=100.0%, 2=0.0%, 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=0,2,0,0 short=0,0,0,0 dropped=0,0,0,0

latency : target=0, window=0, percentile=100.00%, depth=1

bs=256m: (groupid=2, jobs=1): err= 0: pid=33261: Sun Mar 23 16:50:16 2025

write: IOPS=16, BW=4231MiB/s (4437MB/s)(1024MiB/242msec); 0 zone resets

clat (usec): min=50520, max=57872, avg=53634.48, stdev=3087.01

lat (usec): min=56562, max=64858, avg=60330.90, stdev=3418.37

clat percentiles (usec):

| 1.00th=[50594], 5.00th=[50594], 10.00th=[50594], 20.00th=[50594],

| 30.00th=[52691], 40.00th=[52691], 50.00th=[52691], 60.00th=[53216],

| 70.00th=[53216], 80.00th=[57934], 90.00th=[57934], 95.00th=[57934],

| 99.00th=[57934], 99.50th=[57934], 99.90th=[57934], 99.95th=[57934],

| 99.99th=[57934]

lat (msec) : 100=100.00%

cpu : usr=9.96%, sys=26.56%, ctx=296, majf=0, minf=10

IO depths : 1=100.0%, 2=0.0%, 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=0,4,0,0 short=0,0,0,0 dropped=0,0,0,0

latency : target=0, window=0, percentile=100.00%, depth=1

bs=128m: (groupid=3, jobs=1): err= 0: pid=33264: Sun Mar 23 16:50:16 2025

write: IOPS=33, BW=4339MiB/s (4550MB/s)(1024MiB/236msec); 0 zone resets

clat (usec): min=22927, max=37575, avg=26969.37, stdev=5592.00

lat (usec): min=24376, max=40133, avg=29419.52, stdev=5944.49

clat percentiles (usec):

| 1.00th=[22938], 5.00th=[22938], 10.00th=[22938], 20.00th=[22938],

| 30.00th=[23462], 40.00th=[23462], 50.00th=[23462], 60.00th=[25560],

| 70.00th=[25822], 80.00th=[33817], 90.00th=[37487], 95.00th=[37487],

| 99.00th=[37487], 99.50th=[37487], 99.90th=[37487], 99.95th=[37487],

| 99.99th=[37487]

lat (msec) : 50=100.00%

cpu : usr=7.66%, sys=18.72%, ctx=228, majf=0, minf=10

IO depths : 1=100.0%, 2=0.0%, 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=0,8,0,0 short=0,0,0,0 dropped=0,0,0,0

latency : target=0, window=0, percentile=100.00%, depth=1

bs=64m: (groupid=4, jobs=1): err= 0: pid=33266: Sun Mar 23 16:50:16 2025

write: IOPS=66, BW=4285MiB/s (4493MB/s)(1024MiB/239msec); 0 zone resets

clat (usec): min=12291, max=21729, avg=14183.41, stdev=2246.48

lat (usec): min=12941, max=22353, avg=14880.08, stdev=2225.22

clat percentiles (usec):

| 1.00th=[12256], 5.00th=[12256], 10.00th=[12387], 20.00th=[12780],

| 30.00th=[12780], 40.00th=[13304], 50.00th=[13566], 60.00th=[14222],

| 70.00th=[14746], 80.00th=[14877], 90.00th=[15139], 95.00th=[21627],

| 99.00th=[21627], 99.50th=[21627], 99.90th=[21627], 99.95th=[21627],

| 99.99th=[21627]

lat (msec) : 20=93.75%, 50=6.25%

cpu : usr=2.52%, sys=15.55%, ctx=16, majf=0, minf=11

IO depths : 1=100.0%, 2=0.0%, 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=0,16,0,0 short=0,0,0,0 dropped=0,0,0,0

latency : target=0, window=0, percentile=100.00%, depth=1

bs=32m: (groupid=5, jobs=1): err= 0: pid=33267: Sun Mar 23 16:50:16 2025

write: IOPS=136, BW=4357MiB/s (4569MB/s)(1024MiB/235msec); 0 zone resets

clat (usec): min=5372, max=15180, avg=7187.41, stdev=2164.28

lat (usec): min=5547, max=15256, avg=7325.78, stdev=2164.62

clat percentiles (usec):

| 1.00th=[ 5342], 5.00th=[ 5997], 10.00th=[ 6063], 20.00th=[ 6390],

| 30.00th=[ 6456], 40.00th=[ 6521], 50.00th=[ 6587], 60.00th=[ 6783],

| 70.00th=[ 6849], 80.00th=[ 6980], 90.00th=[ 7177], 95.00th=[14877],

| 99.00th=[15139], 99.50th=[15139], 99.90th=[15139], 99.95th=[15139],

| 99.99th=[15139]

lat (msec) : 10=93.75%, 20=6.25%

cpu : usr=2.56%, sys=20.94%, ctx=32, majf=0, minf=9

IO depths : 1=100.0%, 2=0.0%, 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=0,32,0,0 short=0,0,0,0 dropped=0,0,0,0

latency : target=0, window=0, percentile=100.00%, depth=1

bs=16m: (groupid=6, jobs=1): err= 0: pid=33269: Sun Mar 23 16:50:16 2025

write: IOPS=331, BW=5306MiB/s (5563MB/s)(1024MiB/193msec); 0 zone resets

clat (usec): min=2164, max=10660, avg=2952.64, stdev=1072.82

lat (usec): min=2214, max=10710, avg=3004.38, stdev=1073.04

clat percentiles (usec):

| 1.00th=[ 2180], 5.00th=[ 2245], 10.00th=[ 2343], 20.00th=[ 2507],

| 30.00th=[ 2638], 40.00th=[ 2704], 50.00th=[ 2769], 60.00th=[ 2868],

| 70.00th=[ 2999], 80.00th=[ 3195], 90.00th=[ 3294], 95.00th=[ 3490],

| 99.00th=[10683], 99.50th=[10683], 99.90th=[10683], 99.95th=[10683],

| 99.99th=[10683]

lat (msec) : 4=96.88%, 10=1.56%, 20=1.56%

cpu : usr=3.65%, sys=18.23%, ctx=64, majf=0, minf=11

IO depths : 1=100.0%, 2=0.0%, 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=0,64,0,0 short=0,0,0,0 dropped=0,0,0,0

latency : target=0, window=0, percentile=100.00%, depth=1

bs=8m: (groupid=7, jobs=1): err= 0: pid=33270: Sun Mar 23 16:50:16 2025

write: IOPS=349, BW=2798MiB/s (2934MB/s)(1024MiB/366msec); 0 zone resets

clat (usec): min=1045, max=17290, avg=2820.53, stdev=3760.88

lat (usec): min=1073, max=17342, avg=2852.24, stdev=3763.47

clat percentiles (usec):

| 1.00th=[ 1074], 5.00th=[ 1156], 10.00th=[ 1270], 20.00th=[ 1401],

| 30.00th=[ 1467], 40.00th=[ 1532], 50.00th=[ 1598], 60.00th=[ 1663],

| 70.00th=[ 1729], 80.00th=[ 1876], 90.00th=[ 7046], 95.00th=[15926],

| 99.00th=[16909], 99.50th=[17171], 99.90th=[17171], 99.95th=[17171],

| 99.99th=[17171]

lat (msec) : 2=82.81%, 4=5.47%, 10=5.47%, 20=6.25%

cpu : usr=1.64%, sys=28.22%, ctx=130, majf=0, minf=11

IO depths : 1=100.0%, 2=0.0%, 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=0,128,0,0 short=0,0,0,0 dropped=0,0,0,0

latency : target=0, window=0, percentile=100.00%, depth=1

bs=4m: (groupid=8, jobs=1): err= 0: pid=33272: Sun Mar 23 16:50:16 2025

write: IOPS=1361, BW=5447MiB/s (5711MB/s)(1024MiB/188msec); 0 zone resets

clat (usec): min=492, max=8566, avg=714.11, stdev=524.32

lat (usec): min=506, max=8603, avg=729.45, stdev=525.55

clat percentiles (usec):

| 1.00th=[ 498], 5.00th=[ 506], 10.00th=[ 515], 20.00th=[ 529],

| 30.00th=[ 537], 40.00th=[ 562], 50.00th=[ 611], 60.00th=[ 668],

| 70.00th=[ 783], 80.00th=[ 898], 90.00th=[ 947], 95.00th=[ 1045],

| 99.00th=[ 1221], 99.50th=[ 1221], 99.90th=[ 8586], 99.95th=[ 8586],

| 99.99th=[ 8586]

lat (usec) : 500=1.56%, 750=65.23%, 1000=26.95%

lat (msec) : 2=5.86%, 10=0.39%

cpu : usr=2.14%, sys=33.16%, ctx=256, majf=0, minf=11

IO depths : 1=100.0%, 2=0.0%, 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=0,256,0,0 short=0,0,0,0 dropped=0,0,0,0

latency : target=0, window=0, percentile=100.00%, depth=1

bs=2m: (groupid=9, jobs=1): err= 0: pid=33273: Sun Mar 23 16:50:16 2025

write: IOPS=1759, BW=3519MiB/s (3690MB/s)(1024MiB/291msec); 0 zone resets

clat (usec): min=210, max=8091, avg=558.00, stdev=671.29

lat (usec): min=217, max=8098, avg=565.82, stdev=671.27

clat percentiles (usec):

| 1.00th=[ 217], 5.00th=[ 223], 10.00th=[ 229], 20.00th=[ 237],

| 30.00th=[ 243], 40.00th=[ 258], 50.00th=[ 273], 60.00th=[ 322],

| 70.00th=[ 660], 80.00th=[ 750], 90.00th=[ 1156], 95.00th=[ 1876],

| 99.00th=[ 2147], 99.50th=[ 2900], 99.90th=[ 8094], 99.95th=[ 8094],

| 99.99th=[ 8094]

lat (usec) : 250=35.74%, 500=31.25%, 750=13.09%, 1000=7.62%

lat (msec) : 2=9.96%, 4=1.95%, 10=0.39%

cpu : usr=1.72%, sys=20.34%, ctx=516, majf=0, minf=10

IO depths : 1=100.0%, 2=0.0%, 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=0,512,0,0 short=0,0,0,0 dropped=0,0,0,0

latency : target=0, window=0, percentile=100.00%, depth=1

bs=1m: (groupid=10, jobs=1): err= 0: pid=33274: Sun Mar 23 16:50:16 2025

write: IOPS=5171, BW=5172MiB/s (5423MB/s)(1024MiB/198msec); 0 zone resets

clat (usec): min=136, max=7674, avg=187.74, stdev=283.76

lat (usec): min=139, max=7677, avg=191.76, stdev=283.77

clat percentiles (usec):

| 1.00th=[ 143], 5.00th=[ 147], 10.00th=[ 149], 20.00th=[ 155],

| 30.00th=[ 159], 40.00th=[ 161], 50.00th=[ 165], 60.00th=[ 172],

| 70.00th=[ 176], 80.00th=[ 182], 90.00th=[ 194], 95.00th=[ 210],

| 99.00th=[ 355], 99.50th=[ 660], 99.90th=[ 3097], 99.95th=[ 7701],

| 99.99th=[ 7701]

lat (usec) : 250=98.14%, 500=1.17%, 750=0.20%

lat (msec) : 2=0.10%, 4=0.29%, 10=0.10%

cpu : usr=2.54%, sys=35.03%, ctx=1024, majf=0, minf=11

IO depths : 1=100.0%, 2=0.0%, 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=0,1024,0,0 short=0,0,0,0 dropped=0,0,0,0

latency : target=0, window=0, percentile=100.00%, depth=1

bs=512k: (groupid=11, jobs=1): err= 0: pid=33275: Sun Mar 23 16:50:16 2025

write: IOPS=7816, BW=3908MiB/s (4098MB/s)(1024MiB/262msec); 0 zone resets

clat (usec): min=85, max=7781, avg=124.11, stdev=239.29

lat (usec): min=87, max=7782, avg=126.51, stdev=239.26

clat percentiles (usec):

| 1.00th=[ 95], 5.00th=[ 100], 10.00th=[ 102], 20.00th=[ 105],

| 30.00th=[ 108], 40.00th=[ 111], 50.00th=[ 113], 60.00th=[ 116],

| 70.00th=[ 120], 80.00th=[ 124], 90.00th=[ 131], 95.00th=[ 139],

| 99.00th=[ 163], 99.50th=[ 200], 99.90th=[ 1352], 99.95th=[ 7439],

| 99.99th=[ 7767]

lat (usec) : 100=5.86%, 250=93.80%, 500=0.05%, 750=0.05%

lat (msec) : 2=0.15%, 10=0.10%

cpu : usr=5.36%, sys=27.59%, ctx=2048, majf=0, minf=11

IO depths : 1=100.0%, 2=0.0%, 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=0,2048,0,0 short=0,0,0,0 dropped=0,0,0,0

latency : target=0, window=0, percentile=100.00%, depth=1

bs=256k: (groupid=12, jobs=1): err= 0: pid=33277: Sun Mar 23 16:50:16 2025

write: IOPS=11.4k, BW=2860MiB/s (2999MB/s)(1024MiB/358msec); 0 zone resets

clat (usec): min=63, max=7244, avg=85.32, stdev=113.40

lat (usec): min=64, max=7245, avg=86.43, stdev=113.41

clat percentiles (usec):

| 1.00th=[ 70], 5.00th=[ 72], 10.00th=[ 73], 20.00th=[ 75],

| 30.00th=[ 77], 40.00th=[ 80], 50.00th=[ 82], 60.00th=[ 85],

| 70.00th=[ 87], 80.00th=[ 91], 90.00th=[ 96], 95.00th=[ 101],

| 99.00th=[ 117], 99.50th=[ 135], 99.90th=[ 221], 99.95th=[ 318],

| 99.99th=[ 7242]

lat (usec) : 100=94.53%, 250=5.40%, 500=0.02%, 1000=0.02%

lat (msec) : 10=0.02%

cpu : usr=7.56%, sys=28.57%, ctx=4096, majf=0, minf=10

IO depths : 1=100.0%, 2=0.0%, 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=0,4096,0,0 short=0,0,0,0 dropped=0,0,0,0

latency : target=0, window=0, percentile=100.00%, depth=1

bs=128k: (groupid=13, jobs=1): err= 0: pid=33279: Sun Mar 23 16:50:16 2025

write: IOPS=14.2k, BW=1781MiB/s (1867MB/s)(1024MiB/575msec); 0 zone resets

clat (usec): min=43, max=6551, avg=68.67, stdev=98.48

lat (usec): min=44, max=6551, avg=69.38, stdev=98.49

clat percentiles (usec):

| 1.00th=[ 47], 5.00th=[ 48], 10.00th=[ 49], 20.00th=[ 56],

| 30.00th=[ 61], 40.00th=[ 63], 50.00th=[ 65], 60.00th=[ 69],

| 70.00th=[ 72], 80.00th=[ 77], 90.00th=[ 84], 95.00th=[ 91],

| 99.00th=[ 112], 99.50th=[ 130], 99.90th=[ 245], 99.95th=[ 515],

| 99.99th=[ 6521]

bw ( MiB/s): min= 1732, max= 1732, per=97.29%, avg=1732.66, stdev= 0.00, samples=1

iops : min=13861, max=13861, avg=13861.00, stdev= 0.00, samples=1

lat (usec) : 50=12.77%, 100=85.02%, 250=2.11%, 500=0.02%, 750=0.04%

lat (msec) : 2=0.01%, 10=0.02%

cpu : usr=3.48%, sys=33.45%, ctx=8192, majf=0, minf=10

IO depths : 1=100.0%, 2=0.0%, 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=0,8192,0,0 short=0,0,0,0 dropped=0,0,0,0

latency : target=0, window=0, percentile=100.00%, depth=1

bs=64k: (groupid=14, jobs=1): err= 0: pid=33281: Sun Mar 23 16:50:16 2025

write: IOPS=14.4k, BW=901MiB/s (945MB/s)(1024MiB/1136msec); 0 zone resets

clat (usec): min=36, max=3532, avg=68.30, stdev=46.67

lat (usec): min=36, max=3532, avg=68.66, stdev=46.69

clat percentiles (usec):

| 1.00th=[ 43], 5.00th=[ 48], 10.00th=[ 51], 20.00th=[ 56],

| 30.00th=[ 58], 40.00th=[ 60], 50.00th=[ 62], 60.00th=[ 65],

| 70.00th=[ 69], 80.00th=[ 73], 90.00th=[ 82], 95.00th=[ 94],

| 99.00th=[ 260], 99.50th=[ 289], 99.90th=[ 388], 99.95th=[ 816],

| 99.99th=[ 1385]

bw ( KiB/s): min=982153, max=982153, per=100.00%, avg=982153.00, stdev= 0.00, samples=1

iops : min=15346, max=15346, avg=15346.00, stdev= 0.00, samples=1

lat (usec) : 50=8.20%, 100=87.60%, 250=2.93%, 500=1.19%, 750=0.01%

lat (usec) : 1000=0.04%

lat (msec) : 2=0.02%, 4=0.01%

cpu : usr=2.55%, sys=31.78%, ctx=16383, majf=0, minf=12

IO depths : 1=100.0%, 2=0.0%, 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=0,16384,0,0 short=0,0,0,0 dropped=0,0,0,0

latency : target=0, window=0, percentile=100.00%, depth=1

bs=32k: (groupid=15, jobs=1): err= 0: pid=33283: Sun Mar 23 16:50:16 2025

write: IOPS=16.7k, BW=522MiB/s (547MB/s)(1024MiB/1963msec); 0 zone resets

clat (usec): min=30, max=3769, avg=59.06, stdev=51.91

lat (usec): min=30, max=3769, avg=59.28, stdev=51.92

clat percentiles (usec):

| 1.00th=[ 36], 5.00th=[ 37], 10.00th=[ 38], 20.00th=[ 46],

| 30.00th=[ 49], 40.00th=[ 51], 50.00th=[ 55], 60.00th=[ 59],

| 70.00th=[ 63], 80.00th=[ 69], 90.00th=[ 77], 95.00th=[ 86],

| 99.00th=[ 135], 99.50th=[ 200], 99.90th=[ 420], 99.95th=[ 914],

| 99.99th=[ 2802]

bw ( KiB/s): min=459049, max=588466, per=99.09%, avg=529329.00, stdev=65424.11, samples=3

iops : min=14345, max=18389, avg=16541.00, stdev=2044.34, samples=3

lat (usec) : 50=35.16%, 100=62.38%, 250=2.22%, 500=0.15%, 750=0.01%

lat (usec) : 1000=0.04%

lat (msec) : 2=0.03%, 4=0.02%

cpu : usr=2.40%, sys=33.69%, ctx=32750, majf=0, minf=11

IO depths : 1=100.0%, 2=0.0%, 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=0,32768,0,0 short=0,0,0,0 dropped=0,0,0,0

latency : target=0, window=0, percentile=100.00%, depth=1

bs=16k: (groupid=16, jobs=1): err= 0: pid=33290: Sun Mar 23 16:50:16 2025

write: IOPS=16.8k, BW=263MiB/s (276MB/s)(1024MiB/3892msec); 0 zone resets

clat (usec): min=28, max=3951, avg=58.65, stdev=53.00

lat (usec): min=28, max=3951, avg=58.79, stdev=53.02

clat percentiles (usec):

| 1.00th=[ 34], 5.00th=[ 36], 10.00th=[ 37], 20.00th=[ 44],

| 30.00th=[ 46], 40.00th=[ 49], 50.00th=[ 53], 60.00th=[ 58],

| 70.00th=[ 63], 80.00th=[ 68], 90.00th=[ 77], 95.00th=[ 91],

| 99.00th=[ 178], 99.50th=[ 221], 99.90th=[ 392], 99.95th=[ 725],

| 99.99th=[ 3130]

bw ( KiB/s): min=242949, max=308713, per=99.76%, avg=268781.71, stdev=25076.81, samples=7

iops : min=15184, max=19294, avg=16798.57, stdev=1567.32, samples=7

lat (usec) : 50=43.99%, 100=52.39%, 250=3.26%, 500=0.29%, 750=0.02%

lat (usec) : 1000=0.01%

lat (msec) : 2=0.03%, 4=0.02%

cpu : usr=2.72%, sys=33.02%, ctx=65486, majf=0, minf=10

IO depths : 1=100.0%, 2=0.0%, 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=0,65536,0,0 short=0,0,0,0 dropped=0,0,0,0

latency : target=0, window=0, percentile=100.00%, depth=1

bs=8k: (groupid=17, jobs=1): err= 0: pid=33292: Sun Mar 23 16:50:16 2025

write: IOPS=18.1k, BW=142MiB/s (148MB/s)(1024MiB/7233msec); 0 zone resets

clat (usec): min=28, max=4188, avg=54.54, stdev=39.19

lat (usec): min=28, max=4518, avg=54.66, stdev=40.59

clat percentiles (usec):

| 1.00th=[ 33], 5.00th=[ 35], 10.00th=[ 36], 20.00th=[ 43],

| 30.00th=[ 44], 40.00th=[ 46], 50.00th=[ 49], 60.00th=[ 53],

| 70.00th=[ 59], 80.00th=[ 64], 90.00th=[ 73], 95.00th=[ 83],

| 99.00th=[ 135], 99.50th=[ 167], 99.90th=[ 277], 99.95th=[ 404],

| 99.99th=[ 1795]

bw ( KiB/s): min=126509, max=152208, per=100.00%, avg=145290.93, stdev=6408.76, samples=14

iops : min=15813, max=19026, avg=18161.29, stdev=801.25, samples=14

lat (usec) : 50=53.80%, 100=43.70%, 250=2.36%, 500=0.10%, 750=0.01%

lat (usec) : 1000=0.01%

lat (msec) : 2=0.01%, 4=0.01%, 10=0.01%

cpu : usr=3.80%, sys=31.97%, ctx=131011, majf=0, minf=10

IO depths : 1=100.0%, 2=0.0%, 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=0,131072,0,0 short=0,0,0,0 dropped=0,0,0,0

latency : target=0, window=0, percentile=100.00%, depth=1

bs=4k: (groupid=18, jobs=1): err= 0: pid=33304: Sun Mar 23 16:50:16 2025

write: IOPS=18.4k, BW=71.7MiB/s (75.2MB/s)(1024MiB/14283msec); 0 zone resets

clat (usec): min=27, max=5895, avg=53.89, stdev=40.24

lat (usec): min=27, max=5895, avg=53.99, stdev=40.26

clat percentiles (usec):

| 1.00th=[ 33], 5.00th=[ 35], 10.00th=[ 36], 20.00th=[ 43],

| 30.00th=[ 44], 40.00th=[ 45], 50.00th=[ 48], 60.00th=[ 52],

| 70.00th=[ 58], 80.00th=[ 64], 90.00th=[ 73], 95.00th=[ 82],

| 99.00th=[ 141], 99.50th=[ 182], 99.90th=[ 285], 99.95th=[ 379],

| 99.99th=[ 1975]

bw ( KiB/s): min=61512, max=85229, per=100.00%, avg=73527.25, stdev=5599.00, samples=28

iops : min=15378, max=21307, avg=18381.79, stdev=1399.73, samples=28

lat (usec) : 50=56.99%, 100=40.49%, 250=2.37%, 500=0.12%, 750=0.01%

lat (usec) : 1000=0.01%

lat (msec) : 2=0.01%, 4=0.01%, 10=0.01%

cpu : usr=2.43%, sys=33.09%, ctx=262017, majf=0, minf=10

IO depths : 1=100.0%, 2=0.0%, 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=0,262144,0,0 short=0,0,0,0 dropped=0,0,0,0

latency : target=0, window=0, percentile=100.00%, depth=1

Run status group 0 (all jobs):

WRITE: bw=1105MiB/s (1158MB/s), 1105MiB/s-1105MiB/s (1158MB/s-1158MB/s), io=1024MiB (1074MB), run=927-927msec

Run status group 1 (all jobs):

WRITE: bw=3938MiB/s (4130MB/s), 3938MiB/s-3938MiB/s (4130MB/s-4130MB/s), io=1024MiB (1074MB), run=260-260msec

Run status group 2 (all jobs):

WRITE: bw=4231MiB/s (4437MB/s), 4231MiB/s-4231MiB/s (4437MB/s-4437MB/s), io=1024MiB (1074MB), run=242-242msec

Run status group 3 (all jobs):

WRITE: bw=4339MiB/s (4550MB/s), 4339MiB/s-4339MiB/s (4550MB/s-4550MB/s), io=1024MiB (1074MB), run=236-236msec

Run status group 4 (all jobs):

WRITE: bw=4285MiB/s (4493MB/s), 4285MiB/s-4285MiB/s (4493MB/s-4493MB/s), io=1024MiB (1074MB), run=239-239msec

Run status group 5 (all jobs):

WRITE: bw=4357MiB/s (4569MB/s), 4357MiB/s-4357MiB/s (4569MB/s-4569MB/s), io=1024MiB (1074MB), run=235-235msec

Run status group 6 (all jobs):

WRITE: bw=5306MiB/s (5563MB/s), 5306MiB/s-5306MiB/s (5563MB/s-5563MB/s), io=1024MiB (1074MB), run=193-193msec

Run status group 7 (all jobs):

WRITE: bw=2798MiB/s (2934MB/s), 2798MiB/s-2798MiB/s (2934MB/s-2934MB/s), io=1024MiB (1074MB), run=366-366msec

Run status group 8 (all jobs):

WRITE: bw=5447MiB/s (5711MB/s), 5447MiB/s-5447MiB/s (5711MB/s-5711MB/s), io=1024MiB (1074MB), run=188-188msec

Run status group 9 (all jobs):

WRITE: bw=3519MiB/s (3690MB/s), 3519MiB/s-3519MiB/s (3690MB/s-3690MB/s), io=1024MiB (1074MB), run=291-291msec

Run status group 10 (all jobs):

WRITE: bw=5172MiB/s (5423MB/s), 5172MiB/s-5172MiB/s (5423MB/s-5423MB/s), io=1024MiB (1074MB), run=198-198msec

Run status group 11 (all jobs):

WRITE: bw=3908MiB/s (4098MB/s), 3908MiB/s-3908MiB/s (4098MB/s-4098MB/s), io=1024MiB (1074MB), run=262-262msec

Run status group 12 (all jobs):

WRITE: bw=2860MiB/s (2999MB/s), 2860MiB/s-2860MiB/s (2999MB/s-2999MB/s), io=1024MiB (1074MB), run=358-358msec

Run status group 13 (all jobs):

WRITE: bw=1781MiB/s (1867MB/s), 1781MiB/s-1781MiB/s (1867MB/s-1867MB/s), io=1024MiB (1074MB), run=575-575msec

Run status group 14 (all jobs):

WRITE: bw=901MiB/s (945MB/s), 901MiB/s-901MiB/s (945MB/s-945MB/s), io=1024MiB (1074MB), run=1136-1136msec

Run status group 15 (all jobs):

WRITE: bw=522MiB/s (547MB/s), 522MiB/s-522MiB/s (547MB/s-547MB/s), io=1024MiB (1074MB), run=1963-1963msec

Run status group 16 (all jobs):

WRITE: bw=263MiB/s (276MB/s), 263MiB/s-263MiB/s (276MB/s-276MB/s), io=1024MiB (1074MB), run=3892-3892msec

Run status group 17 (all jobs):

WRITE: bw=142MiB/s (148MB/s), 142MiB/s-142MiB/s (148MB/s-148MB/s), io=1024MiB (1074MB), run=7233-7233msec

Run status group 18 (all jobs):

WRITE: bw=71.7MiB/s (75.2MB/s), 71.7MiB/s-71.7MiB/s (75.2MB/s-75.2MB/s), io=1024MiB (1074MB), run=14283-14283msec

Disk stats (read/write):

sda: ios=94/535744, sectors=4200/39849616, merge=299/753, ticks=133/139875, in\_queue=140070, util=53.03%