

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

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```
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%

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## 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

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```
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%

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## 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

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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

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### 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

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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%

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## 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 。

2. (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

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```
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。

2. (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%

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## 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（ $424 - 226 = 198\text{msec}$ ）與 4M 到 4K 的（ $23996 - 265 = 23731\text{msec}$ ）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。

2. (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。

```
shawn@shawn-MASSVM:~/桌面/fio-3.37$ sudo hdparm -t --direct /dev/sda2  
  
/dev/sda2:  
Timing O_DIRECT disk reads: 16502 MB in 3.00 seconds = 5500.51 MB/sec
```

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],

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| 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%

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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],

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| 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%

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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%

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