CS 553 - Cloud Computing, Spring 2020

# DESIGN AND PERFORMANCE REPORT

Team 14
Sandeep Singh (A20450644) ssingh119@hawk.iit.edu
Sruthii Reddi Thukkani (A20452892)
sthukkani@hawk.iit.edu

**Disk Benchmarking** - MyDiskBenchmark measures the throughput in MB/sec for write sequential, write random, read sequential and read random access patterns on disk memory with various record size(64KB, 1MB, 16MB) and different concurrency(threads) in C language.

**Code Design** - The code is written in C language which calculates the throughput and latency for random and sequential read/write operations on disk with different record size and different number of threads.

- Pthread library is used for multithreading.
- I have created a structure named pthreadArgs to pass arguments to function at the time of multithreading.
- Main() function receives command line arguments and then calls respective functions according to the passed arguments.
- sequentialWrite() function accepts parameters (record size and no of files) from main and performs sequential write operation on disk by creating files.
- sequentialRead() function accepts parameters(record size and no of files) from the main function and performs sequential read operation on disk by reading blocks from files.
- createFiles() function is called before sequential read and random read operation to create the files for them.
- randomWrite() function also accepts the same parameters from main and performs random write operation on disk by creating files. First I write 1 chunk of given record size in file, then for every chunk I will pick a random number and will write that chunk in that respective place.
- randomRead() performs random read operation on disk by reading from files. First I will find a random number every time, and then will read a chunk of data from that random position. This process is repeated for every chunk.

**Machine Specifications** - Node_type: Skylake, No of threads: 48, Storage: Samsung MZ7KM240HMHQ0D3 (240 GB), RAM: 192GB, CPUs: 2

## Detailed Description -

1) **Write Sequential** - In write sequential, file is written sequentially on disk with different record sizes(64KB, 1MB, 16MB) and different number of threads(1, 2, 4, 8, 12, 24, 48). Entire 10GB of file is divided into defined blocks for sequential writing. File size keeps on decreasing with increasing number of threads respectively.

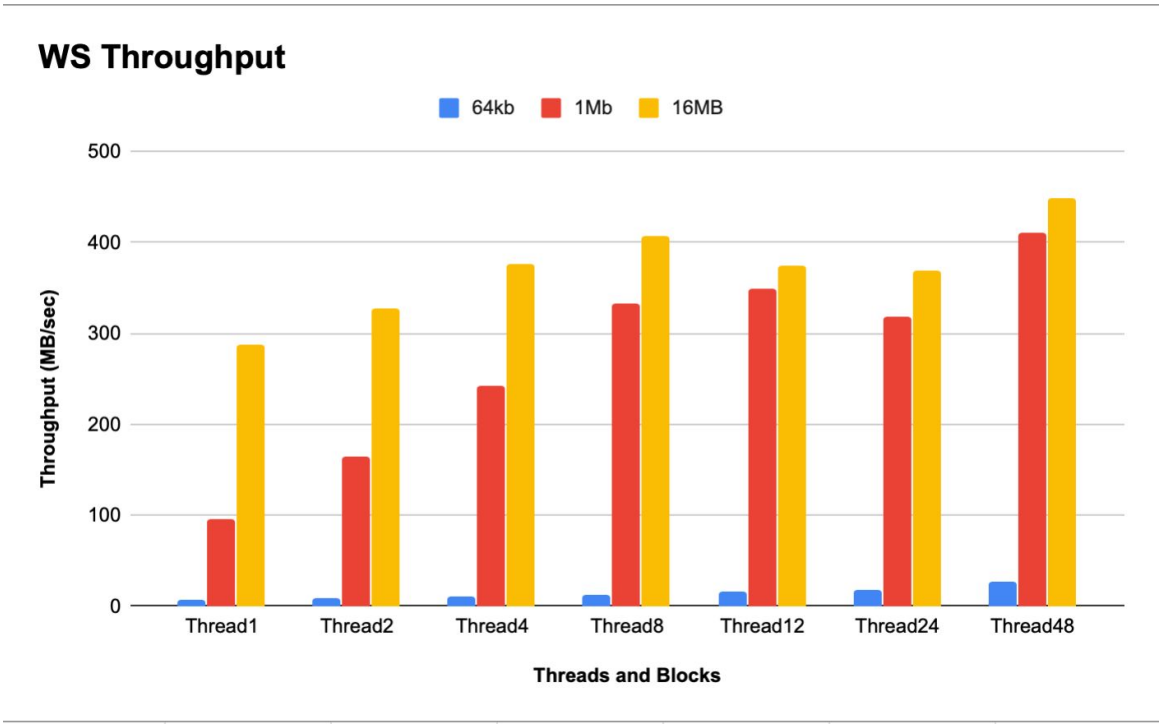
Following are the values of 3 different runs for MyDiskBenchmark and Iozone benchmark -

| Concurrency and Record Size | MyDisk Benchmark Run 1 | MyDisk Benchmark Run 2 | MyDisk Benchmark Run 3 | Iozone bench. Run 1 | Iozone bench. Run 2 | Iozone bench. Run 3 | Average MyDiskBenchmark | Average Iozone bench. |
|---|---|---|---|---|---|---|---|---|
| 1 and 64KB | 8 | 7 | 7 | 368 | 371 | 363 | 7 | 367 |
| 1 and 1MB | 99 | 93 | 97 | 464 | 464 | 463 | 96 | 464 |
| 1 and 16MB | 294 | 283 | 287 | 455 | 451 | 448 | 288 | 451 |
| 2 and 64KB | 10 | 9 | 9 | 451 | 450 | 454 | 9 | 452 |
| 2 and 1MB | 167 | 165 | 162 | 468 | 468 | 465 | 164 | 466 |
| 2 and 16MB | 332 | 326 | 326 | 457 | 455 | 458 | 328 | 457 |
| 4 and 64KB | 13 | 11 | 10 | 463 | 464 | 464 | 11 | 464 |
| 4 and 1MB | 247 | 242 | 239 | 465 | 466 | 459 | 243 | 463 |
| 4 and 16MB | 380 | 377 | 378 | 466 | 464 | 463 | 378 | 464 |
| 8 and 64KB | 14 | 12 | 11 | 461 | 465 | 464 | 12 | 463 |
| 8 and 1MB | 341 | 324 | 330 | 458 | 465 | 461 | 333 | 462 |
| 8 and 16MB | 414 | 411 | 405 | 455 | 448 | 451 | 408 | 451 |
| 12 and 64KB | 21 | 16 | 17 | 460 | 463 | 462 | 18 | 461 |
| 12 and 1MB | 355 | 349 | 347 | 468 | 465 | 468 | 350 | 468 |
| 12 and 16MB | 387 | 370 | 368 | 451 | 454 | 451 | 374 | 452 |
| 24 and 64KB | 20 | 16 | 19 | 464 | 465 | 465 | 18 | 465 |
| 24 and 1MB | 326 | 310 | 317 | 465 | 468 | 465 | 319 | 466 |
| 24 and 16MB | 377 | 367 | 361 | 456 | 455 | 457 | 369 | 456 |
| 48 and 64KB | 29 | 27 | 26 | 466 | 466 | 465 | 27 | 466 |
| 48 and 1MB | 414 | 411 | 409 | 464 | 467 | 465 | 410 | 465 |
| 48 and 16MB | 452 | 451 | 447 | 426 | 428 | 432 | 449 | 429 |

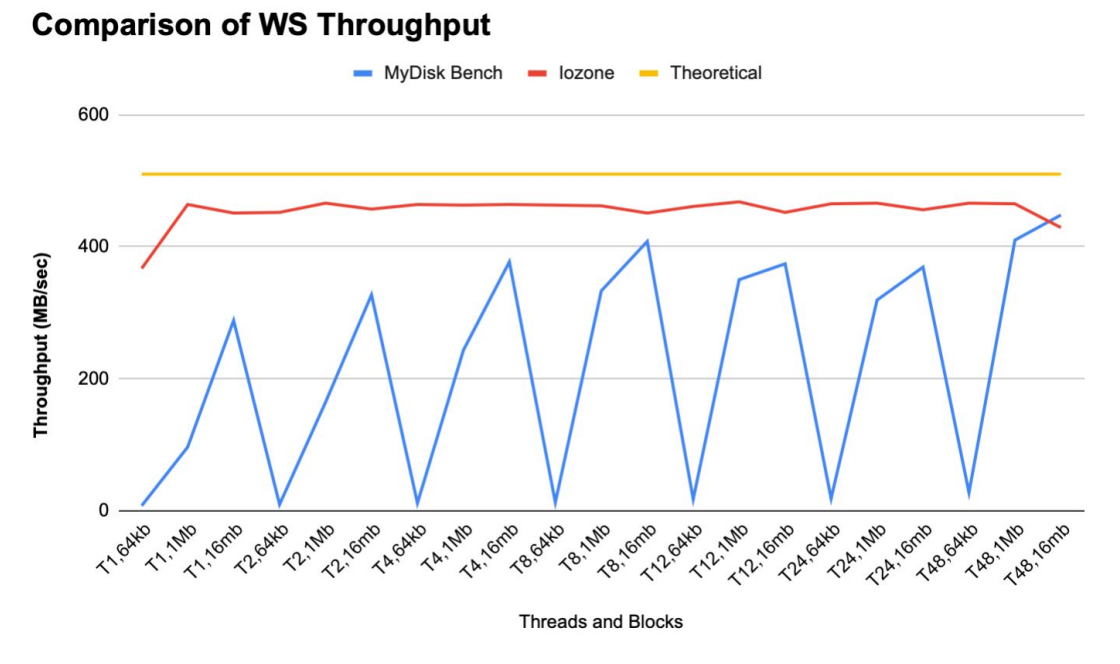
We have taken average values for each record size and concurrency and generated the final table with theoretical throughput and efficiency.

**Write Sequential Final Table** -

| Workload | Concurrency | Record SIze | MyDiskBench Measured Throughput | IOZone Measured Throughput | Theoretical Throughput | MyDiskBench Efficiency(%) | IOZone Efficiency (%) |
|---|---|---|---|---|---|---|---|
| WS | 1 | 64KB | 7 | 367 | 510 | 1.37 | 71.9 |
| WS | 1 | 1MB | 96 | 464 | 510 | 18.82 | 90.9 |
| WS | 1 | 16MB | 288 | 451 | 510 | 56.4 | 88.4 |
| WS | 2 | 64KB | 9 | 452 | 510 | 1.76 | 88.6 |
| WS | 2 | 1MB | 164 | 466 | 510 | 32.15 | 91.3 |
| WS | 2 | 16MB | 327 | 457 | 510 | 64.11 | 89.6 |
| WS | 4 | 64KB | 11 | 464 | 510 | 2.15 | 90.9 |
| WS | 4 | 1MB | 243 | 463 | 510 | 47.6 | 90.7 |
| WS | 4 | 16MB | 377 | 464 | 510 | 73.9 | 90.9 |
| WS | 8 | 64KB | 12 | 463 | 510 | 2.35 | 90.7 |
| WS | 8 | 1MB | 333 | 462 | 510 | 65.2 | 90.6 |
| WS | 8 | 16MB | 408 | 451 | 510 | 80 | 88.4 |
| WS | 12 | 64KB | 17 | 461 | 510 | 3.34 | 90.3 |
| WS | 12 | 1MB | 350 | 468 | 510 | 74.7 | 91.7 |
| WS | 12 | 16MB | 374 | 452 | 510 | 73.3 | 88.6 |
| WS | 24 | 64KB | 18 | 465 | 510 | 3.5 | 91.1 |
| WS | 24 | 1MB | 319 | 466 | 510 | 62.5 | 91.2 |
| WS | 24 | 16MB | 369 | 456 | 510 | 72.3 | 89.4 |
| WS | 48 | 64KB | 27 | 466 | 510 | 5.2 | 91.2 |
| WS | 48 | 1MB | 410 | 465 | 510 | 80 | 91.1 |
| WS | 48 | 16MB | 448 | 429 | 510 | 87.8 | 84.1 |




Above graph plot represents values of MyDiskBench WS Throughput with Threads of block sizes 64kb,1Mb,16 Mb respectively.




Above graph plot compares the WS Throughput of MyDiskBench, Iozone,Theoretical values with Threads of block sizes 64kb,1Mb,16Mb.

**Analysis -** MyDiskBenchmark values are increasing with the larger record size. For 1MB and 16MB record size our benchmark values are quite close to iozone values but for 64kb record size our throughput is low because we are writing a very small block or chunk at a time which is taking longer time. Our throughput is not varying much with the number of threads but varies only with record size. Iozone values are quite consistent for different record sizes and different concurrency.

2) **Read Sequential -** In read sequential, file is read sequentially from disk with different record sizes(64KB, 1MB, 16MB) and different number of threads(1, 2, 4, 8, 12, 24, 48). Entire 10GB of file is divided into defined blocks for sequential writing. File size keeps on decreasing with increasing number of threads respectively.

Following are the values of 3 different runs for MyDiskBenchmark and Iozone benchmark for read sequential-

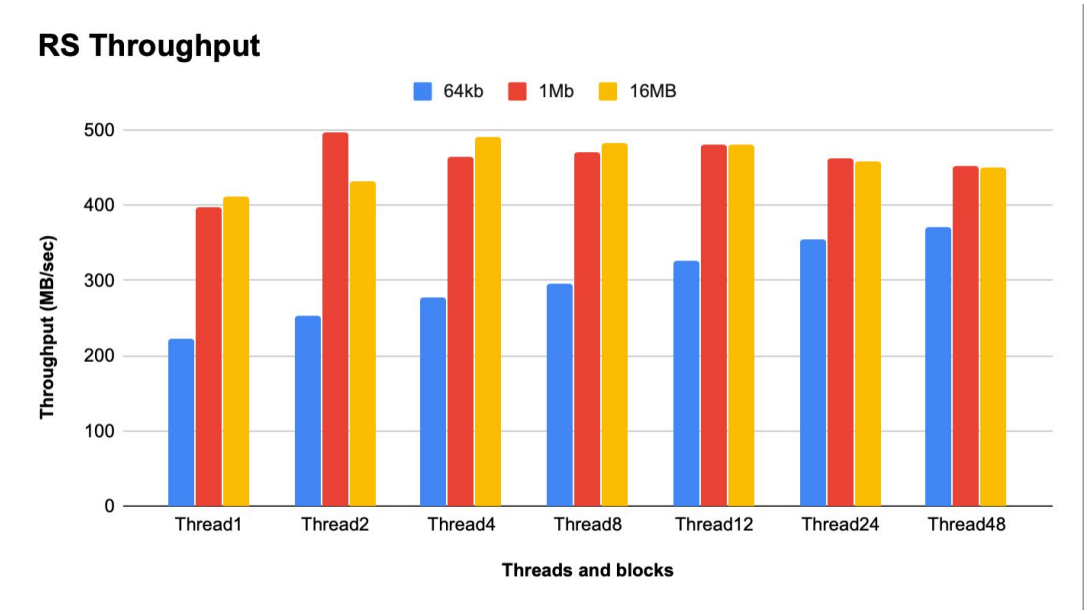
| Concurrency and Record Size | MyDisk Benchmark Run 1 | MyDisk Benchmark Run 2 | MyDisk Benchmark Run 3 | Iozone bench. Run 1 | Iozone bench. Run 2 | Iozone bench. Run 3 | Average MyDiskBenchmark | Average Iozone bench. |
|---|---|---|---|---|---|---|---|---|
| 1 and 64KB | 214 | 249 | 218 | 347 | 344 | 353 | 223 | 348 |
| 1 and 1MB | 393 | 403 | 398 | 363 | 369 | 361 | 398 | 364 |
| 1 and 16MB | 411 | 414 | 411 | 401 | 404 | 407 | 412 | 404 |
| 2 and 64KB | 251 | 249 | 258 | 339 | 334 | 338 | 254 | 337 |
| 2 and 1MB | 498 | 501 | 490 | 460 | 460 | 461 | 496 | 460 |
| 2 and 16MB | 434 | 436 | 427 | 419 | 418 | 414 | 432 | 417 |
| 4 and 64KB | 275 | 278 | 281 | 350 | 348 | 351 | 278 | 349 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 4 and 1MB | 465 | 466 | 465 | 422 | 409 | 416 | 465 | 416 |
| 4 and 16MB | 491 | 491 | 490 | 492 | 491 | 491 | 490 | 491 |
| 8 and 64KB | 290 | 299 | 297 | 369 | 372 | 371 | 295 | 371 |
| 8 and 1MB | 459 | 491 | 465 | 422 | 423 | 422 | 471 | 422 |
| 8 and 16MB | 487 | 488 | 481 | 442 | 442 | 439 | 484 | 441 |
| 12 and 64KB | 327 | 326 | 327 | 394 | 389 | 391 | 326 | 391 |
| 12 and 1MB | 480 | 482 | 478 | 416 | 417 | 418 | 480 | 417 |
| 12 and 16MB | 488 | 464 | 475 | 480 | 483 | 477 | 479 | 480 |
| 24 and 64KB | 346 | 349 | 362 | 408 | 406 | 405 | 355 | 406 |
| 24 and 1MB | 465 | 463 | 457 | 441 | 441 | 441 | 462 | 441 |
| 24 and 16MB | 434 | 455 | 473 | 471 | 471 | 470 | 458 | 470 |
| 48 and 64KB | 377 | 367 | 369 | 410 | 412 | 414 | 371 | 412 |
| 48 and 1MB | 451 | 451 | 456 | 461 | 460 | 460 | 453 | 460 |
| 48 and 16MB | 447 | 452 | 453 | 489 | 490 | 488 | 450 | 489 |

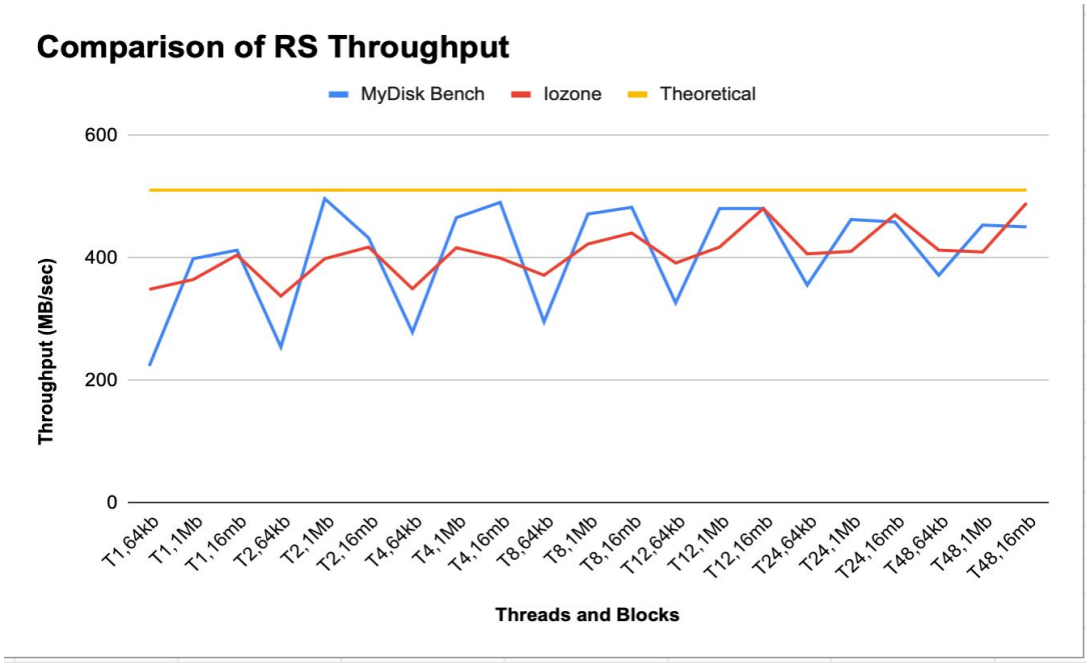
We have taken average values for each record size and concurrency and generated the final table with theoretical throughput and efficiency.

**Read Sequential Final Table-**

| Workload | Concurrency | Record SIze | MyDiskBench Measured Throughput | IOZone Measured Throughput | Theoretical Throughput | MyDiskBench Efficiency (%) | IOZone Efficiency(%) |
|---|---|---|---|---|---|---|---|
| RS | 1 | 64KB | 223 | 348 | 510 | 43.7 | 68.2 |
| RS | 1 | 1MB | 398 | 364 | 510 | 78.0 | 71.3 |
| RS | 1 | 16MB | 412 | 404 | 510 | 80.7 | 79.2 |
| RS | 2 | 64KB | 254 | 337 | 510 | 49.8 | 66 |
| RS | 2 | 1MB | 496 | 460 | 510 | 97.2 | 90.1 |
| RS | 2 | 16MB | 432 | 417 | 510 | 84.7 | 81.1 |
| RS | 4 | 64KB | 278 | 349 | 510 | 54.5 | 68.4 |
| RS | 4 | 1MB | 465 | 416 | 510 | 91.21 | 81.5 |
| RS | 4 | 16MB | 490 | 490 | 510 | 96 | 96 |
| RS | 8 | 64KB | 295 | 371 | 510 | 57.8 | 72.7 |
| RS | 8 | 1MB | 471 | 422 | 510 | 92.3 | 82.7 |
| RS | 8 | 16MB | 482 | 440 | 510 | 94.5 | 86.2 |
| RS | 12 | 64KB | 326 | 391 | 510 | 63.9 | 76.6 |
| RS | 12 | 1MB | 480 | 417 | 510 | 94.1 | 81.7 |
| RS | 12 | 16MB | 480 | 480 | 510 | 94.1 | 94.1 |
| RS | 24 | 64KB | 355 | 406 | 510 | 69.6 | 79.6 |
| RS | 24 | 1MB | 462 | 440 | 510 | 90.5 | 86.2 |
| RS | 24 | 16MB | 458 | 470 | 510 | 89.8 | 92.1 |
| RS | 48 | 64KB | 371 | 412 | 510 | 72.7 | 80.7 |
| RS | 48 | 1MB | 453 | 460 | 510 | 88.8 | 90.1 |
| RS | 48 | 16MB | 450 | 489 | 510 | 88.2 | 95.8 |




Above graph plot represents values of MyDiskBench RS Throughput with Threads of block sizes 64kb,1Mb,16 Mb respectively




Above graph plot compares the RS Throughput of MyDiskBench, Iozone,Theoretical values with Threads of block sizes 64kb,1Mb,16Mb

**Analysis -** In Read Sequential, MyDiskBenchmark values are closer to iozone and are not varying much as in case of write sequential. Also, read sequential has higher throughput values as compared to write sequential. Iozone values are quite consistent for different record sizes and different concurrency.

**3) <u>Read Random</u> -** In read random, file is read randomly from disk with different record sizes(64KB, 1MB, 16MB) and different number of threads(1, 2, 4, 8, 12, 24, 48). Entire 10GB of file is divided into defined blocks for sequential writing. File size keeps on decreasing with increasing number of threads respectively.

Following are the values of 3 different runs for MyDiskBenchmark and Iozone benchmark -

| Concurrency and Record Size | MyDisk Benchmark Run 1 | MyDisk Benchmark Run 2 | MyDisk Benchmark Run 3 | Iozone bench. Run 1 | Iozone bench. Run 2 | Iozone bench. Run 3 | Average MyDiskBenchmark | Average Iozone bench. |
|---|---|---|---|---|---|---|---|---|
| 1 and 64KB | 208 | 210 | 203 | 238 | 237 | 237 | 206 | 237 |
| 1 and 1MB | 401 | 432 | 408 | 431 | 435 | 434 | 413 | 433 |
| 1 and 16MB | 425 | 424 | 416 | 408 | 407 | 407 | 422 | 407 |
| 2 and 64KB | 289 | 291 | 297 | 329 | 325 | 324 | 293 | 325 |
| 2 and 1MB | 439 | 439 | 439 | 430 | 429 | 429 | 439 | 429 |
| 2 and 16MB | 450 | 441 | 436 | 418 | 419 | 417 | 442 | 417 |
| 4 and 64KB | 312 | 320 | 301 | 355 | 351 | 353 | 309 | 353 |
| 4 and 1MB | 430 | 433 | 436 | 419 | 419 | 419 | 433 | 419 |
| 4 and 16MB | 422 | 435 | 427 | 415 | 415 | 418 | 428 | 416 |
| 8 and 64KB | 240 | 278 | 259 | 371 | 375 | 376 | 259 | 374 |
| 8 and 1MB | 439 | 428 | 440 | 425 | 427 | 423 | 436 | 425 |
| 8 and 16MB | 443 | 415 | 423 | 439 | 437 | 434 | 425 | 437 |
| 12 and 64KB | 297 | 291 | 295 | 390 | 392 | 392 | 294 | 391 |
| 12 and 1MB | 478 | 479 | 479 | 416 | 415 | 415 | 479 | 415 |
| 12 and 16MB | 432 | 427 | 425 | 426 | 427 | 424 | 428 | 425 |
| 24 and 64KB | 364 | 365 | 361 | 408 | 411 | 405 | 363 | 408 |
| 24 and 1MB | 440 | 457 | 437 | 415 | 417 | 413 | 445 | 414 |

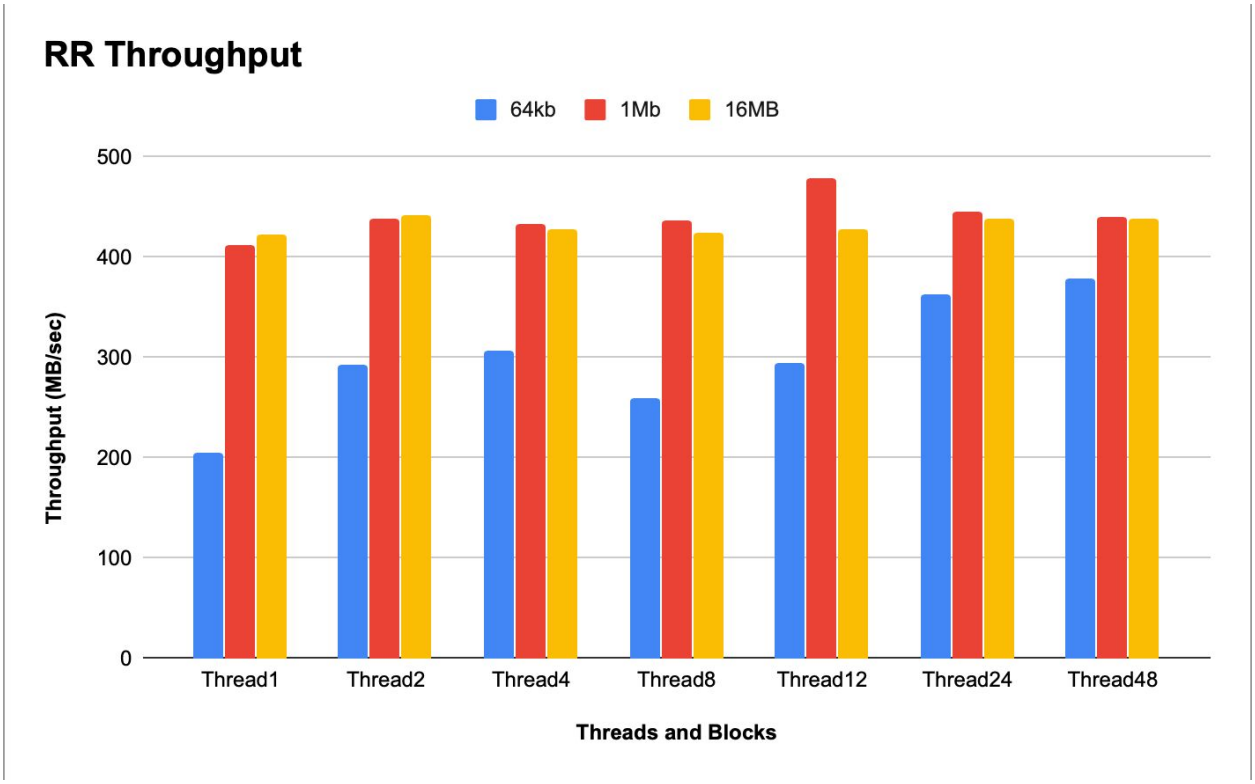
| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 24 and 16MB | 439 | 435 | 437 | 405 | 405 | 403 | 438 | 404 |
| 48 and 64KB | 378 | 375 | 384 | 413 | 410 | 412 | 379 | 411 |
| 48 and 1MB | 441 | 443 | 438 | 411 | 415 | 413 | 441 | 412 |
| 48 and 16MB | 430 | 450 | 437 | 468 | 469 | 469 | 439 | 469 |

We have taken average values for each record size and concurrency and generated the final table with theoretical throughput and efficiency.

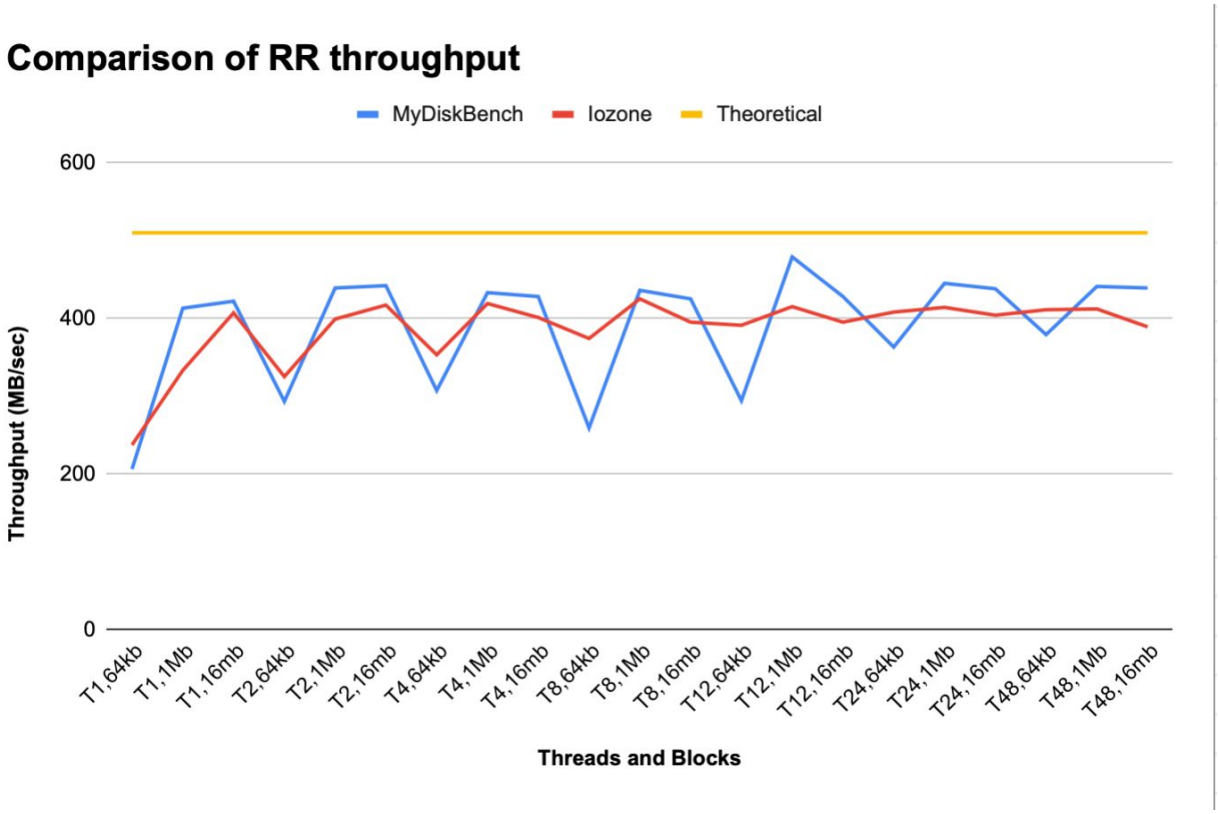
**Final Table Read Random -**

| Workload | Concurrency | Record SIze | MyDiskBench Measured Throughput | IOZone Measured Throughput | Theoretical Throughput | MyDiskBench Efficiency (%) | IOZone Efficiency(%) |
|---|---|---|---|---|---|---|---|
| RR | 1 | 64KB | 206 | 237 | 510 | 40.3 | 46.4 |
| RR | 1 | 1MB | 413 | 433 | 510 | 80.9 | 84.9 |
| RR | 1 | 16MB | 422 | 407 | 510 | 82.7 | 79.8 |
| RR | 2 | 64KB | 293 | 325 | 510 | 57.4 | 63.7 |
| RR | 2 | 1MB | 439 | 429 | 510 | 86 | 84.1 |
| RR | 2 | 16MB | 442 | 417 | 510 | 86.6 | 81.7 |
| RR | 4 | 64KB | 307 | 353 | 510 | 60.1 | 69.2 |
| RR | 4 | 1MB | 433 | 419 | 510 | 84.9 | 82.1 |
| RR | 4 | 16MB | 428 | 416 | 510 | 83.9 | 81.5 |
| RR | 8 | 64KB | 259 | 374 | 510 | 50.7 | 73.3 |
| RR | 8 | 1MB | 436 | 425 | 510 | 85.4 | 83.3 |
| RR | 8 | 16MB | 425 | 437 | 510 | 83.3 | 85.6 |
| RR | 12 | 64KB | 294 | 391 | 510 | 57.6 | 76.6 |
| RR | 12 | 1MB | 479 | 415 | 510 | 93.9 | 81.3 |
| RR | 12 | 16MB | 428 | 425 | 510 | 83.9 | 83.3 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| RR | 24 | 64KB | 363 | 408 | 510 | 71.1 | 80 |
| RR | 24 | 1MB | 445 | 414 | 510 | 87.2 | 81.1 |
| RR | 24 | 16MB | 438 | 404 | 510 | 85.8 | 79.2 |
| RR | 48 | 64KB | 379 | 411 | 510 | 74.3 | 80.5 |
| RR | 48 | 1MB | 441 | 412 | 510 | 86.4 | 80.7 |
| RR | 48 | 16MB | 439 | 469 | 510 | 86 | 91.9 |




Above graph plot represents values of MyDiskBench RR Throughput with Threads of block sizes 64kb,1Mb,16 Mb respectively




Above graph plot compares the RR Throughput of MyDiskBench, Iozone,Theoretical values with Threads of block sizes 64kb,1Mb,16Mb.

**Analysis -** In Read Random, MyDiskBenchmark values are closer to iozone and are not varying much as in case of write random. Also, read random has higher throughput values as compared to write random. Iozone values are quite consistent for different record sizes and different concurrency. Read Random has also high efficiency for almost all different record size and different concurrency.

**4) <u>Write Random</u> -** In write random, file is written randomly on disk with different record sizes(64KB, 1MB, 16MB) and different number of threads(1, 2, 4, 8, 12, 24, 48). Entire 10GB of file is divided into defined blocks for sequential writing. File size keeps on decreasing with increasing number of threads respectively.

Following are the values of 3 different runs for MyDiskBenchmark and Iozone benchmark -

| Concurrency and Record Size | MyDisk Benchmark Run 1 | MyDisk Benchmark Run 2 | MyDisk Benchmark Run 3 | Iozone bench. Run 1 | Iozone bench. Run 2 | Iozone bench. Run 3 | Average MyDiskBenchmark | Average Iozone bench. |
|---|---|---|---|---|---|---|---|---|
| 1 and 64KB | 8 | 7 | 8 | 377 | 376 | 377 | 8 | 377 |
| 1 and 1MB | 95 | 98 | 94 | 463 | 462 | 459 | 96 | 461 |
| 1 and 16MB | 282 | 288 | 287 | 457 | 455 | 462 | 286 | 458 |
| 2 and 64KB | 10 | 10 | 10 | 447 | 448 | 450 | 10 | 449 |
| 2 and 1MB | 163 | 165 | 163 | 462 | 462 | 462 | 164 | 462 |
| 2 and 16MB | 340 | 318 | 326 | 450 | 451 | 450 | 327 | 450 |
| 4 and 64KB | 11 | 12 | 12 | 461 | 462 | 462 | 12 | 462 |
| 4 and 1MB | 245 | 244 | 244 | 457 | 463 | 462 | 244 | 461 |
| 4 and 16MB | 378 | 379 | 371 | 456 | 455 | 456 | 376 | 455 |
| 8 and 64KB | 12 | 12 | 12 | 457 | 459 | 465 | 12 | 461 |
| 8 and 1MB | 344 | 350 | 339 | 457 | 458 | 457 | 345 | 457 |
| 8 and 16MB | 401 | 399 | 399 | 470 | 465 | 471 | 401 | 469 |
| 12 and 64KB | 13 | 15 | 16 | 461 | 468 | 465 | 14 | 464 |
| 12 and 1MB | 379 | 378 | 378 | 467 | 468 | 462 | 379 | 466 |
| 12 and 16MB | 419 | 415 | 401 | 460 | 460 | 461 | 411 | 460 |
| 24 and 64KB | 17 | 16 | 16 | 455 | 458 | 457 | 16 | 457 |
| 24 and 1MB | 398 | 388 | 392 | 455 | 471 | 457 | 393 | 462 |

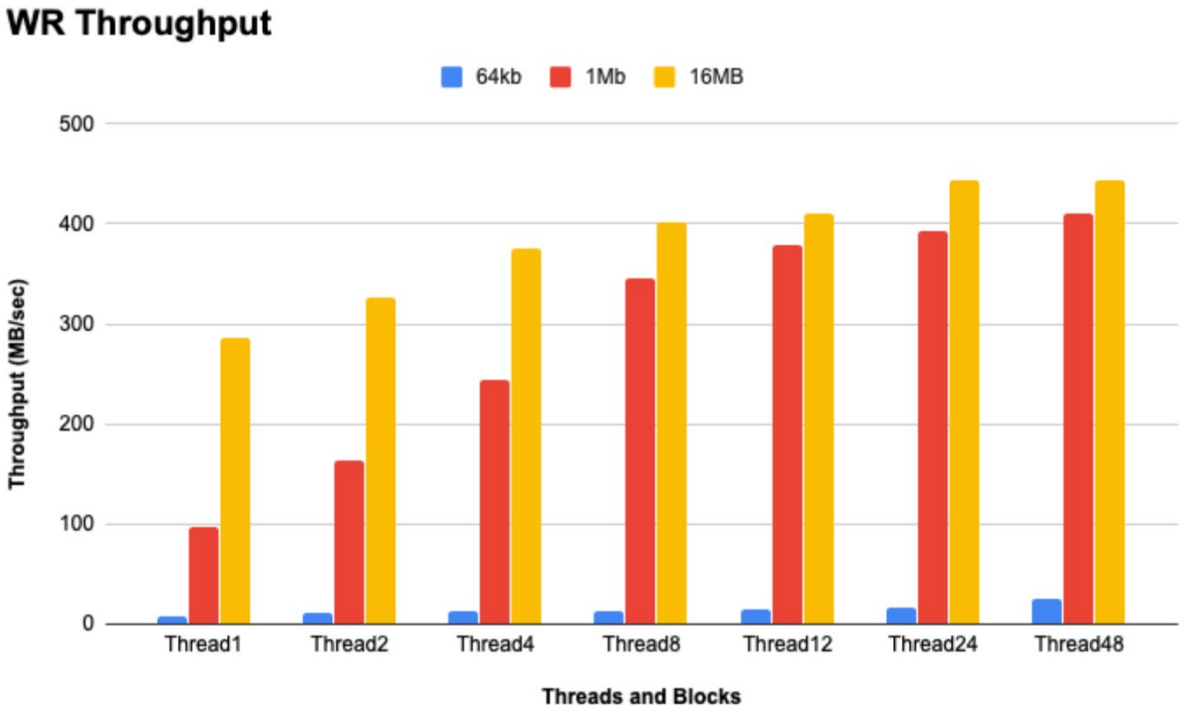
| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 24 and 16MB | 444 | 449 | 439 | 449 | 451 | 453 | 444 | 451 |
| 48 and 64KB | 25 | 24 | 24 | 448 | 453 | 452 | 25 | 451 |
| 48 and 1MB | 414 | 411 | 409 | 446 | 447 | 447 | 410 | 447 |
| 48 and 16MB | 429 | 441 | 457 | 437 | 439 | 431 | 443 | 436 |

We have taken average values for each record size and concurrency and generated the final table with theoretical throughput and efficiency.

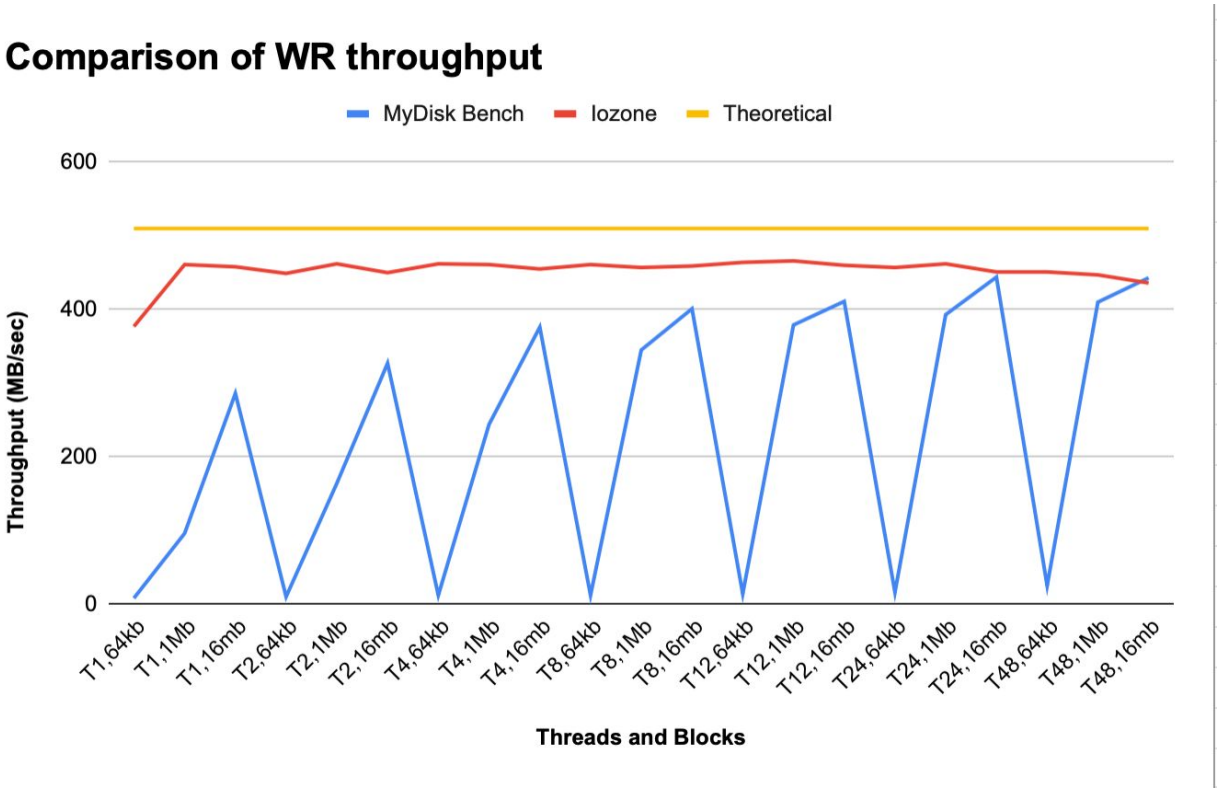
Write Random

| Workload | Concurrency | Record SIze | MyDiskBench Measured Throughput | IOZone Measured Throughput | Theoretical Throughput | MyDiskBench Efficiency(%) | IOZone Efficiency(%) |
|---|---|---|---|---|---|---|---|
| WR | 1 | 64KB | 8 | 377 | 510 | 1.5 | 73.9 |
| WR | 1 | 1MB | 96 | 461 | 510 | 18.8 | 90.3 |
| WR | 1 | 16MB | 286 | 458 | 510 | 56 | 89.8 |
| WR | 2 | 64KB | 10 | 449 | 510 | 1.9 | 88 |
| WR | 2 | 1MB | 164 | 462 | 510 | 32.1 | 90.5 |
| WR | 2 | 16MB | 327 | 450 | 510 | 64.1 | 88.2 |
| WR | 4 | 64KB | 12 | 462 | 510 | 2.35 | 90.5 |
| WR | 4 | 1MB | 244 | 461 | 510 | 47.8 | 90.3 |
| WR | 4 | 16MB | 376 | 455 | 510 | 73.7 | 89.2 |
| WR | 8 | 64KB | 12 | 461 | 510 | 2.35 | 90.3 |
| WR | 8 | 1MB | 345 | 457 | 510 | 67.6 | 89.6 |
| WR | 8 | 16MB | 401 | 459 | 510 | 87.3 | 90 |
| WR | 12 | 64KB | 14 | 464 | 510 | 3.01 | 90.9 |
| WR | 12 | 1MB | 379 | 466 | 510 | 74.3 | 91.3 |
| WR | 12 | 16MB | 411 | 460 | 510 | 80.5 | 90.1 |
| WR | 24 | 64KB | 16 | 457 | 510 | 3.1 | 89.6 |
| WR | 24 | 1MB | 393 | 462 | 510 | 77 | 90.5 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| WR | 24 | 16MB | 444 | 451 | 510 | 87 | 88.4 |
| WR | 48 | 64KB | 25 | 451 | 510 | 4.9 | 88.4 |
| WR | 48 | 1MB | 410 | 447 | 510 | 91.7 | 87.6 |
| WR | 48 | 16MB | 443 | 436 | 510 | 86.8 | 85.4 |



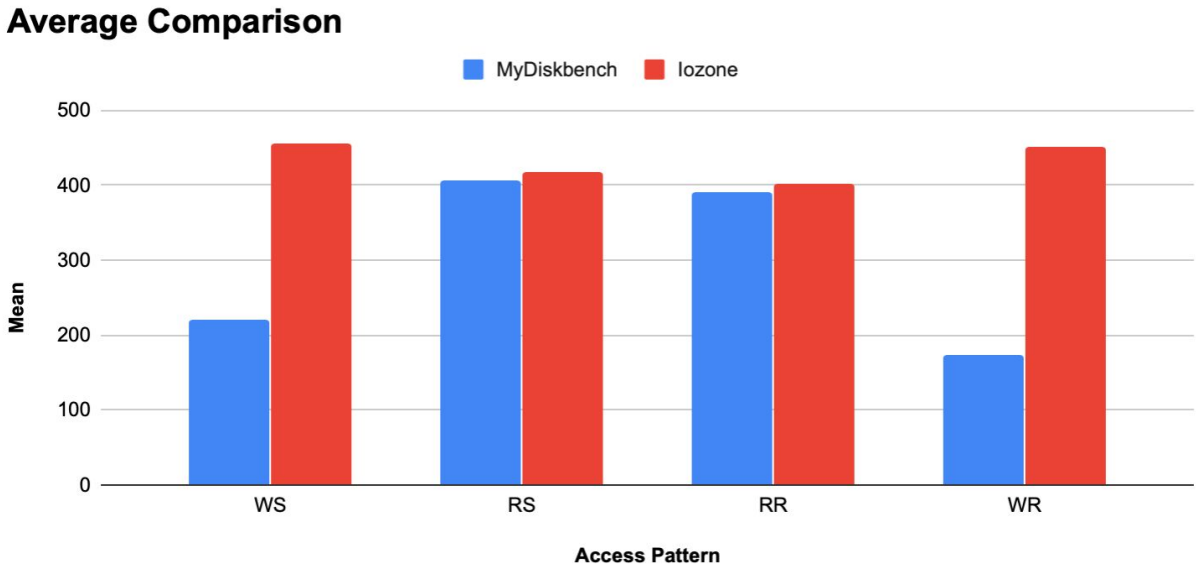

Above graph plot represents values of MyDiskBench WR Throughput with Threads of block sizes 64kb,1Mb,16 Mb respectively



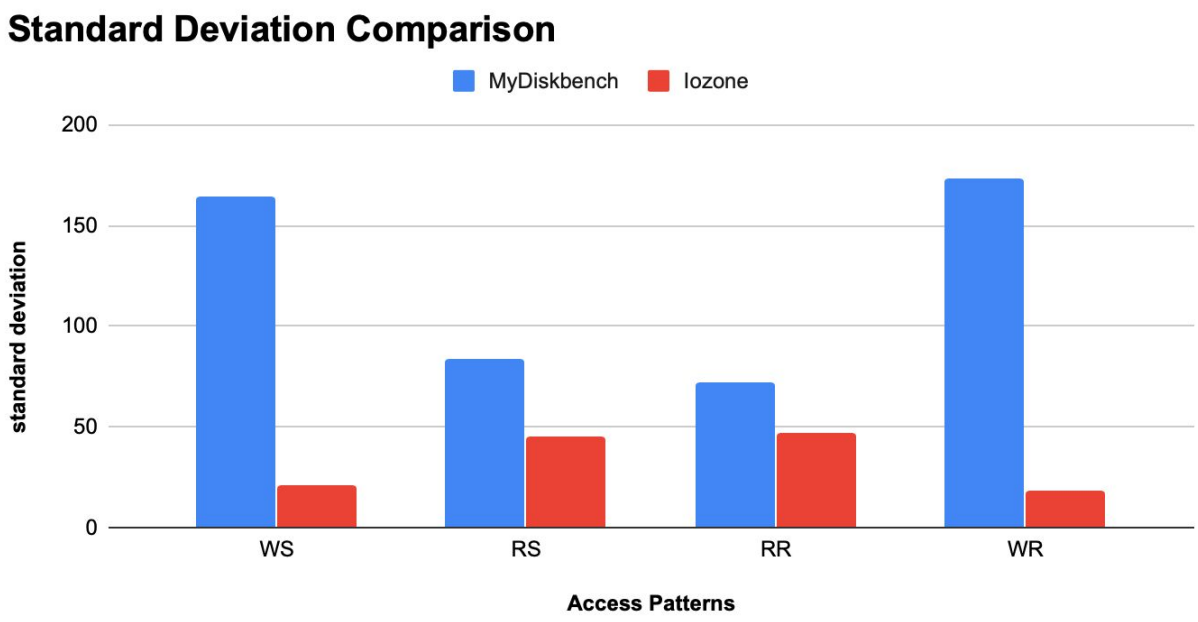

Above graph plot compares the WR Throughput of MyDiskBench, Iozone,Theoretical values with Threads of block sizes 64kb,1Mb,16Mb.

**Analysis -** In Write Random, MyDiskBenchmark values are increasing with the larger record size. For 1MB and 16MB record size our benchmark values are quite close to iozone values but for 64kb record size our throughput is low because we are writing a very small block or chunk at a time which is taking longer time. Our throughput is not varying much with the number of threads but varies with record size. Iozone values are quite consistent for different record sizes and different concurrency.

# Average and Standard Deviation Plot



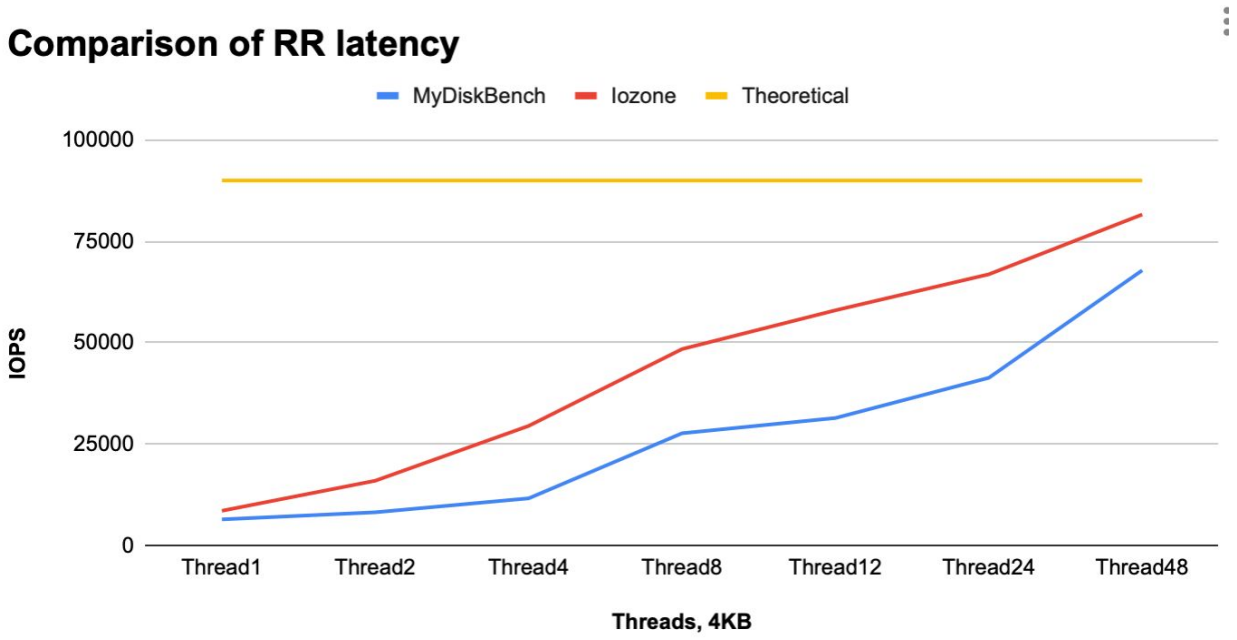

Above Graph plots compares the averages of Access patterns WS,RS,RR,WR




Above Graph plots compares the Standard Deviations of Access patterns WS,RS,RR,WR

## 5) Read Random Latency(IOPS 4KB) -

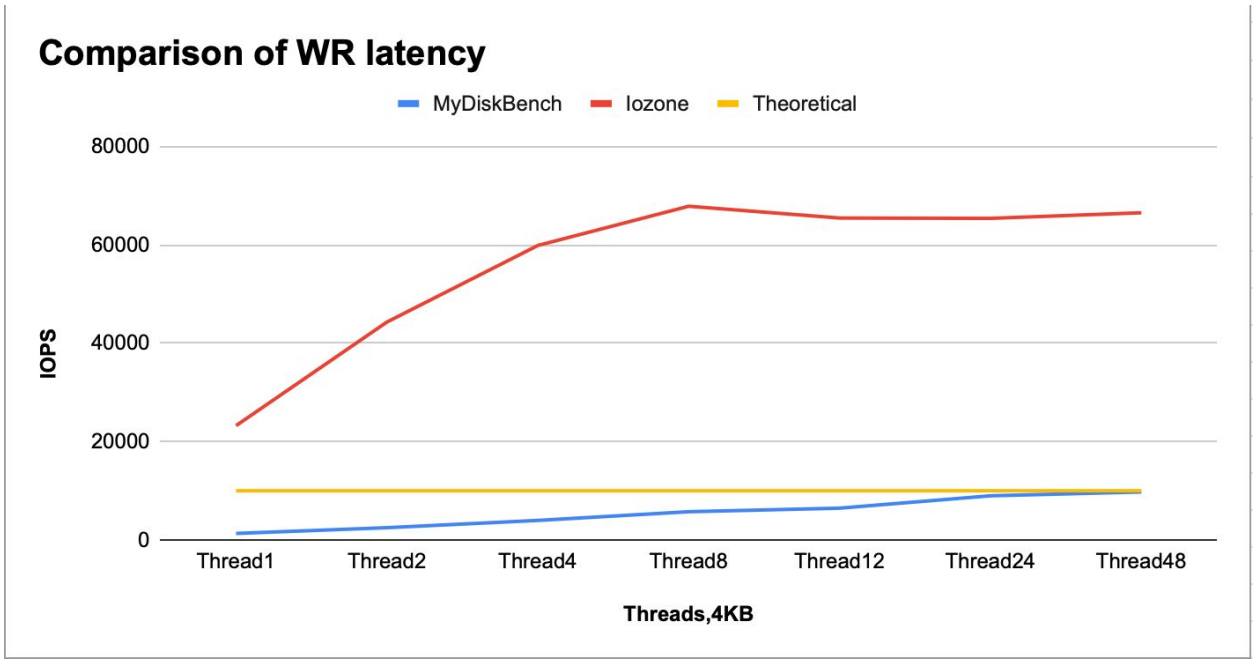
| Work-Load | Concurrency | Record size | MyDiskBench Measured IOPS (OPS/sec) | IOzne Measured IOPS (ops/sec) | Theoretical IOPS (ops/sec) | MyDiskBench efficiency(%) | IOzone Efficiency (%) |
|---|---|---|---|---|---|---|---|
| RR | 1 | 4KB | 6408 | 8528 | 90000 | 7.12 | 9.4 |
| RR | 2 | 4KB | 8156 | 15944 | 90000 | 9.06 | 17.71 |
| RR | 4 | 4KB | 11598 | 29466 | 90000 | 12.88 | 32.74 |
| RR | 8 | 4KB | 27652 | 48416 | 90000 | 30.72 | 53.79 |
| RR | 12 | 4KB | 31413 | 57983 | 90000 | 34.9 | 64.4 |
| RR | 24 | 4KB | 41328 | 66857 | 90000 | 45.92 | 74.2 |
| RR | 48 | 4KB | 67840 | 81608 | 90000 | 75.3 | 90.6 |




Above Graph plot compares the RR latency values of MyDiskBench,Iozone,Theoretical for threads with 4kb block size

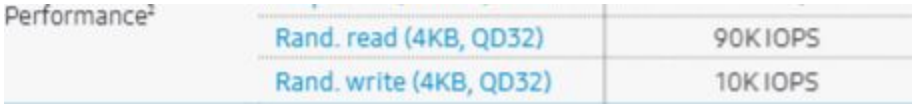
## 6) Write Random latency - (IOPS 4KB)

| Work-Load | Concurrency | Record size | MyDiskBench Measured IOPS (OPS/sec) | IOzne Measured IOPS (ops/sec) | Theoretical IOPS (ops/sec) | MyDiskBench efficiency(%) | IOzone Efficiency (%) |
|---|---|---|---|---|---|---|---|
| WR | 1 | 4KB | 1319 | 23242 | 10000 | 13.19 | 232.42 |
| WR | 2 | 4KB | 2487 | 44309 | 10000 | 24.87 | 443.09 |
| WR | 4 | 4KB | 3966 | 59876 | 10000 | 39.66 | 598.76 |
| WR | 8 | 4KB | 5734 | 67856 | 10000 | 57.34 | 678.56 |
| WR | 12 | 4KB | 6458 | 65459 | 10000 | 64.58 | 654.59 |
| WR | 24 | 4KB | 8972 | 65392 | 10000 | 89.72 | 653.92 |
| WR | 48 | 4KB | 9753 | 66529 | 10000 | 97.53 | 665.29 |




Above Graph plot compares the WR latency values of MyDiskBench,Iozone,Theoretical for threads with 4kb block size.

**Theoretical Throughput -** For theoretical throughput we have referred to Samsung PM863a SSD for data centers having the same specifications as the one used in skylake machines.



| Performance[1] | | |
|---|---|---|
| | Rand. read (4KB, QD32) | 90K IOPS |
| | Rand. write (4KB, QD32) | 10K IOPS |

**Tradeoffs and Improvements** - Sequential and Random write operation can be improved for smaller record size. In this experiment, disk cache plays an important role which increases throughput if not flushed properly. Few other system calls can be used to bypass cache completely and multithreading can be optimized to increase the benchmark speed.

**Conclusion** - Sequential and Random read is closer to iozone values but write sequential and random operation gets slower with smaller record size. Iozone values are consistent throughout different experiments. Benchmarking can be improved by optimizing threading in code.

**Contributions -** MyDiskBenchmark code written by Sandeep. Iozone experiments and script written and recorded by Shrutii.