

# Read/Write Performance Evaluation of Optane SSD

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## 1. Introduction

Non-volatile memory is an emerging technology and it is expected to be widely used as storage-class memory (SCM). We reveal Optane SSD's performance behavior and discuss its effect on the information technology field.

## 2. Performance Evaluation

All the experiments are conducted on an x86 desktop PC (Linux 4.4.244, Intel Core i9-9900K CPU@3.60GHz, 8cores, 16GB DRAM) with three types of storage devices: Optane SSD (Intel Optane M10 32GB/PCIe 3.0), NAND SSD (Samsung SSD 850 EVO 1TB/SATA), and HDD (HGST Deskstar 7K1000.B 1TB/SATA300). We developed our micro-benchmark program to perform the tests by generating various I/O requests. We use direct I/O to avoid the effect of page cache in this experiment.

Fig. 1 shows the sequential read/write performance. The bandwidth was measured by accessing 128MB units from the beginning of the storage. In an HDD, the throughput steadily decreases as the address gets closer to the periphery. In contrast, the performances of NAND SSD and Optane SSD are quite constant, regardless of the logical block address. The performances of reading and writing operations of Optane SSD are asymmetry compared to the other two devices.

Fig. 2 depicts the random read/write performance. The IOPS (I/O operations per second) with a 4KB request was measured 100000 times and the average and 95% confidence interval was obtained. The results indicate that Optane SSD outperformed NAND SSD in reading operations, but on the other hand, NAND SSD outperformed in writing operations. The random read performance behavior of NAND SSD is well known that it is due to the low prefetching accuracy of the read-ahead mechanism [1]. We need to make further investigations on Optane SSD performance behavior.

## 3. Discussion

Many emerging SCMs have asymmetric reading/writing performance [2] as we showed with the evaluation on Optane SSD. This implies that the challenge of re-designing of system software and database management system is important.

For example, storing read-heavy data in Optane SSD and write-heavy data in NAND SSD is expected one of the effective usages. In the case of using Optane SSD and NAND SSD as a cache for HDD, choosing the cache area to promote from HDD based on its reading/writing ratio also is expected effective.

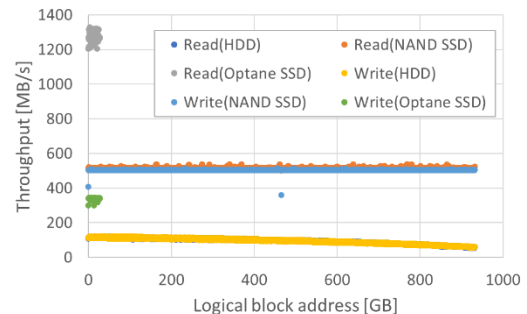


Fig. 1 Sequential access performance.

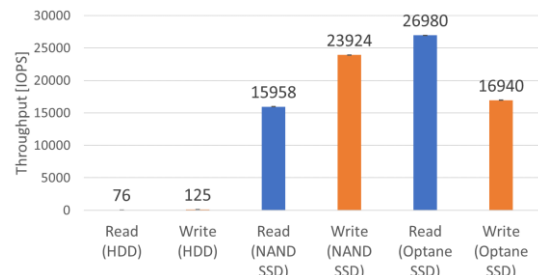


Fig. 2 Random access performance.

## References

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