Technical Note

Improving Random Read Performance Using Micron's SNAP READ Operation

Introduction

NAND flash devices are designed for applications that require nonvolatile, high-density, fast reads. These advantages make NAND flash attractive as the storage element in solid state drives (SSDs).

SSDs offer many advantages over traditional hard disk drives (HDDS). One of these advantages is random read performance.

Random read performance measures the ability of a drive to read data that is scattered (where the data being read is not located in the same sequential memory locations). Reading data across random memory locations is time-consuming and limits the amount of data available for readout at a given time. Random read performance is directly related to NAND read access time, which is the time delay (latency) between the request for data and when it becomes available.

Latency is a very important parameter for read-intensive applications because these applications rely on data being available at the shortest time. The quicker the data is available, the better the system performance, or quality of service (QOS).

Micron has been constantly improving read access time to provide better performance. Micron’s first generation 3D NAND introduced an additional read operation designed for better performance for random read operations: SNAP READ. SNAP READ provides a faster read operation than PAGE READ to further improve NAND flash device output performance. This new operation provides flexibility for systems that have random read operations and use random read-intensive applications.

This technical note highlights the performance advantages of Micron's SNAP READ operation as compared to full PAGE READ for random read operations and discusses how systems can benefit from using SNAP READ.

Device-Level Random Read Performance

An increasing number of applications are relying heavily on a device's read performance. These applications typically are read-intensive and require high performance during read operations. Latency requirements are also critical as more applications become time-sensitive and require data be available for readout with minimum delay.

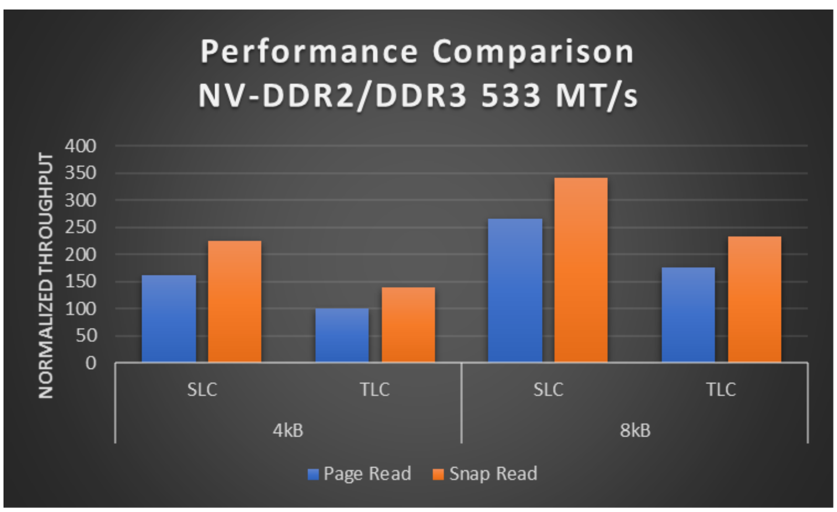
NAND-based systems are increasingly being used in mobile, security and artificial intelligence applications which require fast access to data so that the data can be served quickly, understood more completely, and acted on sooner. Because of the performance sensitivity of these applications, many systems are switching to smaller workloads, primarily 4KB to 8KB. These are the applications that can take advantage of the performance improvement of SNAP READ.

Micron NAND flash devices have two read operations available for these applications: PAGE READ and SNAP READ. Both operations have superior performance when compared to traditional HDDs, especially during random read operations.

These two read operations have different target purposes in terms of random read performance: PAGE READ is designed for larger workloads (> 8KB), while SNAP READ is designed for smaller workloads (<=8KB). While PAGE READ can provide data for the entire page length of a NAND device, SNAP READ is limited to 8KB of data access at a time. The benefit of targeting a smaller workload is faster read time, which is why SNAP READ is a better fit for applications using small workloads that require better random read performance.

The image below shows a comparison between PAGE READ and SNAP READ performance using the same workload from a NAND device standpoint. This comparison shows that with a system using either a 4KB or 8KB workload, SNAP READ offers better performance. As shown, SNAP READ has consistently better performance than PAGE READ across the different device configurations—an average improvement of 30% is seen for SNAP READ in TLC operations.

Figure 1: PAGE READ vs. SNAP READ Performance on a NAND Device

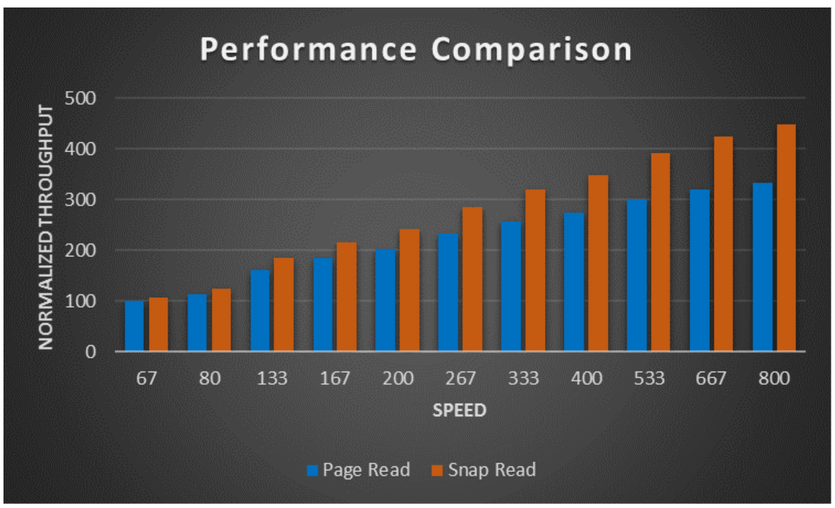


An 8KB configuration offers better performance than 4KB because on a single read operation, 8KB data is available for readout compared with 4KB. The SLC SNAP READ performance improvement is greater than TLC, which translates to a better performance for SLC SNAP READ operations versus SLC PAGE READ operations.

The performance gap between SNAP READ and PAGE READ improves as the speed increases. With interface speed increase, a device's read access time becomes more significant in system performance, where any improvement in read access time translates directly to the system performance.

The image below shows the relative performance of PAGE READ and SNAP READ across different interface speeds. For this comparison, a TLC 8KB workload configuration was used. As the interface speed increases, the performance of SNAP READ improves relative to PAGE READ. As more applications are gearing towards faster interfaces, the performance of SNAP READ operations increases over that of PAGE READ operations.

Figure 2: PAGE READ vs. SNAP READ Performance Across Different Interface Speeds



System-Level Random Read IOPS Performance

Systems that use SNAP READ instead of PAGE READ see improved performance in random read when using small workloads.

The following image shows a random read performance comparison between SNAP READ and PAGE READ on both SLC and TLC configurations in a 4KB read workload SSD application. SNAP READ consistently performs better than PAGE READ in this setup, where SNAP READ has >30% better performance on the different system configurations.

Figure 3: Random Read Performance Comparison: PAGE READ vs. SNAP READ

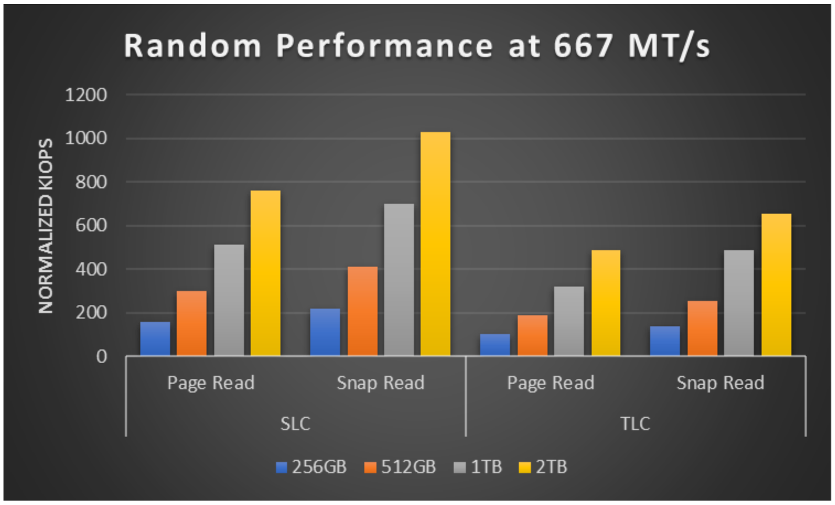


Figure 3 Legend: 256GB: 4 LUNs; 512GB: 8 LUNs; 1TB: 16 LUNs; 2TB: 32 LUNs

The system-level data shows that utilizing SNAP READ operation versus PAGE READ for 4KB read workloads in the SSD application translates to a system performance increase. Systems using small workloads of 4KB or 8KB will see performance improvements by using SNAP READ. Many systems that use higher densities through better parallelism can take advantage of SNAP READ to improve the read latency and use the time saved for data recognition and analysis.

Summary

Micron NAND flash memory devices designed for use in SSDs offer distinct performance advantages over traditional HDDs, particularly in random read performance. This is an inherent advantage of NAND flash memory.

As more applications become increasingly time sensitive, requiring data be available with minimum delay, Micron continues to improve our NAND flash memory to meet these demands. The introduction of SNAP READ on Micron's 3D NAND devices is an example—providing high performance for small workload operations. With this new operation, Micron flash memory devices now offer two operations ideal for random read applications: PAGE READ and SNAP READ.

While PAGE READ is ideal for >8KB workloads, SNAP READ offers better performance for <8KB workloads, making SNAP READ ideal for applications that use intensive small random read operations.

Revision History

Rev. A – 12/18

- Initial release

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