The Density and TCO Benefits of the Optimus MAX™ 4TB SAS SSD

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1. Executive Summary

SanDisk® introduced the Optimus MAX™ drive — a 4TB* SAS solid-state drive (SSD) —in April 2014, bringing ultra-high capacity to read-intensive application workloads, such as caching, media streaming, and video on demand (VOD). All of these workloads are becoming increasingly important in a computing world that is leveraging Big Data/Analytics, Cloud Computing, Social Media and Mobility to reach the next stage of IT performance — and business results.

The Optimus MAX SSD delivers a price/capacity point that, when compared to smaller capacity mechanical hard-disk drives (HDDs) that require a larger hardware infrastructure, can actually deliver an overall lower total cost of ownership (TCO). This new SSD cost solution is approaching that of HDDs for a similar total cost of acqusition (TCA).

That's because the Optimus MAX drive provides better capacity and performance characteristics in a smaller hardware footprint. Sample configurations, tested by SanDisk, show that the Optimus MAX SSD delivers the same capacity as much as 10 HDDs[1] – and it does so with a single drive that fits into a standard SAS-compatible enclosure.

Hardware footprint, enclosure needs, controllers and cabling are all reduced, saving the user valuable financial resources, while reducing the number of points of failure in the overall architecture. The efficient power usage of the Optimus MAX SSD, compared to a HDD, can reduce power needs down to less than 7% of the HDD solution. Additional power savings are also realized in situations where drives are holding inactive data.

2. Data Trends in the Data Center

Large data-sets are becoming commonplace in the data center, driven by the megatrends towards Big Data/Analytics, Cloud Computing, Mobility and Social Media. These large trends are the basis for what IDC calls the Third Platform, and Gartner calls the Nexus of Forces. Both market-research firms see the need for a technology refresh and data center transformation through the use of new technologies, such as high-speed network devices, fast processors and flash storage, addressing storage bottlenecks in the data center while additionally bringing hardware footprint relief and cost savings to bear.

IDC's forecast for enterprise SSD growth expects a 26.9% five-year CAGR (compound annual growth rate) for enterprise SSDs deployed in servers and storage throughout the data center. IDC expects revenue for enterprise SSDs to grow from $3.3 Billion in 2013 to $10.9 Billion in 2018, the end of the forecast period[2].

IDC expects unit shipments for enterprise SSDs to grow from 4.8 million enterprise SSDs shipped in 2013 to 20.9 million in 2018. This represents a 34.1% CAGR for unit shipments of enterprise SSDs.[2]

[1] This number is based on 300GB HDDs with 15 drives per enclosure
[2] Source: IDC #248727, Worldwide Solid-State Drive 2014-2018 Forecast and analysis; The Need for Speed Grows, June, 2014

3. New Data-Types for Wide Distribution to End-Users

Read-intensive application workloads, incorporating video, images and sensor information, requires consistent and reliable data-transfer, to ensure smooth end-to-end quality-of-service (QoS). This is particularly important in the areas of VOD and media streaming, in which end-users are accessing the media for immediate viewing from smart hand-helds, tablets and phones.

The emergence of the Internet of Things (IoT) – with many new data sources on the "edge" of the network (e.g. road sensors, heat sensors, RFID labels on consumer goods, and medical devices) is pushing the levels of data that must be gathered, analyzed and maintained to new levels. These media streams must be supported by high-performance servers and storage, and by fast network connections – where the data must be stored along the way, for later viewing and archiving.

4. The Optimus MAX 4TB SAS SSD

High-density flash drives offer expanded capacity for a range of workloads, including read-intensive application workloads, such as media streaming and web serving. High-density drives can also be deployed to support mixed-use application workloads that combine reads and writes provided the user does not exceed the "Drive Writes Per Day" (DWPD) specification of the drive for extended periods of time such that the warranty of the device is not exhausted prematurely.

Each SSD brings a different mix of capabilities, and customers should consider how to best match those capabilities with the workloads they plan to run. The sweet spot for deployments of specific SSD products will depend on the type of NAND used, and the performance specifications for each SSD product, the type of controller used in the system, and the ratio of reads to writes.

This paper will focus on the Optimus MAX, a 4TB* SAS SSD that has been optimized for read-intensive application workloads. Its combination of high capacity and competitive pricing make it attractive for enterprise data centers and cloud service provider (CSP) data centers – both focused on capability and competitive cost.

5. Optimus MAX SSD Specifications

In terms of endurance, the Optimus MAX SSD leverages SanDisk's innovative Guardian Technology™ Platform to ensure maximum possible write capability to the drive. The Optimus MAX 6Gb/s SAS SSD provides rates of up to 500/500 MB/s** sequential read/write and performance of up to 85K/10K IOPS for random read/write workloads.

The Optimus MAX SSD supports 0.5 full drive writes per day (DWPD)*** with a warranty for the lesser of 5 years or maximum endurance used. Higher DWPD endurance rates from 1 - 45 DWPD, are supported by other drives in the Optimus® SAS SSD family, such as the Optimus Eco™, Optimus Ascend™ and Optimus Ultra™ SAS SSD models.

* 1 GB = 1,000,000,000 bytes. Actual user capacity less.
** Up to stated speed. Based on internal testing; performance may vary based on host device. 1 megabyte (MB) = 1 million bytes. X=150KB/s.
*** Warranty/DWPD - The lesser of 5 years from the date of manufacture of the product or the date on which the product's relevant endurance thresholds set forth in the product specifications are reached.

However, customers who want to run a mixed-use, 70/30 read/write workloads can do so, given the extensive capacity of the drive. That is, the amount of data that can be stored in a single drive allows many writes to take place without over-taxing the DWPD limits of the drive. Each customer should evaluate which workload profiles fit best with the Optimus MAX SSD specifications – and with their own use case.

Operationally, the Optimus MAX SSD has a much faster access response time than a mechanical HDD solution. The Optimus MAX SSD has very low power consumption under load, and it consumes even less power when in idle mode. In contrast, a HDD must consume power spinning the disks – even when no data transfer is occurring. The large-capacity design of this drive, and its low-power usage in near-idle states makes the Optimus MAX SSD ideal for data that is stored long term but still requires quick access.

Environmentally, the Optimus MAX SSD saves on data center space, power and cooling – saving businesses in the area of operational costs. The Optimus MAX SSD enables a 10:1 ratio[3] of enclosure consolidation against HDDs. Using less data center space leads to a "ripple effect" of savings of operational costs that are associated with maintenance, power and cooling.

6. Key Workloads for the Optimus MAX SSD

SanDisk has designed the Optimus MAX SSD to provide high capacity for read-intensive workloads. For that profile of workload, the following are top use-case scenarios:

- **Caching:** Caching of web content is a continuing task that is highly read-intensive. Having more density on the SSD allows each drive to become more effective when large amounts of web content are being cached for search and access by end-users.

- **Decision Support:** Software tools, such as "dashboards" consolidate data for review by managers and executives. This is a re-use of data that has already been written in a database or data warehouse.

- **Media Serving and Media Streaming:** Media serving is a read-intensive workload, with a ratio of 95% to 100% reads for each write operation. Media serving supports QoS for the data delivery to end-users. The goal for media serving and media streaming is maintaining the customer experience for those who are viewing the media (e.g. movies, videos, audio) across the cloud, or across the Internet.

- **Video on Demand (VOD):** Video on Demand allows users to access video from virtually any device in HD quality. It allows media companies to serve thousands of users simultaneously. Flash storage dramatically shortens the time to stream the first bit of the data, enhancing the viewer experience.

- Moderate workloads of any read/write mix that does not exceed 0.5 drive writes per day for 5 years.

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[3] This ratio is based on the use of 300GB HDDs with 15 drives per enclosure. This ratio may increase or decrease depending on the HDD capacity being consolidated.

- **Virtual Desktop Infrastructure (VDI):** Support for centrally managed VDI workloads support server consolidation – because each server supports more virtual machines (VMs) per physical server. Hundreds, or even thousands, of individual end-users can access central-site applications that are maintained by central IT in this way, reducing operational costs for the business.

- **Web Serving:** Web-based applications leverage the Web for connectivity to end-users. In addition to applications we use every day as consumers, web-based applications also broaden access to corporate applications such as enterprise resource planning (ERP), customer relationship management (CRM), end-to-end supply chain management, and logistics. SSDs allow organizations to optimize processing speed for faster Internet functionality to accelerate business.

7. Designed to be Affordable

The Optimus MAX 4TB SAS SSD is available at the cost of SATA SSD-like prices. Its high density is double that of earlier-generation SAS SSDs – and much higher than the density available in many SAS HDD-based systems. The high density supports workload consolidation onto fewer physical servers – allowing IT managers to do more with less.

8. How High Density Flash Pays Off For Customers

Key advantages of the Optimus MAX 4TB SAS SSD include the following:

- Highest capacity SAS SSD on the market today. This means that it would take over 10x more 300GB HDDs to provide similar data capacity.

- 7% lower total cost of ownership (TCO), than HDDs while using just 10% of the footprint required for HDD-enabled servers running the same workload. Fewer drives means there will be fewer enclosures housing these drives - requiring less power and cooling than HDD-based solutions.

- Overall solution cost for the Optimus MAX SSD is now approaching that of 15K RPM SAS HDD solutions at similar capacity points, with much better performance and latency characteristics. In comparison, customers should see power and space savings of 80-90%, compared with HDD solutions providing similar data capacity.

- Compatibility with current server and storage enclosures – so that HDDs can be swapped out – and the Optimus MAX SSD can be utilized in the same racks and enclosures customers are already using.

Here is a sample configuration of the Optimus MAX 4TB SAS SSD:

- 300GB 15K RPM SAS HDDs,supporting RAID 5
- 4TB Optimus MAX SSD, supporting RAID 5
- 15 drives per enclosure
- The SSD solution is contained inside of a single enclosure.
- The HDD solution is contained in 10 enclosures
- Each enclosure consumes 100 watts to be powered up

Targeting capacity points of over 34TB

- 288 mechanical HDDs reaching 34.56 TB of total capacity
- 24 SSDs reaching 36.86 TB of total capacity
- The TCA (Total cost of acquisition) is 8% higher for the SSD solution
- The TCO (Total cost of ownership) of the SSD solution is 7% lower than the cost of the 15K RPM HDD SAS solution

9. Testing of Optimus MAX SSD – Key Takeaways

The Optimus MAX SSD is best suited for the transmission of data, analysis of already-written data, and cost-effective serving of web and video content.

SanDisk tested the Optimus MAX SSD in a variety of installations, and developed a model for deployment and usage that shows significant benefits for customers. Following, a total cost of acquisition (TCA) analysis was performed with key assumptions comparing the new Optimus MAX SSD with 300GB 15K RPM HDDs also supporting a SAS interface.

TCO Calculator - Cost Breakdown
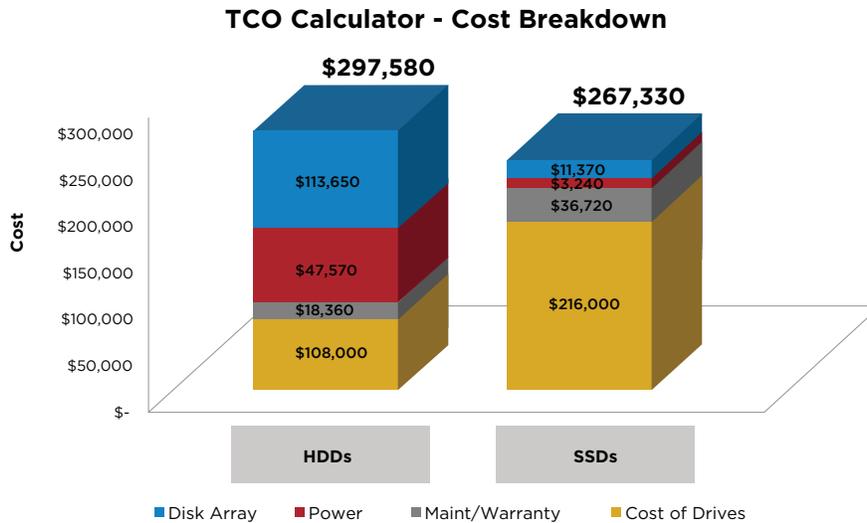
Figure 1 - SSDs support 7% lower TCO than HDDs, while using 10% of the server footprints required by HDDs

Figure 1 shows all costs—for CapEx and OpEx – providing a Total Cost of Ownership (TCO) analysis. It shows that ownership of systems with Optimus MAX SSDs drive down operational costs, reducing business expense.

TCA Calculator - Cost Breakdown
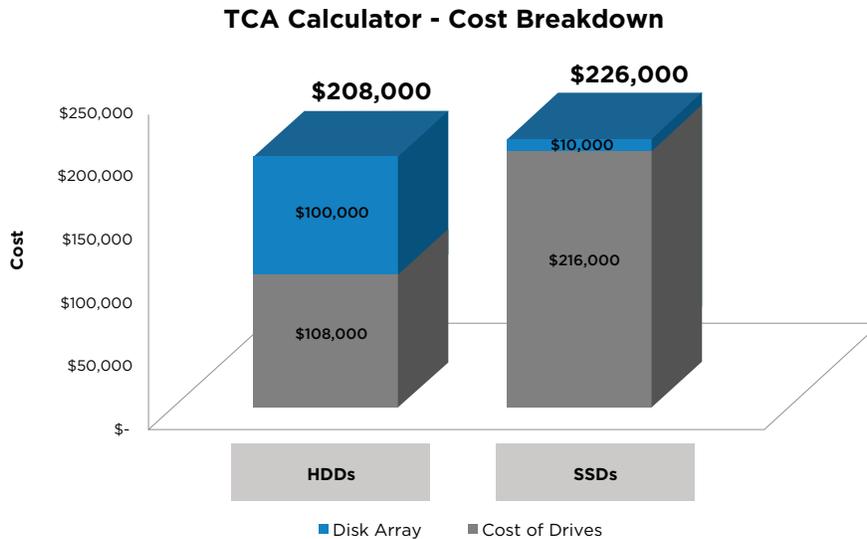
Figure 2 - Over 10x the performance while using 7% of the power for only 8% more acquisition cost

Figure 2 shows a Total Cost of Acquisition (TCA) analysis of the sample configuration.

In all cases, the enclosures used held 15 drives, with each enclosure consuming 100 watts of power. Typical RAID 5 configurations for similar workloads resulted in 288 HDDs compared with just 24 SSDs – and both configurations supported about 35TB of data. That is why the SSD deployments saved so much data center space, while maintaining equivalent capacity.

Our testing cycle found significant benefits for deploying the Optimus MAX SSD, including the following:

- These benchmark tests showed that the Optimus MAX SSD configurations tested, delivered 10x the performance at 7% less the costs (CapEx + OpEx) for a lower overall TCO - which provides meaningful cost savings to the business.

- One example of the Optimus MAX SSD solution was a 10:1 ratio of one SDD with 4TB of capacity vs. 10 HDDs (300GB) to achieve that same capacity. Using less data center space led to lower operational costs due to lower costs for maintenance, power and cooling.

- The Optimus MAX SSD configurations used 7% the power required by the HDD configuration supporting the same workload.

10. Conclusion

SanDisk's introduction of the Optimus MAX, a 4TB SAS SSD, has set a new level of data-density for the SSD marketplace. Importantly, it is offering this capability at SATA-like cost levels. The savings in cost per square foot of hardware space coupled with reduced software expenditure where software is licensed by the enclosure or server count, may in many cases make the Optimus MAX SSD solution a much less expensive acquisition.

Optimized for read-intensive application workloads, the Optimus MAX SSD supports Caching, Decision Support, Media Streaming, Media Serving, VDI, Web Serving, and a moderate workload of any read/write mix that does not exceed 0.5 drive writes per day for 5 years. For this reason, it shows versatility that can be put to work in enterprise data centers – and in Cloud data centers focused on Internet-related streaming of data.

The Optimus MAX 4TB SAS SSD alleviates I/O bottlenecks by providing high-density storage for infrastructure footprint consolidation and reduced power consumption for efficient data throughput to deliver, high performance, high reliability and enhanced endurance for maximum application scalability and TCO savings.