Technical white paper

Choosing storage solutions for demanding imaging applications

HP Workstations

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Overview

Recent, dramatic advances in geo-spatial imaging, video content creation and medical imaging technologies have made selecting the best storage solution a challenging and complicated task. This white paper addresses the concerns and considerations in these market segments.

Challenges

With the advent of 4K video and ever-increasing image resolutions, imaging storage workloads have reached a point where special considerations must be made. The need for rapid image manipulation and storage has become a major concern. In order to address these requirements, many users have started to consider solid-state drives (SSDs) a logical choice. The following list shows some of the major challenges facing workstation customers who require advanced storage capabilities for imaging:

- Very high sequential workloads
- 24/7 operation
- Require high reliability and high endurance
- Critical data integrity

The solution

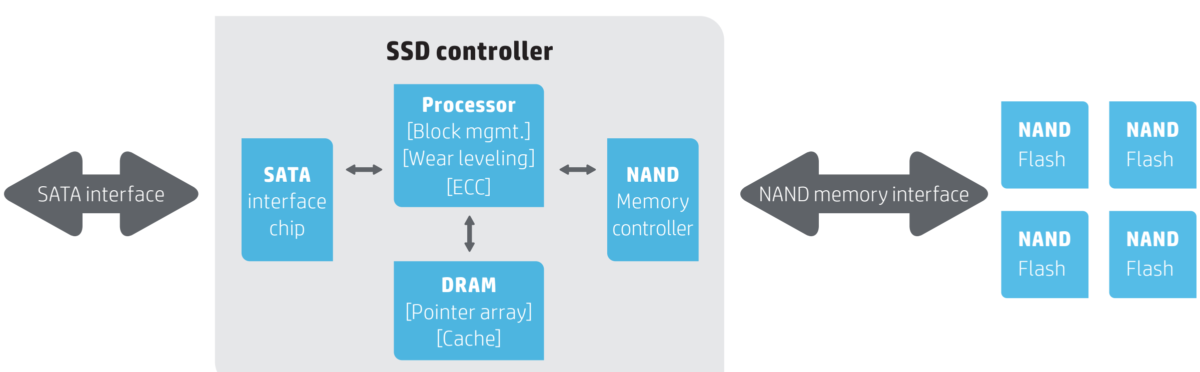
It is recognized that workstation customers involved in image collection and manipulation need a special class of storage device to meet their advanced needs. HP Workstations offer an enterprise-class drive family specifically for these customers. Many of the benefits offered in a device designed for the data center are a perfect fit for customers engaged in imaging tasks. Some of these data center features include:

- Full End-to-End Data Path Protection, contributing to lower bit error rates
- Sudden power loss protection, preventing data loss in the event of power loss
- Rugged design, high endurance NAND and/or more overprovisioning to provide 24/7 operation under high sequential workload stress
- More stringent testing to ensure higher reliability and lower overall annualized failure rate

These benefits will be explored in more detail in the following sections.

End-to-End Data Path Protection (EEED & EEEC)

The following diagram shows the basic configuration of a flash storage device. Although the diagram depicts a SATA device, the basic architecture is the same regardless of the interface. Workstation enterprise-class SSDs are required to have full data path protection comprised of end-to-end error detection paired with end-to-end error correction. This means that the data presented by the host on the drive's connector is protected all along the data path until it is safely stored on the drive's NAND. At each transition (e.g. from the interface to the processor, from the processor to the DRAM, from the DRAM to NAND, etc), the data is checked and verified to be correct. If any errors are detected, the drive's internal error correction mechanisms will correct them.



Power loss protection (PLP)

Workstation enterprise-class devices are required to have power loss protection circuitry to protect data in flight from loss or corruption in the event of a sudden loss in power to the device. This can happen as a result of a power outage, a sudden removal of the power cord to the workstation or from an accidental disconnection of the drive's internal power supply cable. When the drive loses power suddenly, any data residing in the drive's DRAM that has not yet been committed to NAND will be lost (this DRAM is just like system DRAM and must be refreshed at regular intervals or it will lose its contents). Enterprise-class SSDs employ a monitoring circuit to check for a sudden power loss event and some type of energy storage to allow the drive to commit all the data in DRAM to NAND before this ”emergency power” supply is exhausted. The most common method to provide energy storage is through the use of either tantalum or electrolytic capacitors, but other methods, such as batteries or "super" capacitors, can be used.

High-endurance NAND and overprovisioning

Drive designers employ several techniques in enterprise-class devices that allow them to tolerate extreme workloads. One method is to use high-endurance NAND. Typically, high-endurance NAND utilizes multi-level cell (MLC) NAND technology optimized for data center workloads combined with advanced firmware algorithms to minimize program/erase cycles. Another technique used is to overprovision the drive. Overprovisioning simply means equipping the drive with more NAND than is presented to the interface. This additional NAND is used for wear-leveling operations and acts to "spread" the wear over more NAND, lowering the number of writes any individual cell will experience. Often times, drive designers will combine both high-endurance NAND and more overprovisioning to attain even higher levels of endurance.

It is easy to spot a device that has been overprovisioned. If a device has a capacity that is binary-divisible (e.g. 256 GB, 512 GB, etc), it probably has only rudimentary overprovisioning. If a device has a capacity that is not binary-divisible (e.g. 240 GB, 480 GB, etc), it has been overprovisioned. Taking this one step further, a 20% overprovisioning would result in drive capacities like 200 GB and 400 GB. The difference from the original, binary-divisible capacity is the amount of NAND that is being used for overprovisioning. For example, a 256 GB raw capacity drive reporting 240 GB to the interface is using 16 GB (or ≈ 7%) of its raw NAND for overprovisioning. The overprovisioning prevents users from accessing the overprovisioned NAND and increases the device's endurance and overall lifetime.

Data center testing requirements

Workstations storage engineering places much more stringent and demanding test requirements on our storage suppliers who provide enterprise-class devices. Areas such as reliability, error rates, endurance and retention receive special focus. Customers in intensive image-processing fields can rest assured that workstation enterprise-class devices will work well in these demanding environments.

For example, workstations require enterprise-class workloads be applied to supplier tests in Reliability Demonstration Testing (RDT), Endurance Verification Testing (EVT) and data retention tests. The table below shows the comparison between client-class workloads and enterprise-class workloads as specified in the JEDEC standard JESD-218A. Workstations require that enterprise-class suppliers test to the enterprise-class standard for these devices. In addition, workstations also require the use of the enterprise-class JEDEC workloads specified in JEDEC JESD-219A. These requirements ensure that enterprise-class devices are tested properly for their intended function.

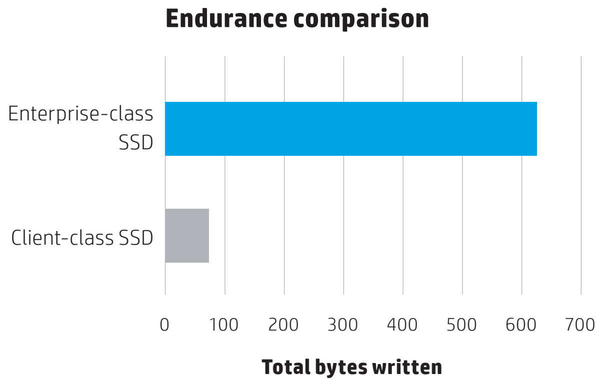
Table 1: SSD classes and requirements

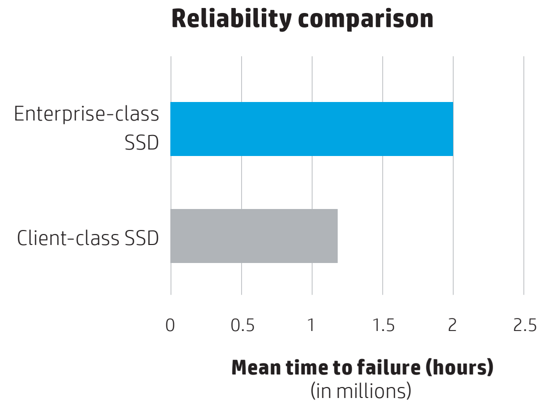
Application class	Workload (see JESD219)	Active use (power on)	Retention use (power off)	Functional Failure Requirement (FFR)	UBER requirement
Client	Client	40°C 8 hrs/day	30°C 1 year	≤3%	$\leq 10^{-15}$
Enterprise	Enterprise	55°C 24 hrs/day	40°C 4 months	≤3%	$\leq 10^{-16}$

It's important to note the UBER specification in the table. UBER stands for Uncorrectable Bit Error Rate or Ratio and is a metric for the rate of occurrence of data errors. It is equal to the number of data errors per bits read. As you can see, enterprise-class devices have an UBER value that is an order of magnitude better than client-class devices (which have an already impressive UBER). This metric, combined with HP's requirements for End-to-End Data Path Protection provide a storage platform that can be relied upon for critical imaging tasks where accuracy and dependability are key concerns.

Reliability and endurance

Reliability and endurance are not the same thing. Reliability is the measure of failure rate within a specified portion of the device's life, whereas endurance is a metric which indicates how long a device is expected to last. Unlike rotational HDDs, SSDs wear out. The endurance specification indicates how much data, either in TBW (total bytes written) or DWPD (Drive Writes per Day), the device is designed to write. Wear occurs on SSDs from writing; reading does not cause wear and is not included in the TBW or DWPD specification. The figures below show comparisons between enterprise-class and client-class devices for both endurance and reliability. For more information, see the SSD endurance whitepaper.





Conclusion

Modern workstation imaging tasks require more consideration when selecting a storage solution. Drives designed for the data center contain many beneficial attributes to users in these market segments. Such features as data path protection, power loss protection, more robust components, higher-endurance NAND, overprovisioning and more rigorous testing put enterprise-class devices at the forefront of consideration. HP Workstations offer enterprise-class devices which are specified, tested and qualified to provide imaging customers with a solid choice in these demanding applications.

For more information

To read more about SSD technology for HP Workstations, go to hp.com/V2/GetPDF.aspx/4AA3-8500ENW.pdf

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