PowerEdge Enterprise HDD Overview

Tech Note by:

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SUMMARY

In selecting server hard drives, users must consider multiple parameters, including form factor, rotational speed, sector format and bus interface.

They must also evaluate trade-offs between performance, capacity and budget, for example.

This brief Tech Note presents preliminary guidance in HDD selection and provides links to further information.

With expanding number of hard drive form factors, interfaces and sector formats, the selection of appropriate hard drives for various applications and workloads is no longer intuitive. Oftentimes there are trade-offs between performance, capacity and budget, for example, and users are seeking guidance in making these decisions. This brief Tech Note provides preliminary guidance in HDD selection and provides links to further information.

Performance Optimized and Capacity Optimized

Performance Optimized drives (also known as Mission Critical drives) are 10K and 15K SAS drives and are used in applications requiring high levels of performance and reliability. That is, think of these drives as being in continual use, 24x7x365. They are available only in 2.5" form factor ("Small Form Factor", or SFF).

Capacity Optimized drives (also known as Business Critical drives) are 7.2K Nearline SAS and SATA drives designed primarily for large storage capacity. They are typically less expensive than Performance Optimized drives but do not offer the peak performance or peak reliability of Performance Optimized drives. Thus they are excellent for less-demanding workloads, and fewer hours of operation per day (e.g. 8x5 rather than 24x7). Capacity Optimized drives are offered in both 3.5" Large Form Factor (LFF) or 2.5" SFF.

Figure 1: Hard disk drive with cover removed, showing spindle, platters and read/write arm

Table 1 on Page 2 shows a complete listing of capacity points for each drive category supported by PowerEdge 13G and 14G servers. Capacities in plain text are supported on both 13G and 14G servers. Capacities in italics are not offered on 14G due to the low level of adoption. Overtime, new larger capacities will be introduced in line with the pace of HDD technology development (For example: 2.4TB 2.5" and 12TB 3.5", as well as 14TB in CY2018).

Form Factor	Interface	Category	RPM (revolutions per minute)	Sector Format	Capacity Options
2.5"	SAS	Mission Critical	15K	4Kn	600GB / 900GB
				512e	900GB
				512n	300GB / 600GB / 900GB 900GB FIPS SED
			10K	4Kn	1.8TB
				512e	1.8TB / 2.4TB 1.8TB / 2.4TB FIPS SED
				512n	300GB / 600GB / 1.2TB 1.2TB FIPS SED
		Business Critical	7.2K	4Kn	2TB
				512n	1TB / 2TB 2TB FIPS SED
	SATA		7.2K	512n	1TB / 2TB
3.5"	Nearline SAS		7.2K	4Kn	8TB / 10TB
				512e	8TB / 10TB / 12TB 8TB / 12TB FIPS SED
				512n	1TB / 2TB / 4TB 4TB FIPS SED
	SATA		7.2K	512e	8TB / 10TB / 12TB
				512n	1TB / 2TB / 4TB

Table 1: PowerEdge Enterprise HDD Options (capacities in gray font are not offered on 14G)

Sector Formats

A fundamental transition is occurring in the HDD industry. The standard size of a basic unit of data (a sector on the disk) is changing from 512 bytes to 4096 bytes (referenced as 4Kn Advanced Format by IDEMA - International Disk Drive Equipment and Materials Association). Customers have been using applications, operating systems and file systems built on 512 bytes (512 native) for decades. The move to 4K byte sector size will impact those software stacks and will result in additional validation work as well as possible structural changes to software as the transition is made.

Recognizing that customers may be reluctant to make a change, an *emulation* model of these drives has been created. The drive is built from 4K technology, but allows for 512-byte addressing and transfer at the interface. These drives are known as 512e.

There are many aspects of modern computing systems that continue to assume that sectors are always 512 bytes. The Dell HDD offerings include 512n drives, 512e drives, and drives in the 4Kn format.
The 512n format is available for customers interested in maintaining the same drive type they have used over time.

Some additional factors to consider concerning sector formats are:

- The 512e drives provide a 512-byte sector size for those larger capacities not available in 512n.
- The 4Kn formatted drives are for those customers interested in adopting the latest, highest capacity HDDs and for those getting prepared for the future direction of the HDD industry.
- The newest, highest capacity HDDs that 4Kn sector format enables will also be available in 512e sector format.

Format type	Bytes per sector value	Bytes per physical sector value
512n	512	512
512e	512	4,096
4Kn	4,096	4,096

Table 2: Sector Format Types of HDD

HDD Interface and Speed

Three interface types characterize hard drives (listed below from fastest to slowest):

- Serial Attached SCSI (SAS)
- Near Line SAS (NL-SAS)
- Serial ATA (SATA)

Drive speed, referencing the rotational speed of the drive spindles, is measured in revolutions per minute (RPM) and affects how quickly data can be accessed on a drive. For example, a 15K RPM drive can deliver faster seek times and subsequently greater IOPS performance compared to a slower 10K or 7.2K RPM drive. Maximum drive speeds vary across the interface types, as explained below.

SAS drives use a Serial-Attached SCSI (SAS) interface for connecting to the server, which provides a full bandwidth connection to *each* drive. This point-to-point controller interface delivers a speed advantage compared to SATA drives, in which *all* drives on the bus share the same interface. Additionally, a second advantage for SAS drives is that they are available in faster rotational speeds (up to 15K RPM) than Near-Line SAS (NL-SAS, explained below) or SATA drives (up to 7.2K RPM). Thus, SAS drives deliver up to 2 times faster seek times than the other varieties.

	HDD 3.5”		HDD 2.5”			
	6Gbps SATA 7.2K RPM	12Gbps NLSAS 7.2K RPM	6Gbps SATA 7.2K RPM	12Gbps NLSAS 7.2K RPM	12Gbps SAS 10K RPM	12Gbps SAS 15K RPM
Random 8K transfer per command 70% Read/ 30% Write (Q depth = 4)	118	118	115	115	220	300
Max Size in GB (as of Dec 2017)	12TB	12TB	2TB	2TB	2.4TB	900GB

Table 3: Comparative HDD Performance and Capacity

The next-fastest interface type is Near-Line SAS drives. NL-SAS drives also use the SAS interface, providing gains of up to 30% performance over traditional enterprise-class Serial ATA (SATA). NL-SAS drives, however, use a different media size to be able to offer greater overall capacity than SAS drives, but are limited to a rotational speed of 7.2K RPM. The primary benefit of NL-SAS drives is the ability to have large-capacity drives, such as the 10TB 7.2K RPM, 3.5" NL-SAS drives available with multiple 13G and 14G Dell PowerEdge servers, while maintaining the faster speed of the SAS interface.

SATA drives are relatively slower than SAS and typically offer less capacity than NL-SAS drives, but are also typically the lowest cost of the three interface options. Thus, a key benefit of SATA drives is that they can provide large capacities of storage at lower cost when compared to SAS or even NL-SAS drives. Using an all-SATA drive configuration, PowerEdge servers can hold vast amounts of internal, low cost storage. To give an illustration of the trade-offs of the benefits between these three types of drives, Table 3 on the previous page shows the estimated IOPS performance and capacity for the three interface drive types.

Conclusions

When considering hard drives, users are presented with a list of parameters spanning, for example, form factor, rotational speed, bus interface speeds, and sector formats, all of which can initially make evaluation of trade-offs challenging. This brief Tech Note has described how users can be assisted in their drive selection by comparing performance and capacity, and then overlaying that comparison with current prices to make a decision. Users should note that it is not an all-or-nothing decision: It is quite typical to select one type of drive (e.g. SATA) for low-activity or archived data; another type of drive (e.g. NL-SATA) for moderately active data; and a third type of drive (e.g. high-RPM SAS) for highly active workloads demanding fastest response times. Such a hierarchical storage infrastructure optimizes by workload and need, and is also the most cost-effective for user budgets.