The Right Drive For The Job

Enterprise, Nearline and Desktop-Class Hard Drives

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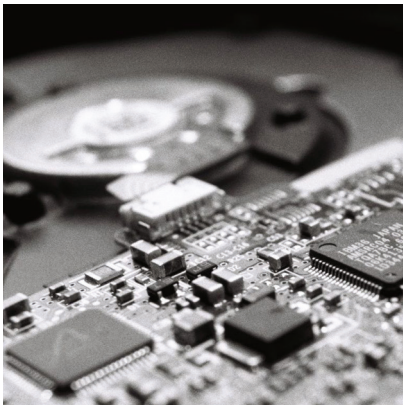
ENTERPRISE vs. NEARLINE vs. DESKTOP-CLASS HDDs



For decades, the storage market has been made up of two categories, 'Desktop' and 'Enterprise'. Recently hard drive vendors got serious about producing duty-specific hard drives. With the growth of the enterprise-class aligning well with massive data explosion, the pains around storing lots of data in a cost effective manner became real for system integrators. It's not surprising that hard drive manufacturers tapped into this trend by creating the nearline segment of hard drives. This along with the emergence of SSDs has created more confusion in determining the type of hard drive that best fits their data storage requirements. The use of SSDs is growing, but their higher cost per GB along with the established reliability of Enterprise-class HDD's remains a factor in IT departments continuing to use HDDs. We take a deeper dive here to unmask the technology highlighting the benefits of enterprise drives and the risks of using low cost drives in server and data storage environments.

When it comes to protecting data, a lot of organizations make buying decisions based on cost only instead of selecting the right product for the job. This trend has influenced many popular manufacturers to putting low cost HDDs in their systems. They generate further confusion by focusing on marketing lingo while concealing technical details. Likewise, there's a certain distrust among some consumers as to whether or not enterprise-class drives are really any better than lower-cost nearline drives. To get past all of this we've worked to go beyond the data sheet to get to the bottom line of what makes enterprise-class drives unique and things that should be considered when purchasing drives that only carry a 3 year warranty.

Drive Classes Summarized

Desktop-Class Drives are commonly designed to work in a less demanding environment, single user access to provide program, application and file access, complete a limited data save, or data retrieval for the OS. They are usually shut down during non-work hours, or left idle for long periods of time and are designed for 8 hours/day, 5 days/week deployment. Desktop drives are low cost drives, tend to have a lower MTBF ratio and usually come with a 1 year warranty.

Nearline-Class Drives are low-cost, high-capacity intermediate storage solutions that are not needed for high availability transactional processing, and typically do not perform OS or application task, so frequent, rapid access to data is not required. Nearline storage requires 24/7 access for storage/archiving used for backups or long-term storage with infrequent access to data. They have a moderate MTBF ratio and typical warranties range from 1 to 3 years.

Enterprise-Class Drives have the highest MTBF ratio and are designed for 24 hours/day, 7 days/week, always accessible. Enterprise systems perform operating system and application tasks locally, and may control multiple drives that add capacity and redundancy to a storage subsystem. During off peak time the enterprise system may patrol hard drives for defects or errors, system backups, and other maintenance tasks. Enterprise workloads create greater wear on bearings, motors, and other components; which generates additional heat and vibration. Enterprise class drives are designed with heavy-duty components and drive firmware programming to meet the rigours of the environment, and utilize sophisticated feedforward anti-vibration circuits to help compensate for vibration. Warranties vary by manufacturer but are regularly up to 5 years.

Each hard drive is composed of about 30 components, depending the size of drive. These items work in concert to deliver a drive that usually lasts beyond it's warranty. The selection of components and the manner of their assembly are what determine the capabilities of the drive. For the purposes of this piece we're comparing enterprise, nearline and desktop product lines to better illustrate the differences between each and to highlight where the step up to enterprise drives makes sense.

Rotational Vibration Protection

Rotational Vibration (RV) Protections starts with RV sensing. This is accomplished by using two linear accelerometers (RV sensors) placed on the printed circuit board assembly. The RV sensor locations (Figure 1 circled in red) are optimized for separation distance and mounting conditions. These RV sensors measure external vibration that the drive is subjected to like fans, acoustic interruptions and rack vibration. This signal is proportional to the vibration magnitude. Nearline and enterprise drives utilize these RV sensors to measure external forces dynamically, providing data to the drive that can be used to help correct for environmental changes. Enterprise drives boost protection through enhanced technology including sophisticated feedforward anti-vibration circuits to monitor the drive and correct both linear and rotational vibration in real time, very similar to technology used in noise cancelling headphones.
The result is a significant improvement in MTFB and probability of unrecoverable errors in normal production environments.

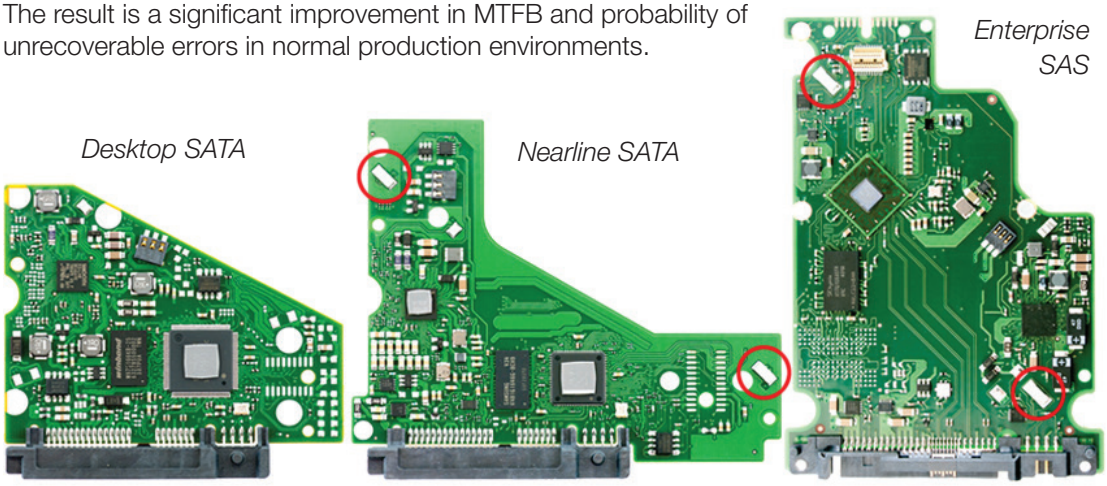


Figure 1, RV Sensors Desktop SATA (left), Nearline SATA (center), and Enterprise SAS (right)

Figure 2 shows RV tolerance that are up to 6 rads/sec^2 for desktop drives, nearline drives are up to 12.5 rads/sec^2, and enterprise drives are up to 21 rads/sec^2. The benefit of this more accurate positioning means a reduced need for extra recovery steps, maintaining throughput performance. This is vital for enterprise drives which have a faster spindle speed and are deployed in more business-critical scenarios.

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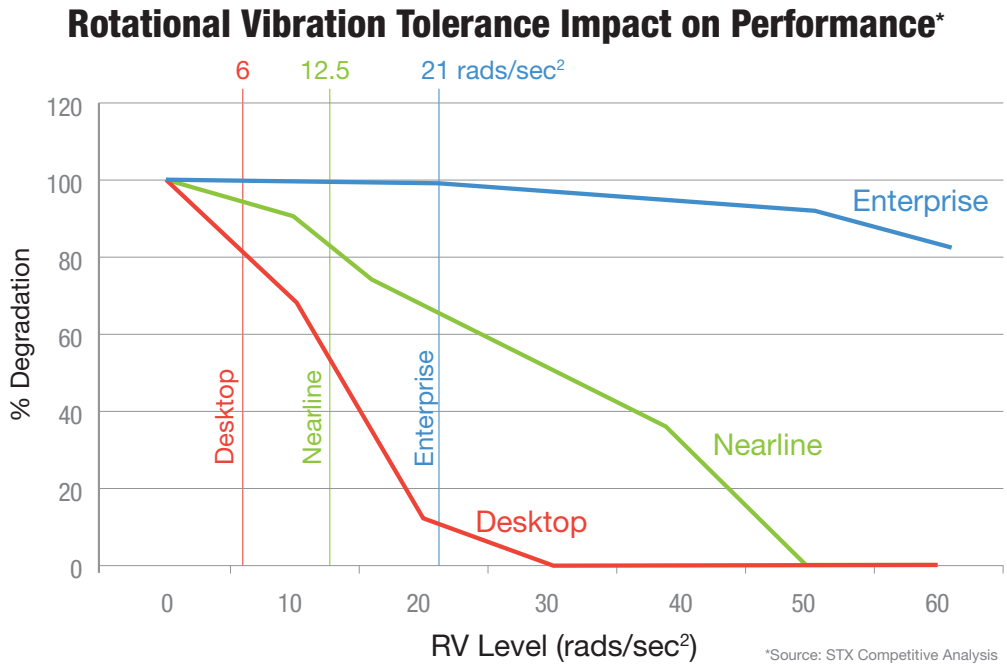

Figure 2, Rotational Vibration Tolerance Impact on Performance

Motor/Spindle/Case Design

Both nearline and desktop drives use a bottom attached motor design. Enterprise drives however make use of a dual top and bottom attached design. Enterprise drives gain a few advantages as a result. The spindle is held more solidly at the bottom end thanks to a direct press fit into the base, and at the top end by a screw in the top cover. In Figure 3 below the desktop drive is on the left, the nearline drive is center and the enterprise drive on the right. Notice the extra screw in the lid on the right, this is the top attachment that adds to the stability of the drive.

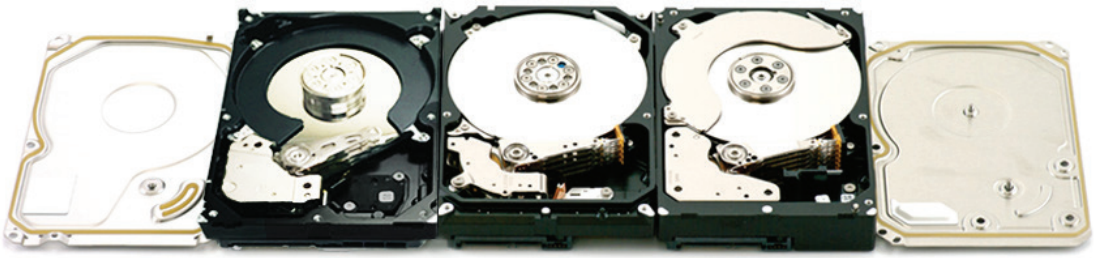

Figure 3, Desktop (left), Nearline (center), and Enterprise (right) drives

By supporting the spindle shaft at both ends, radial response of the disc pack is reduced by 50% compared to a motor which is only supported at the bottom end. A drive with a top cover attached motor will have a substantial advantage in a high vibration environment, like rackmount NAS and SAN arrays, hence the recommendation that enterprise drives be used in larger systems when compared to nearline drives. Also of note are the disk windage plates in the enterprise drive, which reduce air disturbance between the platters for greater reliability.

The bearing systems in the motors have evolved to be very robust. As motor geometry becomes more complex, additional features have been added to the bearings to make them more tolerant of manufacturing variances. The bearings in the motors for enterprise drives are “self purging” which means if bubbles form, they are expelled. They also typically include centrifugal seals which support oil reservoirs giving them an advantage in high temperature environments. Lastly, enterprise drives can support very high pack loads due to relatively high structural rigidity as compared to cantilever style motors.

Voice Coil Magnets (VCM)

The VCM is the electro-mechanical actuator that is the primary means of moving the write/read element across the spinning disc surface, as well as controlling the writer/reader over a desired location. The design of the coil windings and choice of magnet strength govern the acceleration capability of the voice coil motor, and in turn defines the fastest move time capability. A stronger VCM design has the potential to provide higher acceleration & faster move times, hence increased performance. Desktop and nearline drives use a standard VCM build while enterprise drives use a much larger magnet as illustrated to the right. In Figure 4, the VCM for typical desktop and nearline drives is displayed on the left and enterprise drives on the right. Also notice the more beefy VCM plates in the enterprise drive, along with the larger arm damper plates that carry the heads.

Figure 4, Nearline components (left) vs. Enterprise components (right)

High Performance Heads

Both nearline and enterprise drives use high performance heads, compared to a standard head in desktop drives. High performance heads are designed with narrower physical dimensions and higher signal to noise ratio. This allows the margin to hard errors in long term operation to be higher, increasing the robustness to multiple stresses like high operating temperatures, high vibration environments and high/constant work loads. These three points are critical for nearline and enterprise drives and the head quality dramatically alters what the drives are capable of in terms of reliability. By allowing operation with larger “unused” space between tracks as well as starting the drives useful life using much less of the error recovery capability intrinsic in the drive electronics and code, such a drive would have a longer useful life and higher performance as it is less reliant on error recovery. Sustained data rate is maintained at a higher level as the drives can absorb external events much more effectively with extra space between the tracks.

The table below provides key information needed to help determine hard drive requirements.

Requirement	Enterprise	Nearline	Desktop
Operational Availability	24 hours/day 7 days/week	24 hours/day 7 days/week	8 hours/day 5 days/week
Workload	High – 100%	Low/Med – 20% to 40%	Low <10%
Spindle Speed	High –15K / 10K rpm-2.5" Med – 7200 rpm - 3.5"	Med 7200 rpm	Med – 7200 rpm Low – 5400 rpm
Rotational Vibration Tolerance	Up to 21 rads/sec^2	Up to 12.5 rads/sec^2	Up to 6 rads/sec^2
Max Sustainable Transfer Rate	226MB/s to 266MB/s	180MB/s to 250MB/s	185MB/s to 210MB/s
Cache Buffer, Multisegmented	128MB to 256MB	64MB to 256MB	32MB to 256MB
Mean Time Between Failures (MTBF)	**2.0 million hours**	**1.2 million hours**	**0.6 million hours**
Unrecoverable Error Rate (see Figure 5)	1 sector per 10^{-16}	1 sector per 10^{-15}	1 sector per 10^{-14}
Probability of Unrecoverable Errors During RAID Rebuild (see Figure 5)	0.2%	2%	20%
Power-On Hours per Year	8760	8760	2400
Shock, operating/nonoperating (Gs)	40 to 70/150 to 300	40 to 80/250 to 300	70 to 80/300 to 400
Operating Temperature	5 to 60° C	5 to 60° C	5 to 60° C
Best Fit Applications	- Storage-hungry business applications - Storage area networks (SAN) and network attached storage (NAS) - Hyperscale applications/cloud data centers with replicated storage - Substantial scale-out data centers and big data analytics - High-capacity density RAID storage - Mainstream enterprise external storage arrays - Enterprise backup and restore—D2D	- Business applications - File servers - Rich media content storage - Reference and compliance data storage - Backup and restore	- Desktop or all-in-one PCs - Home servers - PC-based gaming systems - Desktop RAID - Direct-attached external storage devices (DAS) - Network-attached storage devices (NAS)
Interface	SAS / SATA	Nearline SAS / SATA	SATA
Capacity	Low ~2.4TB (2.5") High ~12TB (3.5")	High ~14TB	High ~14TB
Warranty	**5 years**	**3 years**	**2 years**

Data based on Seagate® Exos™ (Enterprise) HDD, Seagate® IronWolf™ (Nearline) HDD, and Seagate® BarraCuda® (Desktop) HDD.

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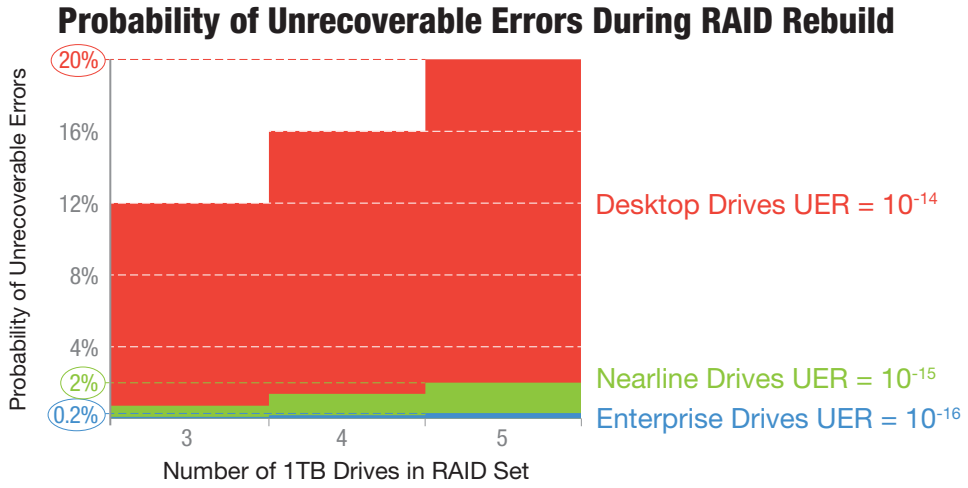

Figure 5, Unrecoverable Error Rate

Conclusion

There are a lot of options system integrators must consider when configuring and purchasing servers and data storage. They must go through all of the possible manufacturer and models within each manufacturer to pick the right solution for their needs. After going through all of the trouble of selecting the proper device with the proper features, they must then select the proper drives. While desktop and nearline drives tend to be less expensive, there are several drawbacks to using them in a server and data storage environments. The drives themselves are not made for constant usage and will age much faster and wear much quicker in the more demanding conditions. Enterprise specific HDDs have higher tolerances, which is a must for a drive that may be potentially running all the time next to several other drives also running. The firmware that comes with the drives is also different being optimized for constant access usage. Enterprise drive firmware is also tuned for RAID and rebuild times.

At the end of the day, the decision on the type of drive to use in anything from a small 2-bay NAS up to rackscale use cases is absolutely critical for data protection and integrity. For small deployments such as home servers, the nearline drive provides enough benefit to the end user that the price delta is minor when compared to the total cost of ownership. In the SMB or enterprise where a rackmount NAS or SAN is in play, the differences are tremendous, using low cost drives is virtually guaranteed to cause problems. At the end of the day, hard drive manufacturers are doing a good job of giving us options based on the intended workload. Enterprise-class drives are clearly superior. Nfina only uses enterprise-class drives in all of our products.

Nfina Technologies is a US based manufacturer of Servers, and Storage products and hyper-converged clusters that combines current high-performance technology with a market leading 5-year warranty & tech support. Nfina provides the best value and lowest TCO in the industry.

We supply products to IT departments with growing compute and storage requirements who need the latest technology in order to maximize their IT infrastructure spending dollars. Every Nfina customer receives personal attention from our staff, because our success is tied to your business.

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