SSD Endurance: The Trend Towards Lower Endurance

When SSDs entered the enterprise storage market in the late 2000s, many of them replaced HDDs. However, customers were often uncomfortable with the wear-out mechanism of flash. With HDDs, customers didn't worry much about the finite life of their storage media. With flash, they had to start thinking about the write profile of their workload, to ensure that the application was not going to wear out the drive before the end of the warranty period. As a result, most customers would choose the highest-endurance media—SLC flash—to ensure they did not have to worry about a premature wear-out. But peace of mind comes with a cost: SLC flash media is not cheap.

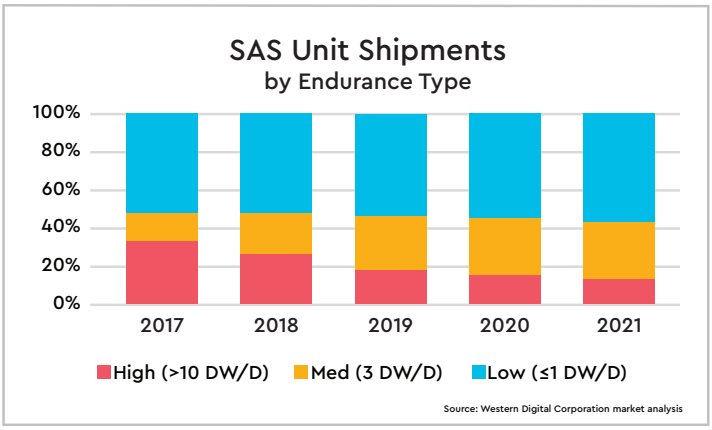

Figure 1. Endurance trends in the SAS SSD Market

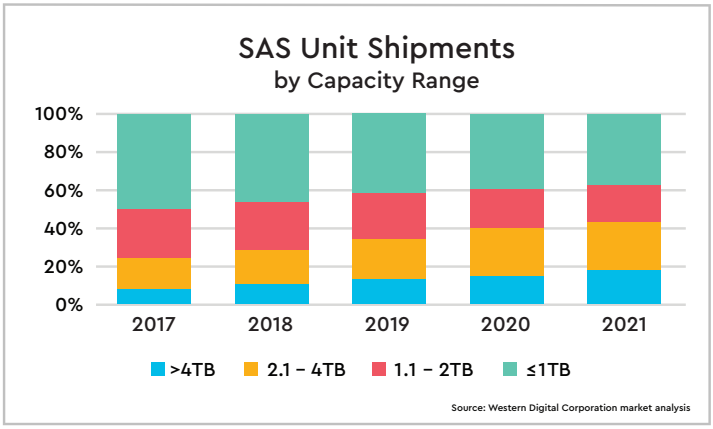

Figure 2. Capacity trends in the SAS SSD Market

As the industry developed, and as the demand for lower-cost devices increased, customers started to use MLC-based SSDs. Still, they were apprehensive about the flash wear-out mechanism and opted for drives with specifications of 10DW/D (Drive Writes Per Day) or even 25DW/D. This made sense at the time, as the sweet spot for capacity points was 100GB and 200GB. Wearing out a drive with such a low capacity was a real possibility.

But times are changing, and the industry is moving towards lower endurance points, across all interfaces (NVMe, SAS and SATA).

SSD Market Trending to Lower Endurance

As flash is used in more applications, customers are continuing to push vendors towards lower- cost MLC drives that come with an even lower endurance spec. In recent years, we have started to see a trend to lower endurance points, with the current sweet spot between 1 and 3 DW/D for enterprise-class SSDs. Figure 1 below shows the trends in the SAS SSD market going towards read-intensive SSDs (1–3 DW/D).

There are two reasons for this trend towards lower-endurance SSDs:

1. *Customers are getting smarter.* Customers realize that their applications are not as write intensive as they originally thought, and hence they are relaxing the endurance requirements for the SSDs they are buying;

2. *The average capacity points are increasing.* When SSDs first entered the market, customers would buy mostly 100GB or 200GB devices due to the high cost of flash. As the cost has lowered over the years, the sweet spot for capacity points has gone up, with a strong trend towards capacity points above 4TB, as shown in Figure 2 above.

Wearing Out High-Capacity Drives is Difficult

High-capacity SSDs are actually quite difficult to wear out, even with demanding applications. Let's assume a fairly write-intensive application that writes 30% of the time with a random write workload (block size of 4KB), at 100% duty cycle. This is probably the worst-case scenario for an SSD, when it comes to wear out.

Furthermore, let's take the two highest endurance points of the Ultrastar DC SS200 SAS SSD (1 and 3 DW/D respectively) as an example in our calculations in Table 1 below. We will assume the application writes at the maximum rate the SSD can handle, which is 37,000 IOPS for the 1 DW/D and 86,000 IOPS for the 3 DW/D device.

As shown in the table, higher-capacity drives are not subject to flash wear-out before the end of the warranty period, even with a heavy write workload at 100% duty cycle. Most applications will use a much lower duty cycle, and this would make Table 1, below, more favorable for lower-capacity SSDs as well.

Capacity	Endurance	Write Performance	SSD Endurance Spec	Application Needs
7.68TB	1 DW/D	37,000 IOPS	7.5 TB/day	3.57 TB/day
3.84TB	1 DW/D	37,000 IOPS	3.75 TB/day	3.57 TB/day
3.2TB	3 DW/D	86,000 IOPS	9.38 TB/day	8.3 TB/day
1.6TB	3 DW/D	86,000 IOPS	4.69 TB/day	8.3 TB/day

Table 1: Ultrastar DC SS200 endurance capability vs application needs

Typical Endurance Needs of Most Popular Applications

Now let's look at some of the most popular data center applications and how they wear out against the Ultrastar DC SS200 SSDs. Again, it is assumed that the applications are writing at maximum write performance to the respective devices, but this time with a 20% duty cycle, which is more common in most data centers.

Figure 3 below shows the minimum capacity needed to ensure that the application can continue writing for the entire 5-year limited warranty period of the Ultrastar DC SS200 SAS SSD.

Conclusion

Over the past decade, the endurance points of SSDs have come down from 45 DW/D to less than 0.5 DW/D in the SATA market. The SAS market has been using 10 DW/D devices in recent years, but that is now changing. As can be seen from the market trend data in Figure 1, endurance points of 1 and 3 DW/D are becoming mainstream in 2017, and that trend should continue. Because customers are getting smarter about their applications, and average SSD capacity points are going up, flash wear-out is becoming less of a concern. Most applications will work fine throughout the 5-year limited warranty period of the SSD, for most capacity points of ~1TB and above (see Figure 3).

With capacity up to 7.68TB and endurance specs of 1 and 3 DW/D, the Ultrastar DC SS200 is the perfect SAS SSD of choice for most applications running in the data center. For more information, visit www.westerndigital.com.

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				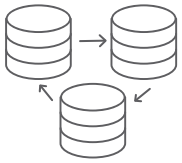	
SS200 1 DW/D	> 960GB	> 1,920GB	> 1,920GB	> 3,840GB	> 3,840GB
SS200 3 DW/D	> 800GB	> 1,600GB	> 1,600GB	> 1,600GB	> 1,600GB

Figure 3: Ultrastar DC SS200 minimum capacity requirements

Source: Workload assumptions @ 20% duty cycle based on Western Digital Corporation internal estimates

This paper contains forward-looking statements that involve risks and uncertainties, including, but not limited to, statements regarding our addressable market, our product and technology positioning and compute platforms, the anticipated benefits of our new technologies, executing on our integrated strategic plans, realizing our strategic imperatives, including our solid-state drive solutions and storage technologies. Forward-looking statements should not be read as a guarantee of future performance or results, and will not necessarily be accurate indications of the times at, or by, which such performance or results will be achieved, if at all. Forward-looking statements are subject to risks and uncertainties that could cause actual performance or results to differ materially from those expressed in or suggested by the forward-looking statements.

Additional key risks and uncertainties include the impact of continued uncertainty and volatility in global economic conditions; actions by competitors; difficulties associated with go-to-market capabilities; business conditions; growth in our markets; and pricing trends and fluctuations in average selling prices. More information about the other risks and uncertainties that could affect our business are listed in our filings with the Securities and Exchange Commission (the "SEC") and available on the SEC's website at www.sec.gov, including our most recently filed periodic report, to which your attention is directed. We do not undertake any obligation to publicly update or revise any forward-looking statement, whether as a result of new information, future developments or otherwise, except as otherwise required by law.

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