



Technology Paper

Evolution to the SATA 6Gb/s Storage Interface

The Progression of the SATA Interface

When parallel SCSI and parallel ATA were developed over 20 years ago, their roles in IT infrastructure were fundamentally distinct: servers needed the speed and reliability of SCSI storage, while economical ATA storage was adequate for desktop use. However, these parallel storage buses became problematic as the demand for faster throughput increased, discouraging further development. By contrast, serial interfaces were growing by leaps and bounds. Simpler, faster and more robust, serial architecture was clearly the wave of the future and serial ATA (SATA) was born.

SATA was designed to replace the older parallel ATA (PATA) interface. SATA and PATA interfaces use the same logical command structures but have different physical (cable, connector and electrical) characteristics. The SATA interface employs the use of two pairs of high-speed conductors compared to 16 low-speed conductors used in the PATA standard.

The SATA 1.0 revision achieved maximum data transfer rates of 1.5Gb/s (gigabits per second) a slight improvement over the existing PATA specification of 133MB/s.

With the release of SATA 2.0, the maximum data transfers doubled to 3Gb/s. In addition, SATA 2.0 introduced a new feature called Native Command Queuing (NCQ). NCQ techniques provide flexibility to the hard drive to change the order in which host commands are executed; if three commands are sent to the hard drive in order A, B, C, the drive can execute these commands in any order, such as B, C, A. This allows a hard drive to improve efficiency and speed by reducing the number of disk rotations needed to achieve a given sequence of host commands. SATA 2.0 with NCQ represented a significant performance improvement in the evolution of the SATA standard.

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SATA 3.0 is the most recent standard, which was officially released on May 27, 2009. Once again, SATA 3.0 doubled the maximum data transfer rate from 3Gb/s to 6Gb/s. In addition, new NCQ commands have been defined to enable isochronous data transfers, primarily intended to improve performance in high-bandwidth applications such as streaming high-definition video. SATA 6Gb/s products have already shown up in the marketplace, with motherboard solutions from the likes of Asus and Gigabyte as well as the first hard drive supporting the SATA 6Gb/s interface, the Seagate® Barracuda® XT drive.

Why Is SATA 6Gb/s Needed Now?

Today, hard drives for PCs don't seem to be pushing the limits of the SATA 3Gb/s interface. The highest-performance desktop drives on the market deliver about 1.5Gb/s in sustained data transfer rates. Add another 0.5Gb/s in command

overhead that is not available for general data transfers, and you still have 1Gb/s of headroom before you bump into the 3Gb/s ceiling. But it won't be long before hard drive technology catches up to the SATA 2.0 standard. Seagate estimates that hard drive transfer rates will exceed 2.5Gb/s by mid-2011. Add in the 0.5Gb/s command overhead, and the SATA 2.0 standard is out of gas. See Figure 1.0.

Since the transition to any new computing standard always involves careful coordination with all impacted players in the ecosystem, it's vital the technology be introduced well before the need becomes critical. In the case of SATA hard drive controllers, device drivers and storage device interfaces began a migration to the 6Gb/s speed in late 2009. This transition to the new, faster standard will likely become mainstream by early 2011.



Figure 1. Sustained Data Transfer Rate Estimates

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Early Adopter Benefits

If hard drives don't yet fill the SATA 3.0 pipe at 6Gb/s speeds, then you may wonder what would be the benefit to adopting the technology now. It's all about cache. Early adopters of SATA 6Gb/s can expect to see performance improvements. Cache-efficient desktop applications such as gaming, graphics design and digital video editing can experience immediate incremental performance using a SATA 6Gb/s interface.

Big Cache + SATA 6Gb/s = Faster

To tap into the 6Gb/s interface speed potential, hard drive vendors are equipping new drives with bigger, faster cache memories. Once data is pre-fetched and stored in cache before actually being requested by the application, there is no delay in retrieving the information from the media. In these cases, the faster transfer rates of SATA 6Gb/s can be exploited. Again, intelligent pre-fetching and caching algorithms are common in applications such as video editing and gaming, where it's easy for the application to predict what data is likely to be needed next.

In comparative performance testing conducted by Seagate, two 500GB/disk, 7200-RPM hard drives were tested under PC Vantage and the new Microsoft Windows 7 operating system. The primary difference between these two drives is cache size (32MB vs. 64MB) and SATA interface speed (3Gb/s vs. 6Gb/s). The results are clear, as shown in Figure 2.

Based on this testing, a clear benefit can be seen with SATA 6Gb/s speeds, especially when coupled with larger caches, with overall performance improvements of 22 percent.

| Drive Description | Serial Number | Music to WMP | App. Loading | Defender | Gaming | Import Picture | Media Center | Video Edit | Vista Startup | HDD Test Suite |
|---|--------------------|--------------|--------------|--------------|--------------|----------------|--------------|--------------|---------------|----------------|
| Barracuda® 7200.12—1TB, 32MB, SATA 3Gb/s | 5VP00TW1 | 8.81 | 5.57 | 22.03 | 14.68 | 53.66 | 92.73 | 38.54 | 18.74 | 4764 |
| Barracuda XT—2TB, 64MB, SATA 6Gb/s | 9WM03W39 | 11.39 | 7.72 | 28.15 | 18.98 | 61.9 | 108.32 | 47.2 | 21.56 | 5823 |
| Performance Delta for Barracuda XT | Change > | 29.3% | 29.6% | 22.2% | 29.3% | 15.4% | 16.8% | 22.5% | 15.0% | 22.2% |

Figure 2. Performance Testing Results

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Raid 0—The Ultimate Performance Booster

For true power junkies, an incremental investment in a duplicate drive configured in a RAID 0 setup can yield dramatic performance improvements. Given that RAID 0 stripes the data across two identical hard drives, effectively doubling the single drive data throughput potential, the faster SATA 6Gb/s bus further amplifies the benefit. Testing on a RAID 0 system was conducted by Marvell, an early supplier of SATA 6Gb/s-enabled chipsets. The Marvell test system equipped with a Seagate Barracuda XT hard drive was able to achieve maximum sustained burst rates of 260MB/s. This is faster than many SSD drives and can be delivered for a substantially lower cost per gigabyte (and in higher capacities) than solid state alternatives.

Conclusion

The computer industry has a well-established history of continued performance enhancements. Many times experts have questioned the need for these newer and faster versions of technology, speculating that they simply weren't needed or could not be effectively utilized by the user community. Without exception, the industry has responded and found new ways to exploit bigger, faster and more efficient enhancements in information technology, resulting in more sophisticated, more valuable and more productive solutions. The march to faster performance within the SATA standard is just another example. While implementation of SATA 6Gb/s will be among early adoptors for the next few months, don't be surprised to see it take hold as a mainstream, high-performance enabler in the very near future.

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