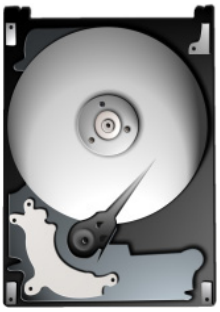
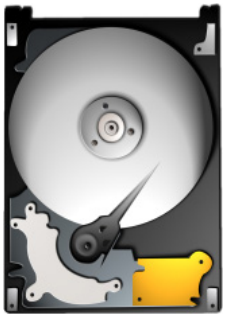
Technology Paper

Seagate Innovation About to Deliver a Windows Vista-Ready Hybrid Drive



Hard Drive



Momentus 5400 PSD

Figure 1. Basic architecture of traditional and hybrid disc drives

Momentus 5400 PSD Combines Nonvolatile Cache and Traditional Hard Drive Storage Technology

Hybrid hard drive technology, pairing a cache of nonvolatile (NV) memory with traditional hard drive technology, offers significant power efficiency, speed and extreme durability benefits, especially for notebook computers and mobile devices. The Microsoft Windows Vista operating system is the first operating system to fully enable the benefits of hybrid technology. Seagate® augments its product portfolio with a Windows Vista-ready hybrid drive, the Momentus 5400 PSD, which will enable consumers to boot almost instantly, load applications quickly, extend battery life and increase the reliability of storage.

Advantages of Hybrid Drive Technology

Hybrid hard drives combine traditional hard drive storage (spinning magnetic platters and read heads) with an NV memory cache within the same disk enclosure (see Figure 1). The presence of the NV cache allows the drive to complete read and write requests without having to perform seek activities or even spin up. The drive can retain or pin a copy of the most performance-critical data in the NV cache, where the copy will reside even during a power interruption. At the same time, a hybrid drive can allocate some of the NV cache space to buffer write requests as the hard drive spindle powers down. When the drive spindle powers up, the cache can refresh or flush the data that it does not need to retain.

Mobile applications—notebook computers, tablet PCs, external storage and portable devices—stand to realize the most immediate gains from hybrid drive technology. The pairing of an NV cache with magnetic hard disk storage yields tangible benefits in three critical areas of storage operations—power efficiency, speed and durability; specifically:

- Reduced power consumption. Reducing platter spin time and having the drive's moving parts at rest whenever they're not needed, hybrid drives take power consumption to a minimum. In mobile applications, that means extended battery life, a significant user advantage.

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- Increased reliability. By the same token, carefully managing and minimizing the activity of a drive's moving parts, hybrid drives prolong the life cycle of drives and the systems they are in. Another distinction to traditional drives: Because the hybrid drive spins less often and parks read/write heads whenever it can, the drive is in a more shock-tolerant state more often, even when it is working. In addition, lowering the duty cycle of the drive's magnetic platters improves field reliability.
- Faster read and write performance. Hybrid drives can use the NV cache to increase the speed of read and write actions of short files. System commands can be executed out of the NV cache. Users can enjoy almost instant application response time.
- Faster boot up and resume. Booting directly from the NV cache, hybrid drives eliminate the delay of three to five seconds that it takes for hard drive platters to spin up and drive heads to synchronize before boot up can begin. When activity resumes after a period of hibernation, data is instantly available from the NV cache, because the drive can commit frequently and most recently accessed data to the NV memory before the system hibernates.

The Microsoft Windows Vista Operating System and Hybrid Drive Technology

The new Microsoft Windows Vista operating system will be the first operating system to take full advantage of hybrid drive technology. At the same time, a hybrid drive is essential for users' ability to experience fully all the performance-enhancing, power-saving, and durability benefits facilitated by Windows Vista.

Windows Vista offers several advanced features for managing hard drives and storage, including enhanced support for new storage devices, such as large drives and optical storage, and wide-ranging performance optimizations. One of the features of Windows Vista, called *Windows ReadyDrive*, aligns the operating system with hybrid drive technology and makes it easy for system builders and their customers to reap the benefits of the new hybrid hard drives.

With Windows Vista, ReadyDrive users do not need to take any special action to manage the hybrid drive—they use their systems the way they always do. Vista automatically detects and manages hybrid drive technology. Vista manages the drive's pinning of data to the NV cache, leaving space to buffer write requests to the hard drive when the spindle powers down. If the size of the NV cache is large enough, system builders and PC manufacturers can determine which programs and file types are to be kept in the NV cache, and Windows ReadyDrive manages the actual process of retaining specific data in the cache. Over time, Windows Vista acquires a memory of the data that is used most often, and stores it in the NV cache, providing users with a continuously improving experience.

To promote the conservative power utilization possible with hybrid drives, Windows Vista implements a special power savings mode when the computer operates on battery power. At that time, Vista proactively powers down the disk spindle and uses the NV cache as much as possible to satisfy read and write requests. In the spun-down state, the hybrid drive's power consumption is between 70 and 90 percent lower, and overall system power draw may decline by as much as 12 percent, depending on system parameters, usage patterns and how much of the time the drive spindle can remain spun down. Users can set the level to which the Windows Vista Power Management system adjusts the hybrid drive for lowest power consumption.

The Seagate Hybrid Drive: Momentus 5400 PSD

Seagate Technology is one of the first technology providers to create a hybrid drive that is fully Windows Vista-ready and that delivers all the advantages of hybrid technology at a low cost per gigabyte. The Seagate Momentus 5400 PSD—consider the PSD a reminder of the drive's showcase strengths in power efficiency, speed and durability—not only provides the enhanced performance, improved reliability and efficient power utilization of hybrid technology, but also introduces additional benefits. The Momentus 5400 PSD manages large and small commands differently to further improve performance. What's more, this drive maintains control of the data on the drive side, strengthening data integrity, and uses a multi-volatile cache to reduce the drive's spin-up cycles.

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Combining SATA and Hybrid Benefits

The Momentus 5400 PSD is a Serial ATA (SATA) drive. That means system builders can count on the Seagate SATA strengths they already know from other Seagate products: excellent throughput performance of 1.5 Gb/s (gigabits per second); high reliability and data integrity with such features as Native Command Queuing; and reasonable cost. Seagate will offer the Momentus 5400 PSD with storage capacities of 80, 120 and 160 GB.

Enhancing the User Experience With Performance and Responsiveness

As a hybrid drive, the Momentus 5400 PSD is a perfect fit for notebook computers and other mobile applications running on Windows Vista, meeting—and in some cases, exceeding—the Microsoft specifications for drive storage under the new operating system. For example, Microsoft specifies a drive read performance of 16 megabytes (MB) per second; Seagate, however, is architecting the Momentus 5400 PSD to perform above that threshold. In addition to consistently fast performance, people can enjoy unprecedented responsiveness of the drive to user-issued commands, providing data and applications immediately from the NV cache. In a system with a fast basic input/output system (BIOS), the Momentus 5400 PSD can deliver data to the user in less than a second.

Ensuring Most Efficient Power Usage

Hybrid drive technology minimizes power usage by letting the drive spindle rest and the drive heads park, whenever possible. However, when the drive powers up again, it consumes more power during spin up than it does during normal operation. Therefore, it is important to balance those high-demand moments at spin up with the lowest possible power consumption at other times. And to accomplish that, the NV cache needs to be of sufficient size, so that it can house enough data for the hard drive to power down for lengthy periods. To begin with, Seagate will offer the Momentus 5400 PSD with an NV cache of 256 MB, double the 128 MB recommended by Microsoft for a system that combines Windows Vista and hybrid drive technology. Following market demand, the drive may become available with a 512-MB NV cache in the future.

Streamlining System Builder Involvement

For system builders and PC manufacturers, working with the Seagate hybrid technology will be much like using any other Seagate drive. If system builders want to use the Momentus 5400 PSD in the notebook computers and other systems they already provide, they will not need to do anything differently in order to profit from hybrid technology.

Seagate will ship the Momentus 5400 PSD in a standard configuration, leaving it to system builders to fine-tune how aggressively they want the drive to conserve power or augment performance in their customers' environments.

Innovating With the Momentus 5400 PSD

However, if system builders are interested in creating new system designs to add to their existing offerings, Seagate can be of assistance in their efforts. As a fee-based service, Seagate Design Centers can help system builders validate system architectures and help shorten the time-to-market for new solutions.

Hybrid technology could prove to be valuable in certain user scenarios even outside of mobile applications. For example, hybrid drives could be used in computers with dual operating systems, with files associated with both operating systems residing in the NV cache, thereby improving the performance of such configurations.

Delivering Files and Applications Instantly

Another possible application could be a computer used as a media center. If a hybrid drive were to be present in a multimedia system, the NV cache could minimize boot up time and deliver requested files and applications quickly. The user experience then could be much more like that of switching on a consumer electronics device. System builders could determine how the Momentus 5400 PSD used its cache in order to deliver that positive user experience consistently.

Why NV Memory and Traditional Storage Should Be Integrated

While Seagate tends to be at the forefront of technological innovation, it is by no means the only technology provider developing hybrid technology that can take advantage of Windows

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Vista. System builders will have a choice between integrated drives, such as the Momentus 5400 PSD, and other technology that separates the hard drive and NV memory.

For the following compelling reasons, Seagate maintains that the combination of NV cache and traditional storage within the same drive housing is preferable:

- When the system saves data, by either caching them to NV memory or writing them to the hard drive, integration of the two storage technologies helps to ensure data integrity and the consistency of write and caching operations. If the two storage components are separated, the likelihood of data corruption is significantly higher.
- System builders can, by using the Momentus 5400 PSD with its SATA interface, simplify system architecture. They don't need to use any additional interface card or motherboard add-on to connect the hybrid drive to the system—the SATA connection is the only one required.
- Windows Vista completely supports hybrid drive technology, and, with the Momentus 5400 PSD, all drivers fully integrate with Windows Vista. System builders do not need to obtain additional, separate drivers for NV memory they might otherwise be sourcing from a separate vendor.

Next Steps

By providing hybrid drives that can take full advantage of the advanced storage management features of Windows Vista, you can differentiate your innovative business and deliver higher value to customers who want to generate optimal results from their operating system upgrade and storage technology. You can get involved with Seagate hybrid technology today:

- Learn more about the Seagate Momentus 5400 PSD at www.seagate.com/products/notebook/momentus5400PSD.html
- Join the Seagate Partner Program to benefit from Seagate expertise and resources: spp.seagate.com

Also visit these Microsoft sites:

- Windows Hardware Developer Central: www.microsoft.com/whdc/default.mspx
- Storage Architecture and Driver Support Overview at Windows Hardware Developer Central: www.microsoft.com/whdc/device/storage/default.mspx
- Microsoft paper on hybrid drive technology: www.microsoft.com/whdc/device/storage/hybrid.mspx

AMERICAS Seagate Technology LLC 920 Disc Drive, Scotts Valley, California 95066, United States, 831-438-6550
ASIA/PACIFIC Seagate Technology International Ltd. 7000 Ang Mo Kio Avenue 5, Singapore 569877, 65-6485-3888
EUROPE, MIDDLE EAST AND AFRICA Seagate Technology SAS 130–136, rue de Silly, 92773, Boulogne-Billancourt Cedex, France 33 1-4186 10 00

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