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Disc Drive Capacity and Performance

Executive Summary

As the size and complexity of operating systems, user applications and data files increase, so does the importance of disc drive capabilities to overall PC system performance and end-user productivity. Two of the most critical considerations in selecting disc drives for a PC system are capacity and performance. Disc drive capacity refers to the size of storage memory available on a disc drive. Disc drive performance describes the speed and efficiency with which data can be written to and read from a drive.

Reacting to the trends for richer and more intensive data storage and use, PC system integrators and designers are increasingly looking to the hard drive as a key component of the overall system performance. And they are increasingly specifying higher-capacity, higher-performance drives to their users so they can more efficiently manage and utilize their data.

Capacity: The Race for Space

A recent study by the University of California at Berkeley estimated that the amount of original digital content creation each year is about 1.6 million terabytes. As a result, there is strong demand for low cost-per-gigabyte storage solutions: high capacity disc drives.

There is no "optimum" storage capacity for a disc drive. Determining storage requirements can be difficult, primarily because each user has unique needs for data storage and access. What is "enough" storage to a casual PC user will be completely different from what is enough for an audiophile storing her CD-based music collections.

In general, however, users find it best to utilize drives with the highest possible capacity. Since storage needs over time invariably increase, and keeping in mind the trends driving data use, it is likely that any user will find greater use for storage capacity over time. Larger-capacity drives also protect users' overall PC investment by allowing room for growth in storage, resulting in less spending for upgrades as they evolve their data use. Smaller drives are more limiting to users as they experience the phenomenon of needing to do more and store more data over time.

As the table below demonstrates, the uses of extra storage space can quickly escalate.

Storage Requirements for Various Applications

Average Storage	Data Type/Use
10 Megabytes	1 minute SDTV quality video clip
700 Megabytes	1 data CD ROM
1 Gigabyte	12 hours of MP3 audio files
2 Gigabytes	62 rolls of low-resolution digital film
2.5 Gigabytes	Installation of Windows XP, Microsoft Office, Quicken, Netscape Navigator
6 Gigabytes	Audiophile digitized music library
12 Gigabytes	6 feature length video movies
100 Gigabytes	1800 digital images, 4 hours digital video, 40 hours MP3 music, 15 games, 25 applications



INTELLIGENCE

Corporate Headquarters
 Scotts Valley, California, USA +1-831-438-6550

Asia/Pacific Headquarters
 Singapore +65-488-7200

Europe, Middle East and Africa Headquarters
 Boulogne-Billancourt, France +33 1-41 86 10 00



The desirability of higher-capacity drives is well known within the PC industry. Computer Source Magazine, for example, says, "Not that many years ago a 20-Gbyte hard drive was seen as the biggest drive you'd ever need. How times have changed...60-Gbyte+ hard drives are a thing of everyday life."

Performance: The Need for Speed

Within the hard disc drive, spindle speed plays the most important role in drive performance. Spindle speed is a measure of how many revolutions per minute the drive's platters can make. The faster the spindle speed, the faster the speed at which bits of data pass under the read/write head of the drive...and the faster data can move to and from the computer.

Intel has found in tests that, on average, PC systems are waiting on disc drives about 30 percent of the time, and that this wait time "dilutes software and system performance." Faster spindle speeds deliver greater productivity by enabling users to more quickly load and use applications and data files.

For mainstream PCs, 7,200 RPM is quickly becoming an industry standard. Again, the improvement in spindle speed delivers significant boosts in the performance of typical applications, as the following chart illustrates.

Disc Drive Performance Comparison

#1) PC with 1 GHz Pentium III, 256 Mbyte RAM, Windows 2000 O/S, ATA/100 Interface

Application Activity	Time at 5,400 RPM	Time at 7,200 RPM	% Improvement at 7,200 RPM
	Seagate® U Series	Seagate Barracuda® ATA IV	
Open 1 Mbyte Microsoft Excel file	3.5 sec.	2.0 sec.	43% faster
Adobe Photoshop Image files	4.8 sec.	3.8 sec.	21% faster
148 Mbyte file copy	31.5 sec.	27.1 sec.	13% faster

#2) PC with 1 GHz Pentium III, 256 Mbyte RAM, Windows 98 O/S, ATA/100 Interface

Application Activity	Time at 5,400 RPM	Time at 7,200 RPM	% Improvement at 7,200 RPM
	Seagate U Series	Seagate Barracuda ATA IV	
Boot-up time	15.4 sec.	11.5 sec.	25% faster
Open 1 Mbyte Microsoft Excel file	5.0 sec.	3.2 sec.	36% faster
Open 2 Mbyte Microsoft Power Point file	4.8 sec.	3.8 sec.	21% faster
148 Mbyte file copy	46.6 sec.	30.0 sec.	35% faster

#3) PC with 866 MHz Pentium III, 128 Mbyte RAM, Windows 98 O/S, ATA/100 Interface

Application Activity	Time at 5,400 RPM	Time at 7,200 RPM	% Improvement at 7,200 RPM
	Seagate U Series	Seagate Barracuda ATA IV	
Boot-up time	15.5 sec.	11.6 sec.	25% faster
Open 1 Mbyte Microsoft Excel file	4.7 sec.	3.2 sec.	32% faster
Adobe Photoshop Image files	3.6 sec.	3.0 sec.	17% faster
148 Mbyte file copy	50.3 sec.	32.5 sec.	35% faster

Clearly, faster spindle speeds make for better system performance and a more satisfactory user experience. In fact, with its latest operating system version, Windows XP, Microsoft has gone so far as to strongly recommend that users employ 7,200-RPM disc drives in order to get the full speed advantage of various features the software delivers, such as PC boot-time. According to Microsoft, "Using a 7,200-RPM hard disc can improve overall boot time dramatically across all (BIOS POST, Pre-logon and Post-logon) phases."

The Hard Drive for Increased System Performance

Technology constantly advances to keep pace with changing user needs. In the disc drive world, this means that user requirements for storage space and speed are pushing increases in drive capacity and performance.

PC users want to do more with their digital content and do it more efficiently. Realizing this, system integrators and PC manufacturers typically specify the fastest CPU clock speed and largest RAM in order to help maximize system performance. Of equal importance, however, is the specification of the highest-capacity and fastest-performing hard disc drives.

The contribution of the storage platform to overall system performance is often under-appreciated. The fact is, just like processor speed and RAM, hard disc drives have a great impact on both PC performance and the end-user experience. Simply stated, the capacity in Gbyte and performance in RPM of the hard disc drives in a PC or desktop system can either hinder or boost user productivity. To a large extent, the hard drive influences how fast operating systems boot, how quickly applications launch and how long the user has to wait for data, graphics or multimedia files to load.

Recognizing the increased importance of disc drive capacity and performance to the end-user experience, Seagate has developed a flexible and broad-ranging set of drive options. Comprising two families, the Barracuda ATA line and the U Series, these drives are specifically designed for today's more demanding PC and consumer electronics applications, operating systems and data.

Seagate PC Desktop Drive Capacity Range and Best-Fit Applications

Model Name	Capacity	Speed
Entry-level PC Applications		
U Series 20410	20 Gbyte	5,400 RPM
U Series 40810	40 Gbyte	5,400 RPM
Mainstream PC Applications		
Barracuda ATA IV	20 Gbyte	7,200 RPM
Barracuda ATA IV	40 Gbyte	7,200 RPM
High-Performance PC Applications		
Barracuda ATA IV	60 Gbyte	7,200 RPM
Barracuda ATA IV	80 Gbyte	7,200 RPM



Market Trends and Applications: Storing and Accessing the Limitless Universe of Data

A number of important trends have created a virtually limitless universe of digital data and an equally insatiable need to store and process content. The following accelerating trends are driving requirements for increased disc drive capacity and performance by everyone from casual home PC users to small businesses and professionals.

Exploding growth of complex multimedia data

Multimedia applications require much larger storage capacity and higher-performance drives in order to play music or view video.

A single song, even in compressed MP3 format, takes up an average of 4 Mbyte of storage space; one symphony in high fidelity sound requires 1 Gbyte. A full audio CD might occupy 600-700 Mbyte on a hard disc drive. Music industry statistics suggest that most music listeners maintain collections of 60 to 100 CDs, with avid listeners assembling collections of 200-400 or more CDs. This alone totals 20 Gbyte of storage—often more than the typical disc drive in use on current PCs—just to maintain a digital music collection; not to mention the additional storage space needed for other applications and data files.

Playback requirements for audio and video often exceed the capabilities of today's installed drives. MP3 music files take up 33 Mbyte/hr of storage, SDTV (Standard Definition Television) uses 1 Gbyte/hr, and HDTV (High Definition Television) uses 4 Gbyte/hr of hard disc drive storage capacity. Added to expanded capacity requirements is the need for higher performance read and write capabilities, so that multimedia reproduction can be free of gaps and freezes, and provide the user the ability to simultaneously record and view multiple audio and video streams.

Larger and more capable operating systems and applications

Today's software advancements enable users to be more productive, but only if the capacity and performance of the disc drive enables them to use the full capabilities of the software.

The latest Microsoft operating system, Windows XP, requires nearly three times the amount of disc drive space as the previous generation. When combined with a basic application suite of Microsoft Office, Quicken and Netscape Navigator, over 2.5 Gbyte of storage space is required. For many users, this alone could take up 10 percent of their total storage space, above and beyond the space they need for storing data files and other applications. As operating systems and applications continue to advance, inadequate disc drive capabilities will require them to spend more time managing the storage of their data, rather than working with it productively.

This increasing complexity of system software and applications also requires higher-performance disc drives in order to at least maintain user productivity. Installation times, boot-up times, and file opening times are improved by up to nearly 30% when moving from a 5,400-RPM model to a 7,200-RPM disc drive.

Vast volumes of Internet file transfers

Networked PCs, whether connected to LANs, enterprise networks or the Internet, are being used like never before to download and store a variety of data-rich files. The proliferation of email and the supernova-like expansion of websites have meant a virtual quantum leap in the amount of information users are storing on the disc drives of their PCs. This is creating a significant need for higher-capacity disc drives.

Users today commonly download or create hundreds of files from networks over the space of even a few weeks, including everything from data rich Microsoft Excel spreadsheets and graphics-intensive PowerPoint presentations, to JPEG images, MP3 downloads and MPEG movies. Making storage room for all of these files requires large-capacity drives, while opening them quickly so they can be worked productively requires high-performance drives.

Ever-increasing system capabilities

Because of the huge new demands to process digital content, system integrators and PC manufacturers are specifying increased PC performance to meet user requirements. Faster CPUs and bus standards make it possible to process all of these new data-intensive applications and files. This, in turn, requires increased disc drive capacity and performance in order to read and write all the data at a speed that matches the rest of the system's capabilities. In today's environment of limitless data, the capability of the hard disc drive component of a PC is a critical element of overall systems performance.

If a given PC's specifications don't include disc drives capable of meeting the rest of the system's ability to process data, user productivity and satisfaction will degrade, causing them to turn to other, more capable systems. Therefore, the speed of reading and writing data to and from the disc drive is accelerating, and the size of disc drive capacity is increasing—all so that the drives can keep pace with other system capabilities and deliver a productive and satisfying experience to the user.

Conclusion

A new world of virtually limitless data is demanding higher-performance PC systems and storage platforms. System integrators and PC manufacturers are meeting this need for greater performance by specifying higher-capacity drives ranging from 40 to 80 Gbyte of storage and higher-performance drives of 7,200-RPM spindle speeds. Seagate has responded to customer needs by offering an extensive family of high-capacity, high-performance drives specifically designed to meet virtually any desktop PC need.