

Why 7200 RPM Mobile Hard Disk Drives?

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1. Introduction

Recently notebook computers have become more popular with commercial users and consumers. With the advancements of increased areal density, there is now more than enough storage capacity to run a full complement of desktop applications on notebooks. One important factor helping to drive the notebook trend is the decreasing price of notebooks. This has been with the help of lower costs for displays, processors, memory and hard disk drives.

The performance and cost gap between notebooks and desktops has continued to narrow, so much so, analysts data shows notebook unit growth rates are now faster than desktop unit growth rates. With the performance gap between notebooks and desktop systems narrowed, commercial users and consumers alike are beginning to use the notebook more as a desktop replacement. From a performance perspective, to achieve desktop like performance, one important parameter that is required to be enhanced is the performance of the disk drive. The best way to achieve that is by increasing the spindle speed.

To use an example of performance trends, the desktop segment today is shifting from 5400 RPM hard disk drives to 7200 RPM drives. Over sixty percent of desktop systems shipping today are shipping with 7200 RPM hard drives and this trend is expected to continue. Primary reasons include the reduction in cost of 7200 RPM drives and improved performance compared to 5400 RPM drives. There is a level of expectation on performance when a desktop user considers replacing or augments his desktop system with a notebook computer. A notebook system with a 7200 RPM drive will further narrow the gap for attaining desktop like performance. This will continue to help drive more demand for notebook systems.

This paper discusses the performance trends of mobile hard disk drives, the factors which have influenced the need for higher performance, and the performance results of 7200 RPM mobile hard disk drives.

2. HDD Performance Trends

From the inception of the hard disk drive, there has been a continual evolution of the hard drive through smaller form factors, and new technologies. This has resulted in continuous design and performance improvements. Hard disk drive performance improvements have resulted from faster data rates, faster seek times, larger cache sizes, higher interface speeds and advances in microcode algorithms.

One of the most important parameters for improving performance is the higher spindle speed, effectively improving the internal data rate and reducing latency.

Early mobile hard drives were designed with average seek times as high as 16 milliseconds and spindle speeds as low as 3600 RPM. Spindle speeds continued to increase over time, with 3800 RPM, 4000 RPM, 4200 RPM and 5400 RPM. Today, two spindle speeds are currently being offered in the mobile segment, 4200 RPM for the mainstream user, and 5400 RPM for the high end power user. Average seek times are now down to 12 milliseconds. Within the next two years, it is expected that 5400 RPM mobile drives will be the mainstream storage for notebooks.

Elements driving the trend for higher performance hard drives are higher system processor speeds, continued advancements in the operating system, higher interface speeds, higher internal bus speeds, and the need to perform system boots faster. These trends are expected to continue, driven by the advances in technology, the need to run applications faster, and to greatly enhance the user experience.

New opportunities for 2.5 inch mobile drives continue to develop. They are currently being used in network devices such as storage hubs and routers, blade servers, small form factor network servers and RAID subsystems. As with any application, performance is an important factor. With the emergence of Serial ATA which provides for higher interface speeds and added interface enhancements such as native command queuing, this provides a powerful argument for the use of 7200 RPM mobile drives for these small form factor applications.

3. Mobile Hard Drive performance

When comparing the performance of 4200RPM mobile hard drives to 5400 RPM drives, by running a series of standard benchmark tests (WinBench99), internal test results have shown improvements of up to 18% with 5400 RPM drives over 4200 RPM drives. This assumes using the same system test platform, same cache size and the same capacity. The contribution of increased spindle speed alone results in a 24% improvement in data rate, and reduced latency by 22%. The increased spindle speed also translates into faster I/O times, as more data can be prefetched into cache for the same finite period of time, resulting in more cache hits.

One cannot improve performance through increased spindle speeds without accepting the tradeoff of increased power consumption, an important parameter when attempting to maximize battery life for notebook computers. This is addressed by effectively utilizing power management techniques.

IBM pioneered a new technology for its mobile drives several generations ago using adaptive battery life extender (A.B.L.E.) This technology effectively monitors the notebook users' usage patterns, and optimizes the power profile for minimum power usage. This technology has been effective on the Hitachi Microdrive and Mobile drives with 4200 RPM and 5400 RPM spindle speeds. This same technology will also be effective on higher performance Hitachi mobile drives with 7200 RPM spindle speeds.

A new technology that has been adopted in Hitachi's 7200 RPM Travelstar drive that will assist in minimizing power usage is the femto slider technology. Current hard disk drives employ the pico slider. The Hitachi 7200 RPM Travelstar drive will be the first mobile product to adopt this latest technology.

The femto slider reduces linear dimensions of the pico slider by 30% and mass by 63%. As a result of this new technology, there is reduced power consumption and improved shock performance.

The improved power consumption as a result of the femto slider and other improvements translates to power metrics of the 7200 RPM platform that has power parity to the Travelstar 5400 RPM platform. This results in no increase

in power consumption normally associated with increases in spindle RPM. The additional benefit of the reduced femto dimensions and mass is the contribution to higher non-operational shock by 25%.

4. Performance Improvements with 7200 RPM

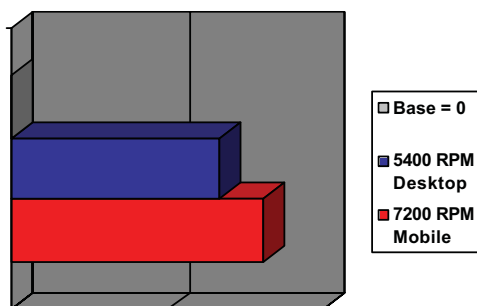
Increasing the spindle speed to 7200 RPM, assuming BPI is held constant, will improve the data rate by 71% over 4200 RPM drives and 33% over 5400 RPM drives. Latency will be improved by 42% and 25% respectively.

Additional areas of improvements on a 7200RPM hard disk drive, such as enhancing pre-fetch, can yield performance improvements over previous generation hard disk drives on the same notebook system.

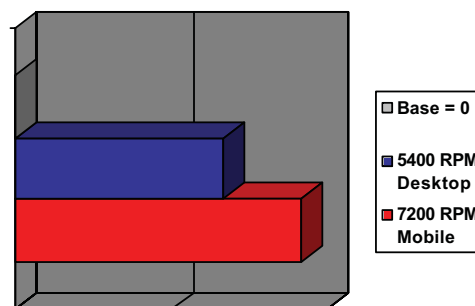
Desktop performance continues to be the performance standard for high performance notebooks. The 7200 RPM mobile hard disk drive now makes it possible to achieve true desktop performance and in many cases exceed performance of some existing desktop platforms.

The composite industry benchmark charts below show performance tests comparing 5400 RPM 2MB cache desktop drives against 7200 RPM 8MB cache Travelstar drives using the same test platform. The results show a range of 20 to 38% improvement over 5400 RPM desktop drives, which clearly demonstrates notebook performance well above expectations for a 5400 RPM desktop platform. In the case of Highend Disk WinMark99, there is a 20% performance advantage, and with Business Disk WinMark99, a 38% improvement.

Winbench 99: High-End WinMark 99



Winbench 99: Business WinMark 99



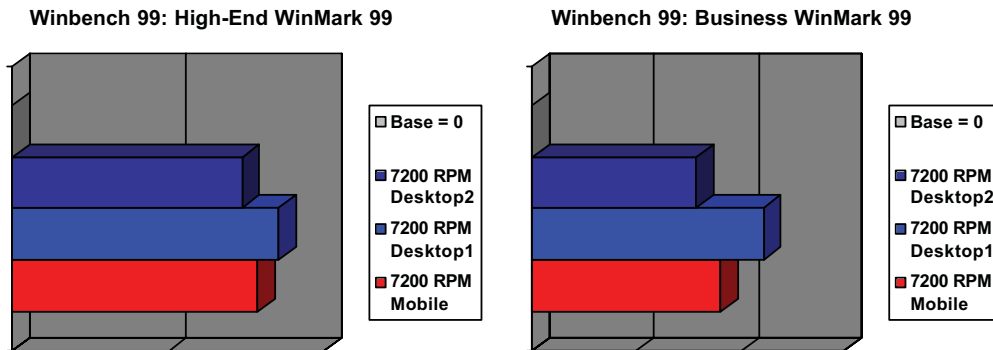
Test Details: WinMark 99 High-End and Business

Windows XP Home, Build 2600 Service Pack 1, v.1050, FAT32 Partition (Average of four runs, two mobile drives, two desktop drives)
Test System Information: Dell Optiplex GX260, Intel(R) Pentium(R) 4 CPU 2.40GHz 2383Mhz, DELL - 6, 510 RAM, 20Kb L1/512KB L2 Cache, Windows XP Home, Build 2600 Service Pack 1, v.1050, FAT32, UDMA, Microsoft Driver

When comparing benchmark performance of Travelstar 7200 RPM, 8MB cache mobile drives to 2MB cache 7200 RPM desktop drives, benchmarks show comparable desktop performance results. In Highend Disk WinMark99, the Travelstar 7200 RPM drives are within 8% of the best performing 7200 RPM drives and 6% better than lower performing 7200 RPM desktop drives. These results validate that the 7200 RPM Travelstar is well within the window of 7200 RPM desktop performance for Highend Disk WinMark 99.

5. Conclusion

The latest generation notebooks with 7200 RPM drives can now offer true desktop performance. With continued improvements in mobile disk drive designs, and the adoption of new technologies such as the femto slider, it is possible to improve the performance of the drive without sacrificing battery life.



Test Details: WinMark 99 High-End and Business

Windows XP Home, Build 2600 Service Pack 1, v.1050, FAT32 Partition (Average of four runs, five mobile drives, four desktop drives) Test System Information: Dell Optiplex GX260, Intel(R) Pentium(R) 4 CPU 2.40GHz 2383Mhz, DELL - 6, 510 RAM, 20Kb L1/512KB L2 Cache, Windows XP Home, Build 2600 Service Pack 1, v.1050, FAT32, UDMA, Microsoft Driver

Business Disk WinMark 99 indicates Travelstar 7200 RPM is within 18% of the best performing 7200 RPM desktop and 13% better than lower performing 7200 RPM desktop drives.. Although the performance range results are wider in these sets of tests, the Travelstar still out performs some 7200 RPM desktop drives. One can continue to conclude Travelstar is within the window of providing 7200 RPM desktop performance.

The introduction of 7200 RPM mobile drives in notebooks is the beginning of a new opportunity for this class of product. As the transition from 4200 RPM to 5400 RPM mobile drives gains momentum, 7200 RPM mobile drives will fill the need created by users who require both desktop performance and mobility. These drives will eventually become a significant storage option for notebook computer users.

6. References

- (1) 1995 Disk/Trend Report—Rigid Disk Drives
- (2) Consultation with Spencer Ng—Hitachi Research
- (3) Consultation with Patricia Wadkins—Hitachi Systems Integration Test Lab
- (4) Performance test data—Hitachi Systems Integration Test Lab

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