

The Hitachi 4GB Microdrive® Disk Drive

Meeting the Average User's Mobile Data Requirements

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Introduction

The mobile market is one of the hottest growth areas in the IT industry today, even in spite of a difficult economy. Notebook PCs are replacing desktops in the enterprise. College students are converting in droves to notebooks rather than using desktops since the college campus has wireless LAN access all over the campus and students can, therefore, get network access in many locations.

“The 4GB Microdrive is the perfect removable storage media that matches the 3.8GB mobile data requirement of the average notebook PC user.”

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Handheld PDAs have passed 20 million users, and digital cameras are poised to pass film camera sales. All of these mobile computing devices need storage,

both internal and removable. Internal storage comes with the mobile device—it's what you get when you turn it on. Removable storage allows users to select the storage they need for the specific application or activity and put that storage unit into the mobile device and then remove it for archive or file transfer. Some of the major trends in the mobile market today are:

Migration from Desktop PCs to Notebooks

Most organizations see the benefit of using a notebook PC and are replacing desktops with notebook PCs. New employees are getting notebooks instead of desktops as well. This provides employees with more flexibility in being able to take their system from one meeting to the next and from work to home and back again.

Implication for mobile storage: Notebooks are portable and use 2.5" internal disk drives. They all have a PCMCIA adapter that can accept PC Cards, CF Cards and even smaller SD cards. Removable storage will be the primary way in which notebook PC users get information into and out of their systems.

Explosion of the Number of Wireless LANs (Wi-Fi) Hotspots

Recently Cometa Networks announced plans to work with IBM and AT&T to develop 25,000+ wireless LAN hotspots. Verizon recently announced plans to convert public phone kiosks in New York City to mini Wi-Fi hotspots. T-Mobile

announced plans to offer Wi-Fi in Starbucks and Wayport announced Wi-Fi available in 75 McDonalds restaurants in the Bay Area. Ten of thousands of people are converting their cable modems and DSL lines in their homes to wireless LAN. Before too long, a network of Wi-Fi hotspots will soon blanket entire metropolitan areas making Wi-Fi truly pervasive.

Implications for mobile storage: notebooks and handhelds that are used in public hotspots and wireless networks and work/home will generate more data. There's a greater need to transfer information from one portable system to another as well using "sneaker net." The more one uses wireless, the greater the need for mobile storage.

Growth of the Handheld PDA Market

Handheld PDAs have grown to an installed base in excess of 20 million units. Although the growth rate of PDAs have slowed over the past year due to the faltering economy, handhelds will continue to grow and eventually will exceed sales of 100 million units a year. Most handheld systems have the ability to add and remove storage, either in the form of solid-state flash or a small 1" Microdrive. The most prevalent slots in handhelds today are Compact Flash (CF) and the smaller SD. CF comes in two thicknesses: CF I at 3.3 mm and CF II at 5 mm. If the user only needs modest amounts of storage, the SD slot and flash storage are adequate, but if the user wants to store substantial amounts of storage (multiple gigabytes), then the CF II slot and Microdrive are the most appropriate.

One of the more exciting areas in handheld computing is the ability to store/playback video using MPEG4 compression. Thus, a typical DVD movie takes 4GB but with MPEG4 compression, the size is reduced to 250MB allowing both movies and other digital video to be stored on a Microdrive and very high end flash cards.

Implications for mobile storage: as the market for handhelds grow, they will be used with more applications including music and digital video. Users will want to carry around more information, from music, to photos to important enterprise information. Growth of handheld PDAs will by its very nature create a bigger need for mobile storage.

Convergence of Handheld PDA and Cell Phone

In recent years, a new class of handheld devices has been created that integrates a PDA and cell phone into a single device. The units can store someone's contacts, appointment calendar, receive/send email and make cell phone

calls with tight integration between the two, e.g. you can select someone in the address book and then dial their phone number with a simple selection.

Implication for mobile storage: converged devices will be used even more than simple PDAs as the user will make phone calls in addition to using the PDA functions. The devices sold today incorporate an SD slot. Users will listen to music, look at family photos, call friends and co-workers and will store lots of information.

Introduction of Tablet Computers

In November 2002, Microsoft and a number of portable systems manufacturers announced the newest portable computer paradigm: the incorporation of pen command and control, as well as the ability to take notes, write emails and highlight documents. This is called the Tablet PC initiative, and most industry experts think that these "pen extensions" in both hardware and software will become more widespread in the coming years, with upwards of 50% or more notebook PCs incorporating pen extensions within five years. Most of the acceptance of the Tablet PC initiative today has been in distinct vertical markets such as home health care, professional services, field engineering and other markets in which a tablet computer is necessary.

The Tablet PC initiative will take a giant leap forward in the Fall of 2003 when Microsoft introduces their newest member of the Office family: OneNote. It is an application designed to assist portable computer users in their creation, storage and retrieval of notes taken in meetings. Most industry analysts believe that this one application will expand the use of tablet PCs more than any other development to date.

Implication for mobile storage: as users begin to use tablet computers to take notes in meetings, they will have a corresponding need for more storage. And, since this information would be extremely critical to the user, it will be important to back up this information regularly using a removable mobile storage device.

Acceptance of Mobile Computing Lifestyle

Ten years ago, it was very unusual to see someone use a notebook PC on an airplane. Today, it's commonplace and accepted as completely normal. Ten years ago, workers could barely connect with their enterprise resources via a telephone, and when it was successful, it was not an enjoyable experience. Today, just about all workers who spend time away from the office can stay connected either at the airport, hotel or from home—and such connectivity is fast at 11M bps using wireless LAN technology. Ten years ago, no one used a handheld system. Today, over 20 million people rely on them to reference contacts, calendars and email when away from the office. Ten years

ago, no one used a digital camera. Today, digital cameras are outselling film cameras and people are sharing digital photos over the internet. Ten years ago, no one had an MP3 player or used MP3 in their handheld. Now, it is commonplace. We have truly created the digital lifestyle where digital media is carried around by tens of millions of people. It won't be too long before digital media will be carried around each day by billions of people.

Today, the mobile lifestyle is a normal way of life for most mobile professionals. They use portable and handheld computers. They connect to the Internet and enterprise resources wherever they go. This can be seen in the following diagram:

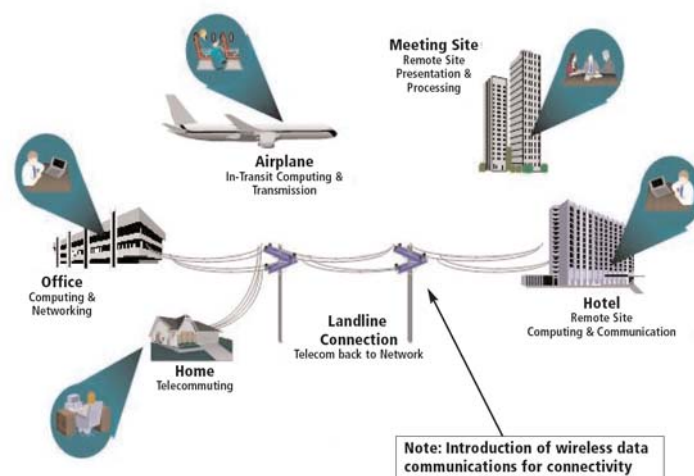


Figure 1. The Mobile Computing Lifestyle

Mobile is going mainstream in our society for the following reasons:

- Increases enterprise effectiveness & productivity—employees are able to be more productive if they can do their mobile computing whenever and wherever they might be.
- Mobile access to email & contact info—wireless email is becoming the "killer application" that's driving a movement toward converged wireless devices.
- Mobile access to enterprise systems—most mobile professionals can easily get access to the enterprise information they need from just about any remote location.
- Shared information among field force—people in the field share information with others in the field. This is becoming a commonplace occurrence that ends up helping support people in particular to find and repair user's problems.
- Digital media (digital photographs, music and video) are a common and accepted part of our culture. It's only going to get more pervasive in the future.

- More up-to-date business processes—with mobile computing, an enterprise is able to modify their business processes to make them more productive. Some of the benefits resulting from developing mobile-centric applications are:

- Faster response times
- Improved order entry/fulfillments
- More “real-time” inventory control
- Just-in-time customer relations
- Increased revenues & profits

Implications for mobile storage: as our mobile lifestyles continue to incorporate more mobile technologies, we'll see an ever increasing need for mobile storage. Someone who may need 500MB today will need 5GB within a few years.

Mobile Market

In spite of the difficult economy that we're currently experiencing (some say the worst since the depression in the early 1930's), mobile and wireless technologies are enjoying growth—into more segments of users, into more geographies and into more places in the enterprise. This is a very fortunate thing to see happening. We suspect that when the economy heats back up that the mobile and wireless sectors will increase even more.

Notebooks are replacing desktops in most organizations. Sales of handheld PDAs and converged PDAs/cell phones are continuing in spite of the economy. You can see the state of the mobile/wireless device market in the following table:

Mobile/ Wireless Device	2000 (millions)	2004 (millions)	GAGR
Notebook PCs	26.0	49.0	17.2%
Handheld PCs	1.0	1.8	15.8%
PDAs	9.4	13.7	9.9%
Vertical Application Devices*	2.1	4.9	23.6%
Smart Phones	0.5	27.6	172.6%
Total	39.0	97.0	25.6%

* Tablet PCs, bar code scanners, portable data collection devices, etc. Source: IDC

Table 1. Size of the Mobile Device market in 2000 and 2004 (IDC)

Mobile storage form factors

Today, there are four important form factors for mobile storage:

- (1) **2.5" hard disk.** This is the form factor used in notebook PCs today. The largest current 2.5" hard disk capacity is 80GB. The transfer rate and average seek time are getting to be as important as overall capacity as much of the time taken by users with their system is loading applications. For example, the new 5400 and 7200 rpm drives are greatly enhancing performance.
- (2) **1.8" hard disk.** For the past few years, this new smaller disk had not seen much traction in the market due to lower capacities when compared with 2.5" drives. Since the typical notebook form factor has enough room to incorporate a 2.5" disk, there's not been any advantage of using a 1.8" disk drive. However, with the recent development of dedicated music players such as the Apple iPod, the 1.8" disk drive is getting more traction in the market. Capacities run about 50-75% of the 2.5" disk, and the drive is thinner, smaller and less weight than a 2.5" drive. We will continue to see the 1.8" disk drive become more important in future years as smaller form factor portable devices come to market that require tens of gigabytes of internal storage.
- (3) **1" Microdrive.** IBM (now Hitachi) introduced the first 1" Microdrive in 1999 with a capacity of 340MB. In 2000, the capacity was increased to 1GB. The Microdrive has seen initial success in high end digital cameras and a number of industrial markets. Now, with the introduction of the 4GB Microdrive, it opens up a much wider market opportunity (as demonstrated below).
- (4) **Flash Storage.** Flash storage uses small integrated circuits in order to enable non-volatile storage. It is used for modest amounts of storage, typically between 32 and 256MB, although higher capacities are available. The price of flash storage is significantly higher per megabyte than hard disks, e.g. the price of a 256MB SD card is \$89 or \$356/GB where as the 4GB Microdrive at launch will be priced at \$499 MSRP. Thus, the 4GB Microdrive will have an average price of \$125 per GB, less than one third the price per megabyte of flash storage. And, high capacity flash (multiple GB's) is very expensive, e.g. 4GB of flash storage today is priced in excess of \$1,000.

Market opportunities for mobile storage

In order to determine the storage requirements for the mobile market, you have to look at the type of information that people keep in their portable and mobile systems, the size of the unit of storage for that type and the total amount of storage that's required for that type.

- **Music**—The most standard file type for digital music is MP3, and it takes about 1MB of storage for each minute of music. Thus, an average 3 minute musical number takes approx 3MB of storage. There's a wide range of minimum to maximum music tunes that people have on their computer.
- **Photos**—Digital cameras are outselling film cameras today and the trend won't stop there. Resolution of digital images has continually increased over the past five years such that all mainstream digital cameras support 3 or 4 megapixels (MP) with high end cameras supporting 8-10MP. The increase in MP is not going to continue because after around 10MP, there's no benefit to the human eye in looking at the digital image, and you can blow up a 10MP photo to be 11"x17" and the image will be the same as an original 35mm film image. Most consumer cameras will level off at 5MP and professional cameras at 10MP. If the image is stored in JPEG format, the image size will be around 1MB for a 5MP image and 2MB for a 10MP image. In the table below, we have taken 1MB as the size of the typical digital photo. Over time, people will accumulate more digital photos but we've assumed that an average user will have 500 digital photos where as a high end user will have 5,000 images.
- **Presentations**—Presentations are typically created in PowerPoint although there are a few other successful presentation graphics programs. We have assumed that a small presentation is 200K or .2MB and a large presentation is 3MB. We've also assumed that the average person would maintain 100 small presentations and 50 large presentations where the power user would maintain considerably more.
- **Word Processing**—Word processing files are most typically generated in MS Word. We have assumed a small Word file to be 20K bytes and a large Word file to be 200K. The average user will have 500 small and 250 large Word files on their system. Again, the power high end user will have more of both.
- **Spreadsheet**—Spreadsheets are maintained in Excel most of the time. We have assumed that the average small Excel file is 50K bytes and 2MB for a large file. The average user will have 250 small and 50 large Excel spreadsheet files on his or her system with correspondingly more files on the system maintained by the power user.

- **Movie**—Movies are just now beginning to be stored on and the hard drive of a portable system. Raw content typically takes 4GB per movie but with MPEG4 compression, the average movie can be reduced to 250MB. We have assumed a modest five movies for the average user and 100 movies for the power user. Digital videos (using MPEG4) are used as mobile entertainment for people traveling.
- **Email**—Outlook currently has 150 million users according to Microsoft and is growing to be the most used application program after MS Word. Most people put the emails they would like to keep for future reference into one or more folders. MS created a special offline file type called the PST file for users to create a folder directory for the emails they want to keep and reference. We have assumed that the average user would have a 200MB PST while the power user would have a 1.5GB PST. The average user would maintain approx. 5,000 emails.

The following table shows a summary of the mobile storage requirements by application for the most typical PC user today as well as for the high end "power user":

Category	Storage Unit (MB)	Total Units		Total Storage (MB)	
		Average	High	Average	High
Music	3.00	500	5,000	1,500	15,000
Digital photo	1.00	500	5,000	500	5,000
PowerPoint (Small)	0.20	100	2,500	20	500
PowerPoint (Large)	3.00	50	500	150	1,500
Word (Small)	0.02	500	10,000	10	200
Word (Large)	0.20	250	2,500	50	500
Excel (Small)	0.05	250	2,500	13	125
Excel (Large)	2.00	50	1,000	100	2,000
Movie (MPEG)	250.00	5	100	1,250	25,000
Outlook (PST) Average	200.00	10	200	0	
Outlook (PST) Large	1,500.00	0	1	0	1,500
Total	2,206	29,101	3,793	51,325	

Note: Estimates are for data, not programs.

Table 2. Requirements for storage for average and high end users

As you can see from the above table, the average user is likely to maintain approximately 2,200 files that correspond to 3.8GB of data. The power user frequently requires two or more gigabytes of storage for a single application. The Hitachi 4GB Microdrive is a breakthrough in small form factor storage for this segment. This information is assumed to be held in a notebook PC. However, within a few years, the same amount of information will be held in a handheld device.

It's important to note that the above estimates are for usage over a 3-5 year period as we tend to accumulate more information over time. For example, we might take 500 digital photos in a year. We would then have 2,500 digital photos in five years. The following diagram demonstrates the above information in a graphical manner:

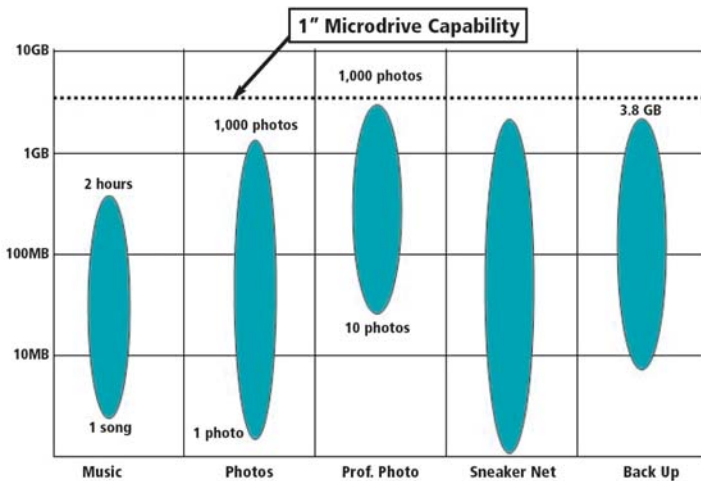


Figure 2. Storage Requirements by Application

As you can see, the new 1" Microdrive with 4GB capacity will support all of the storage requirements for the average user.

In addition to the types of information, there are various processing functions that users often do with removable storage, including:

- **Backup**—This is the most important and least used application on notebook systems. People are basically lazy and don't bother backing up their data. And yet, when they have a loss of data (hard disk crash, theft, etc.), realization that back up is necessary becomes very apparent. It's important to realize that you really only need to back up your data, not your programs as they can easily be re-loaded. But data is original. Therefore, you need to have a back up in case a problem occurs with system.
- **File Transfer**—We often have to transfer files between two computer systems. In the old days, people did this with floppy disks, but they are not being used any longer since they have a capacity of only 1.44MB. This physical transfer became known as "sneaker net" as the person wearing sneakers would take the disk from one system to another. Today, most people just email files to the other person. However, in cases where the information is really large (like 1GB), email is not a viable option. There are a lot flash storage options (including USB DiskOnKey) that provide 64MB to 256MB of storage that can be used to transfer files between systems.

But, when there's a need to transfer a lot of information, either there has to be a shuttle sequence or you can use a Microdrive that has capacities up to 4GB.

- **System Migration**—when people migrate to an upgraded notebook system, one of the more difficult activities is migrating the data from the old system to the new one. This process can require upwards of 1GB or more of information. The best resource to do this is using either a Microdrive or a 1.8" PC Card drive.

As we have seen from this section, the average user has a data requirement that is approx. 3.8GB. Thus, the 4GB Microdrive is an excellent resource for the average computer user to manage, back up and copy files from one system to another.

Hitachi's new mobile 4GB Microdrive

Hitachi has just introduced their new 4GB 1" Microdrive. This is their latest offering in the 1" Microdrive family. As demonstrated above, the 4GB Microdrive is well suited to manage, back up and transfer files from the average user's notebook PC system. It is also a great resource for handheld PDAs and digital cameras that



have a CF Type II slot. A CF Type II device easily is inserted into a PMCMIA card adapter so that the CF device can be used with a notebook computer.

Figure 3. Hitachi Global Storage 1" Microdrive (4GB)

As we migrate into a world of wireless communications, we will have more portable devices in which we use more data. Hitachi's 4GB Microdrive is perfectly positioned to be the best match between user's data requirements and storage resources and relative cost as shown in the following diagram:

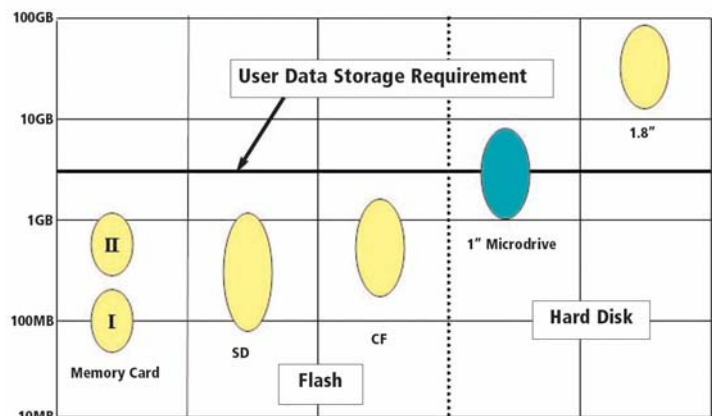


Figure 4. The 4GB Microdrive Meets Most Users' Data Storage Requirements

The Hitachi 4GB Microdrive® Disk Drive

Meeting the Average User's Mobile Data Requirements

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As can be seen in this diagram, flash does not meet the user data storage requirements whereas the 4GB Microdrive does. The 1.8" drive also can meet the user data storage requirement but represents an overkill for these requirements. And, the 1.8" drive cannot be used in digital cameras and handheld PDAs.

Future trends

Since the mobile market is now going mainstream, we'll see an outpouring of new mobile devices, all of which will need significant mobile storage. We'll soon see new mobile phones, PDAs, game devices, personal media players and handheld navigation devices coming to market. The 4GB Microdrive (and its descendents) will provide the storage necessary to allow these future products to meet the associated application requirements.

Final comments

The 1" Microdrive has been in the market for the past four years. This fall, it comes in three capacities: 1GB and 2GB and now 4GB. The older Microdrives have been a success in focused markets such as professional digital cameras and various industrial markets. Now, the introduction of the 4GB Microdrive allows Hitachi to provide a removable storage unit that meets the data requirements for the average user. It is perfectly suited for the digital media market such as digital cameras, camcorders, handheld PDAs and with the notebook adapter in notebook PCS for back up, file transfer and system migration activities.

We recommend that enterprise IT issue a Microdrive to all of their employees who have a notebook PC along with back up software so that each user can back up their most important data on to the Microdrive on a regular basis.

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