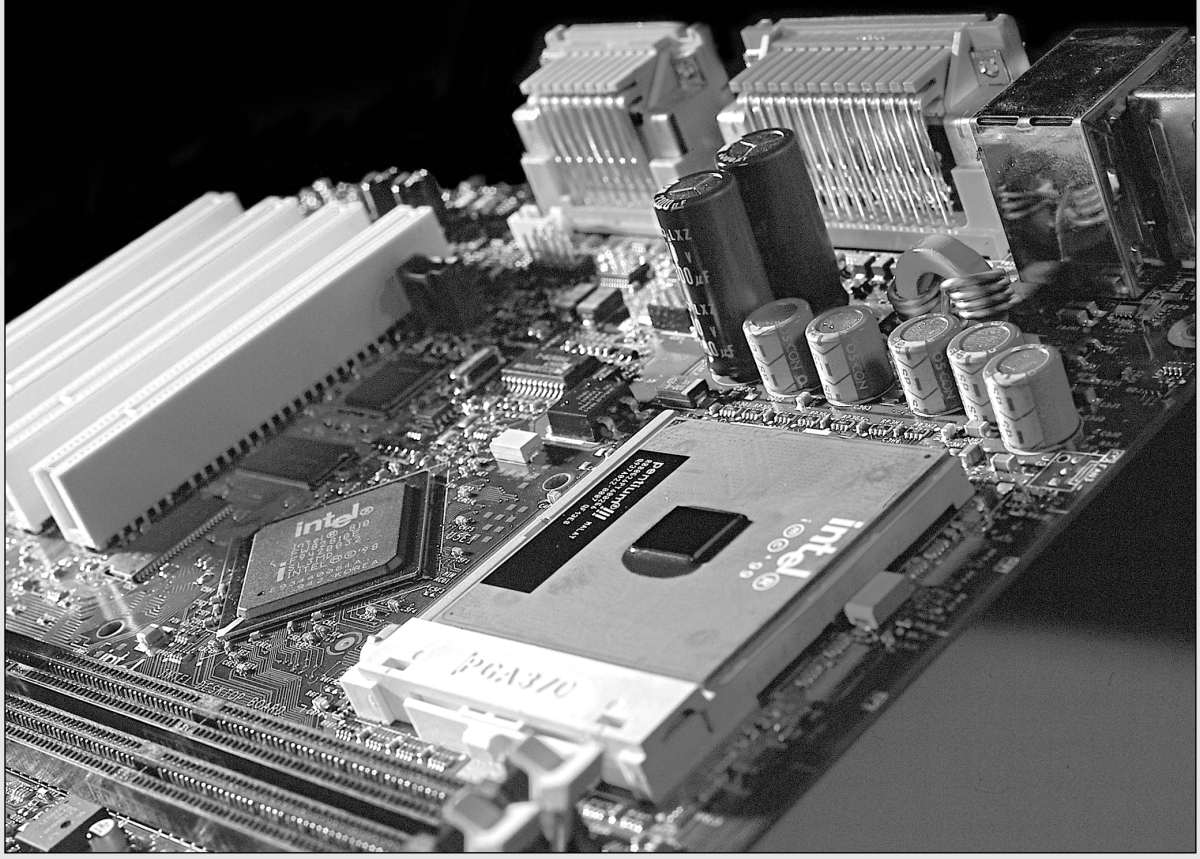
CHAPTER 12

High-Capacity Removable Storage



The Role of Removable-Media Drives

Since the mid-1980s, the primary storage device used by computers has been the hard disk drive. However, for data backup, data transport between computers, and temporary storage, secondary storage devices such as high-capacity removable media drives, floptical drives, magneto-optical drives, flash memory devices, and tape drives are useful supplements to primary storage. Pure optical storage—such as CD-R, CD-RW, DVD-RAM, DVD+RW, DVD-RW, and others—is covered in Chapter 13, "Optical Storage." These types of drives can also be used as a supplement to hard disk storage as well as for primary storage.

The options for purchasing removable devices vary. Some removable-media drives use media as small as a quarter or your index finger, whereas others use larger media up to 5 1/4". Most popular removable-storage drives today have capacities that range from as little as 16MB to as much as 100GB or more. These drives offer fairly speedy performance and the capability to store anything from a few data files or less frequently used programs to complete hard disk images on a removable disk or tape.

The next two sections examine the primary roles of these devices.

Extra Storage

As operating systems and applications continue to grow in size and features, more and more storage space is needed for these programs as well as for the data they create.

Operating systems aren't the only program types that are growing. Applications whose MS-DOS versions once fit on a few floppy disks have now mutated into "everything but the kitchen sink" do-it-all behemoths that can take 500MB or more of disk space. The multimedia revolution—fueled by powerful, low-cost digital cameras, scanners, and video recorders—enables you to capture and store images that easily can consume hundreds of megabytes of space, and the MP3 craze is filling countless gigabytes of storage on individual users' systems with digitized musical hits and classics.

High-capacity removable storage devices provide the capability to easily transport huge data files—computer-aided drawing (CAD) files and graphics files, for example—from one computer to another. Or, you can use removable storage to take sensitive data away from your office so you can lock it safely away from prying eyes. Some types of removable-media storage feature archival durability, whereas others are designed for the "shoot it today, delete it tomorrow" world of digital photography.

Backing Up Your Data

Any computer book worth reading warns repeatedly that you should back up your system regularly. Backups are necessary because at any time a major problem, or even some minor ones, can corrupt the important information and programs stored on your computer's hard disk drive and render this information useless. A wide range of problems can damage the data on your hard drive. Here is a list of some of these data-damaging problems:

- *Sudden fluctuations in the electricity that powers your computer (power spikes), resulting in data damage or corruption.*
- *Overwriting a file by mistake.*
- *Mistakenly formatting your hard disk when you meant to format a floppy.*
- *Hard drive failure resulting in loss of data that has not been backed up.* Not only do you have to install a new drive, but, because you have no backup, you also must reinstall all your software.
- *Catastrophic damage to your computer (storm, flood, lightning strike, fire, theft, and so on).* A single lightning strike near your office or home can destroy the circuitry of your computer, including your hard drive. Theft of your computer, of course, is equally devastating. A recent, complete backup greatly simplifies the process of setting up a replacement computer.

- *Loss of valuable data due to a computer-related virus*. One single download or floppy disk can contain a virus that can damage valuable files and even your entire hard disk. With several hundred new viruses appearing each month, no antivirus software program can keep you entirely safe. A recent backup of uninfected, critical files can help repair even the worst damage.

Backups are also the cure for such common headaches as a full hard drive and the need to transfer data between computers. By backing up data you rarely use and deleting the original data from your hard drive, you free up space once occupied by that data. If you later need a particular data file, you can retrieve that file from your backup. You also can more easily share large amounts of data between computers—when you send data from one city to another, for example—by backing up the data to a tape or other media and sending the media.

Regardless of how important regular backups are, many people avoid making them. A major reason for this lapse is that for many people, backing up their systems is tedious work when they have to use floppy disks or other low-capacity media. When you use these media, you might have to insert and remove many disks to back up all the important programs and data.

Optical storage, high-capacity magnetic media, and tape backups are all useful devices for making backups. Historically, tape backups have been regarded as the most powerful of these technologies because tape backups are among the few backup devices capable of recording the contents of today's multi-gigabyte drives to a single cartridge for restoration.

Comparing Disk, Tape, and Flash Memory Technologies

Several types of removable-media disk drives are commonly used. Traditionally, the most common varieties have used magnetic media, but some use one of two combinations of magnetic and optical storage: floptical or magneto-optical. Magnetic media drives use technology similar to that of a floppy or hard disk drive to encode data for storage. Floptical and magneto-optical media drives encode information on disk by using different combinations of laser and magnetic technologies.

Flash memory devices emulate disk drives and are also discussed in this chapter. Some tape drives are also capable of emulating disk drives by providing drive letter access to a portion of the media but are used primarily to perform streaming backups of large disk drives and network drive arrays.

Magnetic Disk Media

Whether you are looking at "pure" magnetic media, floptical media, or magneto-optical drives, all types of magnetic disk media share similar characteristics. Disk media is more expensive per megabyte or gigabyte than tape, usually has a lower capacity, and is more easily used on a file-by-file basis as compared to tape. Disk media uses random access, which enables you to find, use, modify, or delete any file or group of files on a disk without disturbing the rest of the disk's contents. Disk media is faster for copying a few files but is typically slower for copying large numbers of files or entire drives.

Magnetic Tape Media

Tape media has much less expensive costs overall per megabyte or gigabyte than disk media, has a higher total capacity, and is more easily used on an image or multiple-file basis. Tape drives use sequential access, meaning that the contents of a tape must be read from the beginning and that individual files must be retrieved in the order found on the tape. Also, individual files usually can't be modified on the tape or removed from the tape; the contents of the entire cartridge must be deleted and rewritten. Thus, tape drives are more suited for complete backups of entire hard disks including all applications and data. Because it is suited for mass backup, tape can be difficult to use for copying single files.

Note

Removable-media disk drives can be used as system backup devices similar to tape. However, the higher price of the medium itself (disks or cartridges) and the generally slower speed at which they perform can make this use somewhat prohibitive on a large scale. For file-by-file backups, disk media is ideal; if, however, you're completely backing up entire drives or systems, tape is faster and more economical.

Flash Memory Media

The newest type of removable storage is not magnetically based but uses flash memory—a special type of solid-state memory chip that requires no power to maintain its contents. Flash memory cards can easily be moved from digital cameras to notebook or desktop computers and can even be connected directly to photo printers or self-contained display units. Flash memory can be used to store any type of computer data, but its original primary application was digital photography. However, more and more digital music players have removable flash memory cards, and so-called *thumb* or *keychain* flash memory devices that plug directly into a USB port are helping to make flash memory a mainstream storage medium and an increasingly popular replacement for some types of magnetic removable-media storage.

Tip

Literally dozens of removable storage devices are currently on the market. Be sure to compare your chosen solution against the competition before making a final purchase. Be especially wary of missing statistics in press releases and product packaging—manufacturers are apt to omit a specification if their drives don't measure up to the competition.

Interfaces for Removable Media Drives

In addition to choosing a type of device, you must choose which type of interface is ideally suited for connecting it to your PC. Several connection options are available for the leading removable drives. The most common interface (and one of the fastest) for internally mounted drives is the same AT Attachment (ATA) interface used for most hard drives. SCSI interfacing is as fast or even faster for use with either internal or external drives but requires adding an interface card to most systems. Most high-end tape backups require a SCSI interface.

The most common external interface is now the USB port, which has largely replaced the venerable parallel port for printing as well as for interfacing low-cost external drives and other types of I/O devices. The USB port is available on virtually all recent PCs (both desktop and notebook models); can be hot-swapped; and is supported by Windows 98 and later, including Windows Me, Windows 2000, and Windows XP. For small-capacity (under 300MB) removable-media devices, the performance of USB 1.1 (12Mbps) is adequate, but larger removable-media devices should be connected to the faster USB 2.0 port (480Mbps) or the 400Mbps IEEE-1394a (FireWire/i.Link) port if possible. Most flash memory devices must be connected to a card reader, which usually plugs into a USB port. Older interfaces such as the parallel port and PC Card (for notebook computers) are still used on some devices but have limited performance. These are recommended only for systems that don't support USB (such as those still running Windows 95 or Windows NT). Some external removable-media drives allow you to interchange interfaces to enable a single drive to work with a variety of systems.

Note

Although late versions of Windows 95 ("Win95C" or OSR2.1 and above) also have USB drivers, many developers of USB devices do not support their use with Windows 95. For reliable results and manufacturer support, use Windows 98, Windows Me, Windows 2000, or Windows XP.

As you will see in the following sections, most removable-media drives are available in two or more of these interface types, allowing you to choose the best interface option for your needs.

Note

Connecting or installing removable-media drives is similar to connecting and installing other internal and external peripherals. The external USB, IEEE-1394, or parallel port drives are the simplest of the available interfaces, requiring only a special cable that comes with the drive and installation of special software drivers. See the instructions that come with each drive for the specifics of its installation.

See Chapter 7, "The ATA/IDE Interface"; Chapter 8, "The SCSI Interface"; and Chapter 17, "I/O Interfaces from Serial and Parallel to IEEE-1394 and USB," for details on how these interfaces operate.

Overview of Removable Magnetic Storage Devices

A small group of companies dominates the fading market for magnetic removable-media drives. 3M's spin-off company Imation, Iomega, and Castlewood are the leading names in removable magnetic media drives and media.

Removable magnetic media drives are usually floppy or hard disk based. For example, the popular Zip drive is a 3 1/2" version of the original Bernoulli flexible disk drive made by Iomega. The Imation SuperDisk LS-120 drive is a floppy-based drive that stores 120MB on a disk that looks almost exactly like a 1.44MB floppy; the second-generation LS-240 SuperDisk drives store up to 240MB and can format standard 1.44MB floppy disks to hold 32MB of data! The former SyQuest SparQ, the recently discontinued Iomega Jaz and Peerless, and the Castlewood Orb drives are all based on hard disk technology.

Although they are no longer as popular as they were in the late 1990s, from the standpoint of widespread industry adoption and multiple sources of media, both the Imation LS-120 SuperDisk and Iomega Zip drives can be considered some type of industry standard. Various models can be purchased as upgrades for existing computers, and third-party media vendors such as Maxell, Verbatim, Sony, and Fujifilm sell Zip and SuperDisk media.

Note

Although they can still be found at certain retailers, Imation has discontinued production of its LS-120 SuperDisk drives. It does, however, still make LS-120 and LS-240 media, and other vendors still produce these drives.

The following sections provide information about all types of magnetic media, including floptical and magneto-optical drive types.

Iomega Zip

Unlike the LS-120 SuperDisk, the Iomega Zip drive can't use standard 3 1/2" floppy disks. It is a descendent of a long line of removable-media drives from Iomega that go back to the first Bernoulli cartridge drives released in the early 1980s.

Note

For more information about Iomega Bernoulli drives, see *Upgrading and Repairing PCs, 14th Edition*, available in electronic form on the DVD packaged with this book.

The current form of Bernoulli-technology drive from Iomega is the popular Zip drive. These devices are available in 100MB, 250MB, and 750MB versions with either ATA (internal), USB (external), or FireWire (external) interfaces. They also sell specific external models with either SCSI or parallel port interfaces. In addition, low-power PC Card or internal drive bay versions are available from various aftermarket vendors designed for use in notebook computers.

Zip 100 drives can store up to 100MB of data on a small removable magnetic cartridge that resembles a 3 1/2" floppy disk. The newer Zip 250 drives store up to 250MB of data on the same size cartridge and can read and write to the Zip 100 cartridges. The latest Zip 250 cartridges have a U-shaped case and use media containing titanium particles for greater durability. The most recent Zip drive holds 750MB of data. It's available in separate ATAPI internal versions for PC and Mac and in USB 2.0 and FireWire (IEEE-1394a) versions for use with both platforms. It has read/write compatibility with Zip 250 media, but it has read-only compatibility with Zip 100 media. For best performance, you should use the native media size with Zip 250 and Zip 750 drives; these drives read and write much more slowly when smaller Zip media is used than when their native media size is used.

For more information about Zip drives, see the Technical Reference section of the DVD packaged with this book.

SuperDisk LS-120 and LS-240

Imation developed the LS-120 SuperDisk in the late 1990s as a rival to the Iomega Zip disk. The SuperDisk uses floptical technology, which uses optical tracking to precisely position read-write heads on floppy-type media. Although the SuperDisk is capable of reading and writing to standard 1.44MB and 720KB floppy media as well as to its own 120MB media, it was unable to overcome the huge lead Iomega had gained by being first-to-market with the Zip drives and media in the mid-1990s. Imation and other vendors still sell LS-120 media, but most LS-120 SuperDisk drive products have been discontinued.

The second-generation LS-240 SuperDisk uses both LS-120 and its own 240MB LS-240 media. It can also write to standard 1.44MB and 720KB floppy disks and format a 1.44MB floppy disk to hold 32MB of data. However, similar to its predecessor, it has been unable to make a significant impact in the marketplace. The first LS-240 SuperDisk drives were produced for the OEM market as internal ATAPI drives, but in the U.S. retail market, most have been sold for use with either USB interfaces or the proprietary removable-bay features of some high-end notebook computers. USB-based LS-240 SuperDisk drives have been sold in the U.S. by QPS (`http://www.qps-inc.com`) and Addonics (`http://www.addonics.com`). Several notebook computer vendors, including HP and IBM, also made versions for the interchangeable drive bay featured on some of their notebook computer models. Most of these drives have been discontinued, but some are still available at some dealers.

For more information about SuperDisk technology, see the Technical Reference section of the DVD packaged with this book.

Hard-Disk-Size Removable-Media Drives

The following drives have capacities of 1GB or larger and are fast enough to be considered removable-media hard drives:

- *Iomega Jaz*. Features 1GB and 2GB capacities
- *Castlewood Orb*. Features 2.2GB and 5.7GB capacities
- *Iomega Peerless*. Features 10GB and 20GB capacities

You can install an entire operating system and a major application on these cartridges and boot from them to completely customize your system's operation. Unfortunately, these drives use proprietary designs, so the drives and media are available only from the manufacturer and are not interchangeable with other companies' products. I usually do not recommend proprietary products, preferring instead devices that are more industry standard.

Because of the popularity of external hard drives that interface through USB and IEEE-1394a (FireWire/i.Link) ports and rewritable DVD drives, this category of removable-media drives has also been declining in popularity over the last couple of years. Iomega discontinued Jaz in 2001, and discontinued Peerless in 2002, although it continues to provide media and support for these drives. In

addition, some dealers might still have limited quantities of these drives for sale. Castlewood Orb drives are still sold by Castlewood, even though most retail stores don't carry them.

For more information about Orb, Jaz, and Peerless drives and media, see the Technical Reference section of the DVD packaged with this book.

"Orphan" Removable-Media Drives

Several recent removable-media drives have become "orphans" because of the closing of their manufacturers. Orphan drives include

- SyQuest (all models)
- Avatar Shark

Because orphan drives have very small capacities, limited performance, and limited or no support for current and forthcoming operating systems, I recommend that you transfer all data on orphan drive media to a current removable-media or optical-technology drive. Continuing to depend on an orphan can leave you stranded in the case of a drive or media failure.

If you need support for these drives, see the Technical Reference section of the DVD packaged with this book.

Magneto-Optical Drives

One of the most neglected types of removable-drive technologies is the magneto-optical (MO) drive. Introduced commercially in 1985, magneto-optical drives are now available in capacities exceeding 9GB.

Two sizes of magneto-optical media and drives are available for desktop computers: 3 1/2" and 5 1/4". The 3 1/2" drives have capacities up to 2.3GB, and the 5 1/4" drives have capacities up to 9.1GB. 12" MO drives are also available for enterprise systems. Originally, magneto-optical drives were strictly WORM (write once, read many) drives that produced media that could be added to, but not erased. WORM drives are still available on the market, but for desktop computer users, read/write MO drives are preferable.

Magneto-Optical Technology

At normal temperatures, the magnetic surface of an MO disk is very stable, with archival ratings of up to 30 years.

One surface of an MO disk faces a variable-power laser, whereas the other surface of the disk faces a magnet. Both the laser beam and the magnet are used to change the data on an MO disk. Figure 12.1 illustrates the magneto-optical writing and reading process.

The "optical" portion of an MO drive is the laser beam, which is used at high power during the erasing process to heat the destination area of the MO drive to a temperature of about 200° Celsius (the Curie point, at which a normally magnetic surface ceases to be magnetic). This enables any existing information in that area to be erased by a uniform magnetic field, which doesn't affect the other portions of the disk that are at normal temperature.

Next, the laser beam and magnetic field are used together to write information to the location by applying high power to the laser and applying a controlled magnetic signal to the media to change it to either a binary 0 or 1.

During the read process, the laser is used at low power to send neutrally polarized light to the surface of the MO disk. The areas of the MO disk that store binary 0s reflect light at a polarization angle different from those that store binary 1s. This difference of one degree is called the *Kerr effect*.

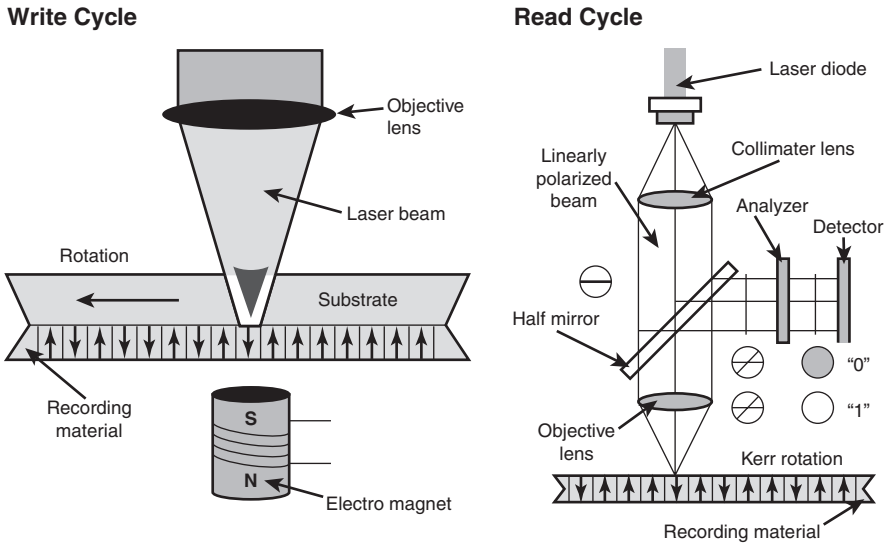


Figure 12.1 Magneto-optical drives use the laser at high power to heat the magnetic surface to enable its contents to be magnetically changed during the write cycle (left) and use the laser at low power to determine the angle of polarization (the Kerr effect) during the read cycle (right).

In older MO drives, the erase and write process involved two separate operations, but most recent MO drives starting with the Plasmon DW260 of 1997 use the LIMDOW method (light intensity modulated direct overwrite) for a single-pass operation with some media types. LIMDOW drives use magnets built into the disk itself, rather than separate magnets as in older MO drives. LIMDOW drives are fast enough to store MPEG-2 streaming video and make achieving higher capacities easier.

MO drives are available from many manufacturers at a variety of price points. The models listed in Table 12.1 are readily available from major computer retailers.

Table 12.1 Typical Magneto-Optical Drives and Media

Size	Example Drive and Interface	Max. Capacity and Other Usable Media	Performance	Approximate Drive Cost	Approximate Media Cost
3 1/2"	Fujitsu DynaMO 1300FE External IEEE-1394	1.3GB; can use 640MB, 540MB, 230MB, and 128MB	5.9MBps maximum with 1/3GB (lower with smaller media)	Around $300	Around $16
5 1/4"	Sony SMO-F551/S Magneto-Optical Drive Internal SCSI	5.2GB; can use 4.8GB, 4.1GB, 2.6GB, and 2.3GB	5.07MBps read, 2.48MBps write (5.2GB media)	Around $1,650	Around $60

Most internal MO drives connect to SCSI interfaces. ATAPI/IDE models are sold by some vendors but aren't as easy to find, and external MO drives are available in SCSI, USB 2.0, and IEEE-1394a interfaces.

Comparing MO to "Pure" Magnetic Media

Compared to most high-capacity removable-media drives, MO drive hardware is more expensive (especially in the 5 1/4" media size), but media costs are far less per MB, durability is far better, and performance is as good or better than the 200MB-or-under class magnetic removable-media drives. The use of SCSI interfaces for most models was a drawback when MS-DOS/Windows 3.1 were the leading operating systems, but Windows 9x/Me/NT/2000/XP have much easier SCSI installation processes, and SCSI interfaces have dropped in price (and are included with some internal drives). IEEE-1394a and USB 2.0 interfaces available on some models allow the easiest installation process of all for external drives. If you can afford the high initial cost of the 5 1/4" media MO drives, you'll have a fairly fast, durable, long-term storage solution that's also a good storage area for works in progress.

Key Factors in Selecting a Removable Drive

When shopping for a removable drive, keep the following in mind:

- *Price per megabyte of storage.* Take the cost of the drive's cartridge or disk and divide it by the storage capacity to see how much you are paying per megabyte of storage. This difference in price becomes quite apparent as you buy more cartridges or disks for the drive. (Don't forget to factor in the cost of the drive itself if you are trying to decide which removable-media drive to buy!) If you plan to use removable storage for temporary data storage only, as with flash memory devices, the cost per megabyte is a less important factor than if you plan to leave data on a cartridge or disk for long periods of time.
- *Access time versus need of access.* The access and data transfer speeds are important only if you need to access the data frequently or quickly. If your primary use is archiving data, a slower drive might be fine. However, if you plan to run programs off the drive, choose a faster drive instead.
- *Compatibility and portability.* Opt for an external SCSI, IEEE-1394a, USB, or parallel port solution if you need to move the drive between various computers. USB is the lowest-cost and friendliest solution because it's built into recent systems and supports hot-swapping. Also verify that drivers are available for each type of machine and operating system you want to use with the drive, and consider whether you need to exchange disks with other users. The Iomega Zip disk and Imation LS-120 SuperDisk drives have become standards for magnetic removable-cartridge media. However, if you don't want the expense of buying a separate drive for each machine, USB keychain storage devices can perform the same tasks and don't need a separate drive for each computer. For some users, this might be the most important factor in choosing a drive.
- *Storage capacity.* For maximum safety and ease of use, the capacity of your storage device should be the largest available that meets your other requirements. Digital camera users, for example, will want the largest possible flash or disk storage supported by their cameras to allow more photos or higher-quality photos to be stored. Desktop and notebook computer users will want the largest drives possible for data backup or program storage.

Note

For many uses, the CD-RW drive is the best choice for two reasons: low media cost (well under $1 each in quantity) and near-universal compatibility (virtually all systems sold since the mid-1990s can read CD-RW media in ordinary CD-ROM drives).

- *Internal versus external.* Most users find external USB drives the easiest to install; additionally, they give you the option of using the drive on several systems. Internal drives are usually faster because of their ATA or SCSI interfaces and are more cleanly integrated into the system from a physical perspective.
- *Bootable or not.* Most systems dating from 1995 or later have a BIOS that supports the Phoenix El Torito standard, which enables them to boot from CD or DVD drives. Most also support the ATAPI/IDE version of the Imation LS-120 SuperDisk as a bootable device; however, those drives are obsolete and difficult to find. Some systems support ATA Zip drives as a bootable drive, but Zip drives are a proprietary format and incompatible with standard 3 1/2" floppy disks.

Flash Memory Devices

Flash memory has been around for several years as a main or an auxiliary storage medium for notebook computers. However, the rise of devices such as digital cameras and MP3 players and the presence of USB ports on practically all recent systems have transformed this technology from a niche product into a mainstream must-have accessory.

How Flash Memory Works

Flash memory is a type of nonvolatile memory that is divided into blocks, rather than bytes as with normal RAM memory modules. Flash memory, which also is used in most recent computers for BIOS chips, is changed by a process known as Fowler-Nordheim tunneling. This process removes the charge from the floating gate associated with each memory cell. Flash memory then must be erased before it can be charged with new data.

The speed, low reprogramming current requirements, and compact size of recent flash memory devices have made flash memory a perfect counterpart for portable devices such as notebook computers and digital cameras, which often refer to flash memory devices as so-called "digital film." Unlike real film, digital film can be erased and reshot. Ultra-compact, USB-based keychain drives that use flash memory are replacing both traditional floppy drives and Zip/SuperDisk drives for transporting data between systems.

Types of Flash Memory Devices

Several types of flash memory devices are in common use today, and it's important to know which ones your digital camera is designed to use. The major types include:

- ATA Flash
- CompactFlash (CF)
- SmartMedia (SM)
- MultiMediaCards (MMC)
- Reduced Size MMC (RS-MMC)
- SecureDigital (SD)
- Memory Stick
- xD-Picture Card
- Thumb or keychain USB devices

Some of these are available in different sizes (Type I/Type II). Table 12.2 shows the various types of solid-state storage used in digital cameras and other devices, listed in order of physical size.

Table 12.2 Different Flash Memory Devices and Physical Sizes

Type	L (mm)	W (mm)	H (mm)	Volume (cc)	Date Introduced
ATA Flash Type II	54.00	85.60	5.00	23.11	Nov. 1992
ATA Flash Type I	54.00	85.60	3.30	15.25	Nov. 1992
CompactFlash (CF) Type II	42.80	36.40	5.00	7.79	Mar. 1998
CompactFlash (CF) Type I	42.80	36.40	3.30	5.14	Oct. 1995
Memory Stick	21.45	50.00	2.80	3.00	Jul. 1998
Secure Digital (SD)	24.00	32.00	2.10	1.61	Aug. 1999

Table 12.2 Continued

Type	L (mm)	W (mm)	H (mm)	Volume (cc)	Date Introduced
SmartMedia (SM)	37.00	45.00	0.76	1.27	Apr. 1996
MultiMediaCard (MMC)	24.00	32.00	1.40	1.08	Nov. 1997
xD-Picture Card (xD)	20.00	25.00	1.70	0.85	Jul. 2002
Reduced Size MMC (RS-MMC)	24.00	18.00	1.40	0.60	Nov. 2002

Note: USB flash drives are not listed because they do not have a standardized form factor.

CompactFlash

CompactFlash was developed by SanDisk Corporation in 1994 and uses ATA architecture to emulate a disk drive; a CompactFlash device attached to a computer has a disk drive letter just like your other drives.

The original size was Type I (3.3mm thick); a newer Type II size (5mm thick) accommodates higher-capacity devices. Both CompactFlash cards are 1.433" wide by 1.685" long, and adapters allow them to be inserted into notebook computer PC Card slots. The CompactFlash Association (`http://www.compactflash.org`) oversees development of the standard.

SmartMedia

Ironically, SmartMedia (originally known as SSFDC for solid state floppy disk card) is the simplest of any flash memory device; SmartMedia cards contain only flash memory on a card without any control circuits. This simplicity means that compatibility with different generations of SmartMedia cards can require manufacturer upgrades of SmartMedia-using devices. The Solid State Floppy Disk Forum (`http://www.ssfdc.or.jp/english`) oversees development of the SmartMedia standard.

MultiMediaCard

The MultiMediaCard (MMC) was co-developed by SanDisk and Infineon Technologies AG (formerly Siemens AG) in November 1997 for use with smart phones, MP3 players, digital cameras, and camcorders. The MMC uses a simple 7-pin serial interface to devices and contains low-voltage flash memory. The MultiMediaCard Association (`www.mmca.org`) was founded in 1998 to promote the MMC standard and aid development of new products. In November 2002, MMCA announced the development of the Reduced Size MultiMedia Card (RS-MMC), which reduces the size of the standard MMC by about 40% and can be adapted for use with standard MMC devices.

SecureDigital

A SecureDigital (SD) storage device is about the same size as MMC (many devices can use both types of flash memory), but it's a more sophisticated product. SD, which was co-developed by Toshiba, Matsushita Electric (Panasonic), and SanDisk in 1999, gets its name from two special features. The first is encrypted storage of data for additional security, meeting current and future Secure Digital Music Initiative (SDMI) standards for portable devices. The second is a mechanical write-protection switch. The SD slot can also be used for adding memory to Palm PDAs. The SDIO standard was created in January 2002 to enable SD slots to be used for small digital cameras and other types of expansion with various brands of PDAs and other devices. The SD Card Association (`http://www.sdcard.org`) was established in 2000 to promote the SD standard and aid the development of new products.

Sony Memory Stick and Memory Stick Pro

Sony, which is heavily involved in both notebook computers and a wide variety of digital cameras and camcorder products, has its own proprietary version of flash memory known as the Sony Memory Stick. These devices feature an erase-protection switch, which prevents accidental erasure of your photographs. Sony has also licensed Memory Stick technology to other companies, such as Lexar Media.

Lexar introduced the enhanced Memory Stick PRO in 2003, with capacities ranging from 256MB up to 1GB. Memory Stick Pro includes MagicGate encryption technology, which enables digital rights management, and Lexar's proprietary high-speed memory controller.

ATA Flash PC Card

Although the PC Card (PCMCIA) form factor is now used for everything from game adapters to modems, from SCSI interfacing to network cards, its original use was computer memory, as the old PCMCIA (Personal Computer Memory Card International Association) acronym indicated.

Unlike normal RAM modules, PC Card memory acts like a disk drive, using the PCMCIA ATA (AT Attachment) standard. PC Cards come in three thicknesses (Type I is 3.3mm, Type II is 5mm, and Type III is 10.5mm), but all are 3.3" long by 2.13" wide. Type I and Type II cards are used for ATA-compliant flash memory and the newest ATA-compliant hard disks. Type III cards are used for older ATA-compliant hard disks; a Type III slot also can be used as two Type II slots.

xD-Picture Card

In July 2002, Olympus and Fujifilm, the major supporters of the SmartMedia flash memory standard for digital cameras, announced the xD-Picture Card as a much smaller, more durable replacement for SmartMedia. In addition to being about one third the size of SmartMedia—making it the smallest flash memory format yet—xD-Picture Card media has a faster controller to enable faster image capture.

Initial capacities range from 16MB up to 128MB, but eventual capacities are expected to reach up to 1GB or above. 16MB and 32MB cards (commonly packaged with cameras) record data at speeds of 1.3MBps, whereas 64MB and larger cards record data at 3MBps. The read speed for all sizes is 5MBps. The media is manufactured for Olympus and Fujifilm by Toshiba, and because xD-Picture media is optimized for the differences in the cameras (Olympus's media supports the panorama mode found in some Olympus xD-Picture cameras, for example), you should use the same brand of camera and media.

USB Keychain Drives

As an alternative to floppy and Zip/SuperDisk-class removable-media drives, USB-based flash memory devices are rapidly becoming the preferred way to move data between systems. The first successful drive of this type—Trek's ThumbDrive—was introduced in 2000 and has spawned many imitators, including many that incorporate a keychain or pocket clip to emphasize their portability.

Unlike other types of flash memory, USB keychain drives don't require a separate card reader; they can be plugged into any USB port or hub. Although a driver is usually required for Windows 98 and Windows 98SE, most USB keychain drives can be read immediately by newer versions of Windows, particularly Windows XP. As with other types of flash memory, USB keychain drives are assigned a drive letter when connected to the computer. Most have capacities ranging from 32MB to 128MB, with some capacities as high as 2GB. However, typical performance is about 1MBps.

Tip

If you have a card reader plugged into a USB hub or port on your computer, you might need to disconnect it before you can attach a USB keychain drive. Use the Windows Safely Remove Hardware icon in the system tray to stop the card reader before you insert the USB keychain drive. After the USB keychain drive has been recognized by the system, you should be able to reattach the card reader.

For additional protection of your data, some USB keychain drives have a mechanical write-protect switch; others include or support password-protected data encryption as an option, and some are capable of being a bootable device (if supported in the BIOS). The Kanguru MicroDrive+ can be upgraded with SD or MMC flash cards for additional capacity.

Figure 12.2 shows the features of a typical USB keychain drive, the NexDisk USB storage device from Jungsoft.

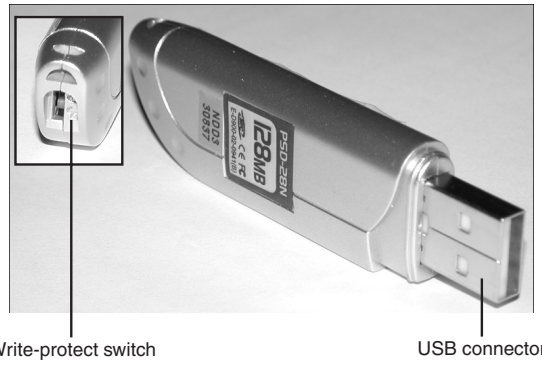


Figure 12.2 The Jungsoft NexDisk USB storage device holds 128MB of data, which can be write-protected to help prevent accidental erasure.

Comparing Flash Memory Devices

As with any storage issue, you must compare each product's features to your needs. You should check the following issues before purchasing flash memory devices:

- *Which flash memory products does your camera or other device support?* Although adapters allow some interchange of the various types of flash memory devices, for best results, you should stick with the flash memory type your device was designed to use.
- *Which capacities does your device support?* Flash memory devices are available in ever-increasing capacities, but not every device can handle the higher-capacity devices. Check the device and flash memory card's Web sites for compatibility information.
- *Are some flash memory devices better than others?* Some manufacturers have added improvements to the basic requirements for the flash memory device. For example, Lexar makes four series of faster-than-normal Compact Flash+ cards (4x, 12x, 16x, and 24x), a series of Write Acceleration Technology (WA) cards for even faster performance with professional digital SLR cameras, and USB-enabled models that can be attached to USB ports for fast data transfer using a simple USB cable rather than an expensive and bulky card reader.

Only the ATA Flash cards can be attached directly to a notebook computer's PC Card slots. All other devices need their own socket or some type of adapter to transfer data. Figure 12.3 shows how the most common types of flash memory cards compare in size to each other and to a penny.

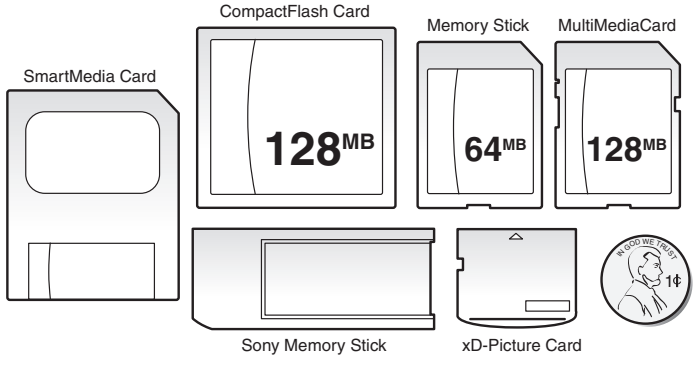


Figure 12.3 SmartMedia, CompactFlash, Memory Stick, MultiMediaCard, SecureDigital, and xD-Picture Card flash memory devices. Some of these formats are not much larger than a U.S. penny (lower right).

Table 12.3 provides an overview of the major types of flash memory devices and their capacities.

Table 12.3 Flash Memory Card Capacities

Device	Minimum Capacity	Maximum Capacity	Notes
CompactFlash+	16MB	4GB	Highest capacity; most flexible format; supported by the best cameras. Lexar Media and SanDisk also make faster versions of CF+ media; Lexar Media also makes USB-enabled CF+ media.
Multi Media Card (MMC)	16MB	128MB	MMC cards can work in most SD sockets.
Secure Digital (SD)	16MB	1GB	SD cards do not work in MMC sockets.
Memory Stick	16MB	128MB	This was developed by Sony and licensed to Lexar Media.
Memory Stick Pro (also known as Memory Stick Magic Gate)	256MB	1GB	This is the enhanced high-speed version of Memory Stick with digital rights management support.
ATA Flash	16MB	2GB	This plugs directly in to a PC Card (PCMCIA) slot without an adapter.
xD-Picture Card	16MB	128MB	Use the same brand as your digital camera for the best results.
USB keychain drive	16MB	2GB	Some include password-protection and write-protect features.

I normally recommend devices (cameras, PDAs, and so on) that use CompactFlash (CF), Secure Digital (SD), or SmartMedia (SM) devices. Any of the others I generally do not recommend due to limitations in capacity, performance, proprietary designs, and higher costs.

CompactFlash is the most widely used format in professional and consumer devices and offers the highest capacity, at the lowest prices, in a reasonably small size. CF cards plug directly into PC Card slots on all laptops by using a simple passive adapter that is extremely inexpensive. Therefore, when you're not using one of those cards in your camera, you can use it as a solid-state hard disk in a laptop. For a long time I would not even consider a camera or other device that did not use CF storage. I have relaxed on that stance a little bit, but it is still by far the best overall format and is available in capacities of up to 4GB or higher. It is also significantly faster than the other formats.

Secure Digital is becoming more popular, is reasonably fast, and is available in capacities up to 256MB. SD sockets also take MultiMediaCard (MMC) cards, which are basically thinner versions of SD. Note that the opposite is not true—MMC sockets do not accept SD cards. MMC is also available in versions up to 128MB. Finally, SmartMedia is a very thin format that has grown in popularity and offers capacities up to 256MB.

In general I would not consider any device that uses other formats, especially Memory Stick, which is a Sony proprietary format (didn't Sony learn anything from the Betamax versus VHS war?). The xD and RS-MMC formats are too new to consider and as such are found in a limited number of devices with very limited capacities. ATA Flash is great, but the cards are physically big, mostly obsolete, and can easily be replaced by a CompactFlash card in a PC Card adapter.

Moving Data in Flash Memory Devices to Your Computer

Several types of devices can be purchased to enable the data on flash memory cards to be moved from digital cameras and other devices to a computer. Although some digital cameras come with an RS-232 serial cable for data downloading, this is a painfully slow method, even for low-end cameras with less than a megapixel (1,000 pixel horizontal width) resolution.

Card Readers

The major companies who produce flash card products sell card readers that can be used to transfer data from proprietary flash memory cards to PCs. These card readers typically plug into the computer's USB ports (some older versions might use the parallel port) for fast access to the data on the card.

In addition to providing fast data transfer, card readers enable the reuse of expensive digital film after the photos are copied from the camera and save camera battery power because the camera is not needed to transfer information. External card readers can be used with any computer with the correct port type and a supported operating system. USB readers, for example, should be used with Windows 98 or above.

Because many computer and electronics device users might have devices that use two or more types of flash memory, many vendors now offer multiformat flash memory card readers, such as the Imation FlashGo! shown in Figure 12.4.

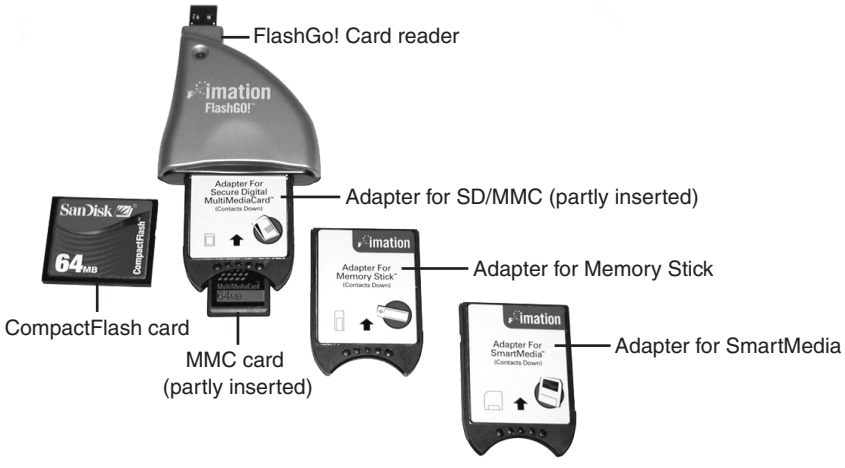


Figure 12.4 The Imation FlashGo! plugs into a USB port and can directly read CompactFlash memory cards. FlashGo! includes adapters for SD/MMC, SmartMedia, and Memory Stick media.

Type II PC Card Adapters

For use in the field, you might prefer to adapt flash memory cards to the Type II PC Card slot. You insert the flash memory into the adapter; then, you slide the adapter into the notebook computer's Type II PC Card slot. Figure 12.5 shows how a CompactFlash card Type II PC Card adapter works. As with card readers, check with the major companies who produce your type of flash memory device for the models available.

Floppy Adapters

If you have a standard 3 1/2" floppy drive connected to a standard floppy controller, you have a third alternative for reading the contents of flash memory cards: SmartDisk (`http://www.smartdisk.com`) makes the FlashPath line of flash memory card adapters that fit in place of a 3 1/2" floppy disk. Separate models are available for SmartMedia, Sony Memory Stick, and CompactFlash cards. As shown in Figure 12.6, the flash memory devices are inserted into the FlashPath adapter. Then, the FlashPath adapter is inserted into a 3 1/2" floppy drive.

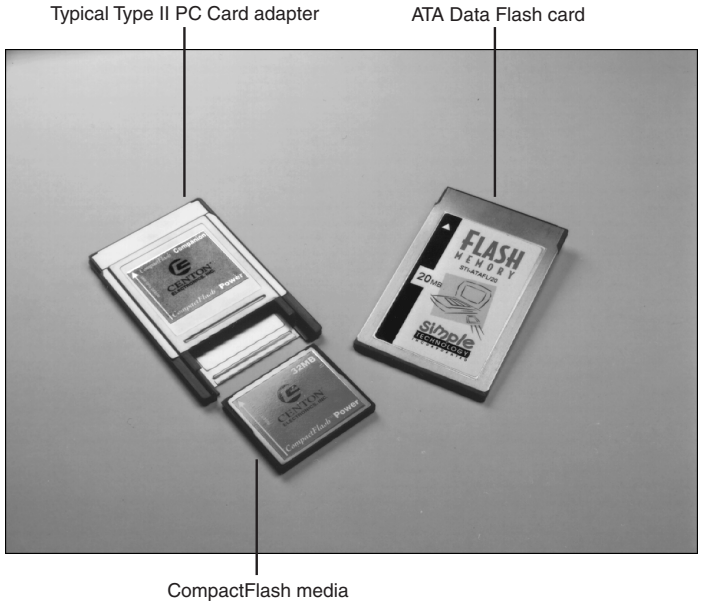


Figure 12.5 A typical Type II PC Card adapter for CompactFlash media (left) compared to an ATA DataFlash card (right).

Figure 12.6 A CompactFlash module is inserted into the FlashPath adapter; the assembly is then inserted into a standard 3 1/2" floppy drive. *Photo courtesy of SanDisk.*

Note that this adapter does not work with the SuperDisk drives found in some computers; it works only with 1.44MB floppy drives.

Microdrive Technology

If you prefer magnetic storage for digital camera data storage, consider the Hitachi Microdrive, originally developed by IBM and now manufactured and sold by Hitachi Global Storage Technologies. The Hitachi Microdrive is also sold by various other companies under OEM agreements.

When first introduced by IBM, the Microdrive was released in a 170MB capacity. Current models, though, have capacities of 340MB, 512MB, 1GB, and 4GB. The 4GB model uses a new five-layer version of the Pixie Dust AFC media technology originally developed by IBM. Microdrives can be used with several digital cameras, many notebook computers, and other devices. The Microdrive is a true hard drive at 1" wide and works in CompactFlash+ Type II slots, enabling it to be a direct replacement for standard CompactFlash memory cards on compatible equipment. The Microdrive is also available as part of a Travel Kit containing a PC Card adapter, and the drive is compatible with many standard CompactFlash card readers. See the `www.hgst.com/` Web site for more information about Microdrive products, a compatibility matrix, and other information. Figure 12.7 shows how Microdrive's mechanism compares in size to a standard U.S. quarter.

Figure 12.7 A U.S. quarter is just slightly smaller than the Hitachi (originally IBM) Microdrive. *Courtesy of International Business Machines Corporation. Unauthorized use not permitted.*

▶▶ Depending on the version of Windows you use and the type of removable-media storage you select, you might see changes in existing drive letters when you install a new removable-media drive or flash memory device into a system. To learn more about these changes and how to control drive letter assignments, see "Removable Drive Letter Assignments," p. 787.

Tape Drives

The data backup and archive needs of a personal computer can be overwhelming. People with large hard drives and numerous applications installed and those who generate a large amount of data might need to back up their computers on a weekly or even a daily basis.

In addition, a critical need on today's PCs is data storage space. Sometimes it seems as though the storage requirements of a PC can never be satisfied. On nearly any PC used for business, study, or

even fun, the amount of software installed can quickly overwhelm even a large hard drive. To save space on the primary storage devices, you can archive infrequently used data to another storage medium. Depending on the method you use for archiving data to secondary storage, you might be able to read the data directly from the device, or you might need to restore the data to the drive before you can access it. If you copy data to the drive with drag-and-drop, the data can be read from the media directly. However, if you use a backup program to create the backup, you will need to use that same program to access the data and restore it to a drive before it can be reused.

Historically, a popular method for backing up full hard disks or modified files has been a tape backup drive. This section focuses on current tape backup drive technologies to help you determine whether this type of storage technology is right for you.

Tape backup drives are the most simple and efficient device for creating a full backup of your hard disk if the tape is large enough. With a tape backup drive installed in your computer, you insert a tape into the drive, start your backup software, and select the drive and files you want to back up. The backup software copies your selected files onto the tape while you attend to other business. Later, when you need to retrieve some or all of the files on the backup tape, you insert the tape in the drive, start your backup program, and select the files you want to restore. The tape backup drive takes care of the rest of the job.

This section examines the various types of tape backup drives on the market, describing the capacities of different drives as well as the system requirements for installation and use of a tape drive. The following topics are covered in this section:

- Hard-disk-based alternatives to tape backup
- Advantages and disadvantages to tape backup
- Common standards for tape backup drives
- Common backup tape capacities
- Newer higher-capacity tape drives
- Common tape drive interfaces
- Portable tape drives
- Tape backup software

Hard-Disk-Based Alternatives to Tape Backup

Before you decide to adopt a tape backup as your backup strategy, keep the following alternatives in mind:

- *External hard drives*. Maxtor, Western Digital, SimpleTech, and others have developed external hard drives with capacities ranging from 20GB up to 200GB. These drives attach through USB 1.1, USB 2.0, or IEEE-1394a ports and can be used for data backup with backup software or drag-and-drop file copying. The Maxtor Personal Storage 5000 family has an exclusive OneTouch feature that starts the file copying process automatically and can be used to launch Dantz Retrospect Express backup software.
- *RAID arrays*. By connecting identical hard disks to a RAID array using RAID 1 data mirroring or RAID 5 data striping with parity, your data is automatically backed up as soon as it is created. RAID arrays were once used strictly for SCSI drives on networks because of their high cost. However, recent developments in high-performance, low-cost, RAID 1-compatible ATA host adapters on motherboards and add-on cards make this another useful backup strategy to consider. RAID 5 arrays generally require a separate host adapter.

▶▶ To learn more about RAID, see "ATA RAID," p. 541.

Disadvantages of Tape Backup Drives

Many computer users who once used tape backups for data backup purposes have turned to other technologies for the following reasons:

- *Creating a tape backup copy of files or of a drive requires the use of a special backup program in almost all cases*. A few tape drives allow drive letter access to at least part of the tape capacity, but this feature is far from universal.

- *Retrieving data from most tape backup drives requires that the data files be restored to the hard disk.* Other types of backup storage can be treated as a drive letter for direct use from the media.
- *Tape backups store and retrieve data sequentially.* The last file backed up can't be accessed until the rest of the tape is read; other types of backup storage use random access, which enables any file on the device to be located and used in mere seconds.
- *Low-cost tape backups using QIC (Quarter Inch Committee), QIC-Wide, or Travan technology once had little problem keeping up with increases in hard disk capacity and once sold for prices comparable to or less than the hard disks they protected.* Today's hard disks have capacities of 20GB–200GB and are far less expensive than most comparably sized tape backups. As a result, more expensive, higher-capacity tape drives are needed to achieve single-cartridge backups.
- *Newer backup and restore techniques, such as drive imaging/ghosting, rival the ease of use of tape backups and permit data restoration with lower-cost optical storage devices such as CD-RW or rewritable DVD drives.* These alternatives are particularly useful if only a few GB of data needs to be backed up on a continuing basis.

For these reasons, the once-unassailable position of a tape backup drive as being the must-have data protection accessory is no longer a secure one; plenty of rivals to tape backups are on the market. However, if you can afford a high-quality DDS or AIT tape drive, you can get a high-performance and high-reliability solution because these same drives are used in the demanding roles of network backup.

Advantages to Tape Backup Drives

Although tape backup drives are no longer the one-size-fits-all panacea for all types of bigger-than-floppy storage problems, they have their place in keeping your data safe. Following are several good reasons for using tape backup drives:

- *Tape backups are a true one-cartridge backup process for individual client PCs, standalone computers, or network servers when high-capacity tape drives and cartridges are used.* Anytime multiple tapes or disks must be used to make a backup, the chances of backup failure increase.
- *If you or your company has made previous backup tapes, you must keep a tape drive to access that data or perform a restore from it.* Tape backup drives are necessary if you need to restore from previously made backup tapes.
- *If you want an easy media rotation method for preserving multiple full-system backups, tape backup drives are a good choice.*

In general, tape drives are used where high capacity and high reliability are paramount. They can be expensive initially but are extremely inexpensive when you factor in the low cost of the media over time.

Common Tape Backup Standards

Tape drives come in a variety of industry-standard as well as some proprietary formats. The following list details several of the available formats:

- *QIC, QIC-Wide, and Travan.* Travan is a development of the QIC and QIC-Wide family of low-cost, entry-level tape backup drives. Travan drives can handle data up to 40GB at 2:1 compression.
- *DAT (Digital Audio Tape).* This is a newer technology than QIC and its offshoots, and it uses Digital Data Storage (DDS) technology to store data up to 40GB at 2:1 compression (DDS-4) and up to 72GB in the new DDS fifth-generation drives. DAT drives are often referred to as DDS drives for this reason.
- *AIT (Advanced Intelligent Tape).* This is becoming the successor to DAT/DDS because it can handle higher capacities than DAT.

- *OnStream's ADR (Advanced Digital Recording) and ADR².* This features a capacity up to 50GB at 2:1 compression and a choice of SCSI, ATA, and popular external interfaces in its 30GB and 50GB (2:1 compression) versions for desktop computers. ADR² has compressed capabilities up to 120GB (2:1 compression).
- *Exabyte (formerly Ecrix)'s VXA-1 and VXA-2 drives.* VXA-1 offers a capacity of 66GB at 2:1 compression and a variety of high-speed SCSI and IEEE-1394 interface options. The VXA-1 format has been approved by the ECMA, an important international organization that establishes standards for information and communication systems. The improved VXA-2 drives have capacities up to 160GB (2:1 compression).

Other tape backup standards, such as DLT (Digital Linear Tape) and 8mm, are used primarily with larger network file servers and are beyond the scope of this book.

QIC and Its Variants (QIC-Wide and Travan)

The first 1/4" tape drive was introduced in 1972 by 3M, and it used a cartridge size of 6"×4"×5/8". This pioneering cartridge established the so-called "DC" data cartridge standard that was used with the first true QIC-standard drive—the 60MB QIC-02, introduced in 1983–1984. The QIC-02-compatible drives were sold for several years and, like many early tape backup drives, used a dedicated host adapter board. QIC-02's small capacity began to be a problem in the mid-1980s, and many other QIC standards were created for larger drives.

The QIC (`http://www.qic.org`) has introduced more than 120 standards over the years in both the older DC and newer minicartridge (MC) forms. This huge number of standards has actually led to a fragmented marketplace that makes it increasingly difficult to determine the backward-compatibility and cross-compatibility factors that QIC, ironically, was established to provide. QIC-Wide technology, developed by Sony, is not an official QIC standard, but QIC-Wide drives can read and write some types of QIC minicartridge media.

This section focuses on the recent and current minicartridge versions of Travan, the latest development of the QIC and QIC-Wide standards.

Note

For more information on QIC and QIC-Wide standards, see Chapter 12 of *Upgrading and Repairing PCs, 11th Edition*, and Chapter 12 of *Upgrading and Repairing PCs, 12th Edition*, found in their entirety on the DVD-ROM accompanying this book.

Travan Cartridge Tape

The successor to both QIC-MC and QIC-Wide drives was created in 1994 by 3M (now Imation). Travan drives maintain backward compatibility with various QIC standards and provide backup capabilities up to 20GB uncompressed and 40GB at 2:1 compression.

The Travan platform features a unique drive/minicartridge interface patented by Imation. The Travan platform fits in a 3 1/2" form factor, enabling easy installation in a variety of systems and enclosures. Travan drives can accept current QIC, QIC-Wide, and Travan minicartridges—a critical need for users, given the installed base of more than 200 million QIC-compatible minicartridges worldwide.

Currently, several levels of Travan cartridges and drives are available, each based on a particular QIC standard. Table 12.4 lists the standard Travan cartridges and capacities. All Travan cartridges use .315" (8mm) wide tape.

Table 12.4 Travan Family Cartridges and Capacities

Travan Cartridge (Previous Name)	Capacity/2:1 Compression	Read/Write Compatible with	Read Compatible with
Travan-1 (TR-1)	400MB/800MB	QIC-80, QW5122	QIC-40
Travan-3 (TR-3)	1.6GB/3.2GB	TR-2, QIC-3020, QIC-3010, QW-3020XLW, QW-3010XLW	QIC-80, QW-5122, TR-1
Travan 8GB (Travan 4/TR-4)	4GB/8GB	Travan 8, QIC-3080, QIC-Wide (3080)	QIC-80, QIC-3010, QIC-Wide (3010), QIC-3020, QIC-Wide (3020), TR-1, TR-3
Travan NS-8[1]	4GB/8GB	TR-4, QIC-3080	QIC-Wide (3080)
Travan NS-20 (Travan TR-5)	10GB/20GB		Travan 8GB, QIC-3095
Travan 40GB (Travan TR-7)	20GB/40GB		Travan NS-20

1. This cartridge can be used in place of the Travan 8GB (TR-4); the same cartridge can be used on either NS8 or TR-4 drives.

Note

Backward compatibility can vary with drive; consult the manufacturer before purchasing any drive to verify backward-compatibility issues.

Most Travan drives on the market today use the Network Series (NS) technology described in the following section.

The Travan NS

Drives that support Travan NS technology are designed to solve two problems that have plagued tape backup users for many years: data compression and data verification.

On QIC-40 and above, QIC-Wide, and standard Travan drives, data compression is performed by the backup software used by the drive. This could cause the following problems:

- Drives might have difficulty reading data if different backup software was used to make the backup and perform the restoration.
- The speed of the computer had a major impact on how fast backups could be performed; a typical backup program (such as Iomega's Ditto Tools) would offer three settings—no compression, compress to save time, and compress to save space—forcing the user to choose between maximum data storage and maximum speed.

On the same drives, backup software supports a verification step that compares the data written to the tape with the data on the drive. Unfortunately, this requires that the tape be rewound to the beginning of the current backup and be read to the end while the hard disk is also read. The result? A backup that took 45 minutes without verification would take more than 90 minutes with verification enabled. This inefficient write-rewind-reread process has discouraged many users from relying on this safer backup method. Also, errors caused by changes in the state of a Windows 9x computer (such as screensavers being enabled or swapfiles changing in size) during the time passage between backup and verify tended to create the erroneous notion that the backup wasn't accurate.

Travan NS–compatible drives (including the Travan 40) use a dual-head design, shown in Figure 12.8, that enables data to be verified as soon as it is written (read-while-write). They also feature hardware data compression, which allows a higher data capacity (up to 40GB at 2:1 compression). The result is faster and more reliable backups. The Travan NS20 and Travan 40 cartridges also use a different metal media formula for greater data density than older Travan drives do.

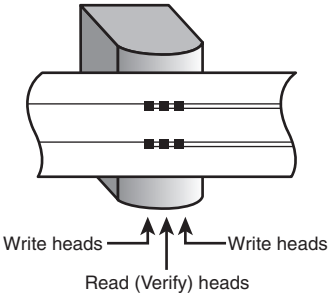


Figure 12.8 Travan NS and Travan 40 tape drives use separate read and write heads to enable data to be verified as soon as it is written, saving the time-consuming rewind and verify operation used with QIC, QIC-Wide, and earlier Travan drives.

Currently, Travan NS20 and Travan 40–based drives are sold primarily by Seagate Removable Storage Solutions LLC (Seagate RSS).

Proprietary Versions of Travan Technology

Ironically, because Travan technology was designed to bring an end to the QIC MC—QIC-Wide tape "wars," some drives use proprietary versions of the Travan standard. Nonstandard sizes include

- 5GB Tecmar/Iomega DittoMax[1]
- 5GB HP/Colorado
- 6.6GB AIWA Bolt[2]
- 7GB Tecmar/Iomega DittoMax[1]
- 10GB Tecmar DittoMax[1]
- 14GB HP/Colorado

1. *Iomega sold the Ditto and DittoMax backup product line to Tecmar, which went out of business in 2002. Although media is still available for these drives from Imation, they are orphans without technical support and should be replaced.*
2. *AIWA Computer Systems Division was shut down in October 1999. These are orphan drives that should be replaced.*

The drive manufacturer is the principal supplier of media for some of these drives, whereas others are also supported with third-party media. Consult the drive manufacturers' Web sites for details.

OnStream ADR Technology

Introduced in 1999, OnStream's ADR (advanced digital recording) technology tape drives are designed to answer many of the limitations of and complaints users have had about traditional tape backup solutions.

OnStream was founded in February 1998, as a spin-off from Philips Electronics. Its CEO, William T. Beierwaltes, had previously founded low-cost backup leader Colorado Memory Systems (now the HP/Colorado division of Hewlett-Packard).

Although the future of OnStream was uncertain after the liquidation of OnStream's U.S. operations (OnStream, Inc.) in March 2001, a new company—OnStream Data B.V.—based in the Netherlands immediately took over sales, support, and development of OnStream drives and technology. The U.S. operations of the new OnStream Data company are located in Austin, Texas. OnStream-compatible ADR tape cartridges are available from Verbatim in both 30GB and 50GB capacities, as well as from OnStream Data. ADR² tape cartridges for 60GB–120GB (compressed) ADR² drives are sold exclusively by OnStream Data.

◀◀ See "Disadvantages of Tape Backup Drives," p. 680.

Features of ADR and ADR²

ADR uses a multiple-track linear recording system that reads and writes eight tracks at once, enabling read-while-write verify for speed and reliability and a relatively low tape travel speed to minimize wear (and noise!). ADR also uses several other techniques to foster additional reliability:

- Embedded servo information keeps the read/write heads aligned with the tracks at all times.
- ECC (error correction code) recording applied over all eight tracks (spatially distributed) allows reliable data recovery even if an entire track is destroyed.
- Continuously variable tape travel speeds enable the drive to adjust to the different speeds of data flow from the hard drive without slowing down the entire tape backup process; as the data transfer rate increases, the drive runs faster, and the drive slows down as the data transfer rate decreases.
- Single-pass media defect mapping allows reliable recording without rewinding the tape for a separate verify pass.

The second-generation ADR² adds the following features:

- Half the track width, allowing twice the data on the same length of tape
- Enhanced servo system
- Reinforced actuator mounting plate (RAM plate) mounting for head assembly on high-speed SCSI drives for improved read/write performance and accuracy
- Adaptive temperature compensation (ATC) to improve recording quality
- Mid-load point tape positioning to cut access times in half

User Benefits of ADR

Several benefits to ADR are as follows:

- *ADR drives can be treated as a drive letter when used with the included Echo software.* This includes drag-and-drop file transfer and direct use of the tape's contents without a restore step (including viewing full-motion video and listening to MP3s).
- *Quiet backups.* These result from the multiple-track recording feature and variable-speed motor.
- *Background "set it and forget it" backup operation at reduced speed or fast dedicated backup of large hard drives in just an hour or two.*
- *Low cost per MB for both drives and media.*
- *Reliable data backup and online storage in a single device.* The claimed reliability for ADR technology media exceeds the reliability of both other tape backup systems and hard drives.

ADR and ADR² Technical Specifications

Table 12.5 lists the technical specifications for OnStream's line of ADR drives, available in ATA, various flavors of SCSI, parallel, and USB interfaces. Drives for Macintosh only and drives bundled with third-party backup programs are also available but are not listed. All drives listed are supplied with OnStream's Echo software. Table 12.6 lists the technical specifications for ADR² drives, available in ATA, SCSI, and USB 2.0. ADR² drives are packaged with Yosemite TapeWare XE software.

Media retail is $40 for the 30GB ADR cartridge in a single pack and $60 for the 50GB ADR cartridge in a single pack. ADR² media retails for about $65 for the 60GB cartridge and about $95 for the 120GB cartridge. Multiple-cartridge packs are available at a reduced price. All capacities listed for media and drives assume a 2:1 compression ratio.

OnStream is the only producer of ADR drives at this writing. The ADR recording process is illustrated in Figure 12.9 (as compared to the DAT helical recording process).

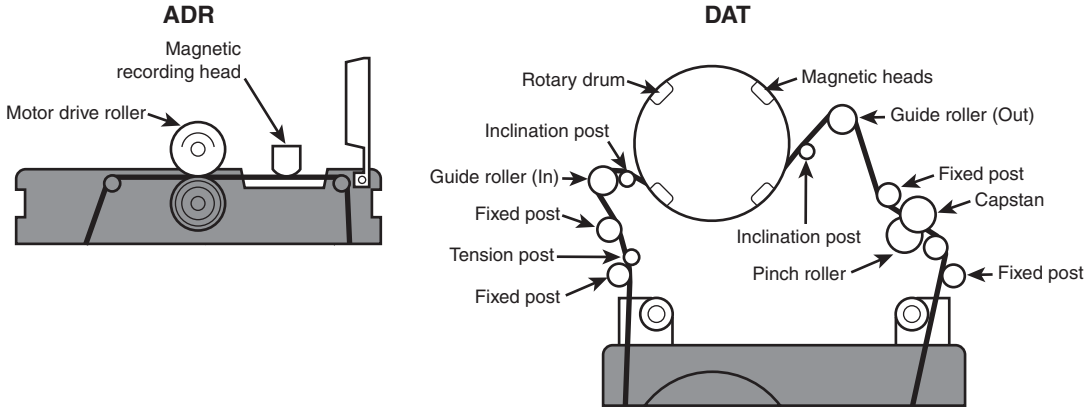


Figure 12.9 ADR-series drives use a multitrack linear recording mechanism (left), whereas DAT drives use a helical scan recording head that resembles the mechanism in a VCR (right). Both methods greatly increase data density compared to QIC-family drives, but helical scan recording exposes more of the tape to potential contamination.

Table 12.5 OnStream ADR Family Specifications for Windows PCs

Drive Model	Interface	Performance	Retail	Media Used
DI30	ATAPI	1–2MBps	$299	ADR 30GB
DP30	Parallel	.7–1.4MBps	$399	ADR 30GB
USB30	USB	.85–1.7MBps	$399	ADR 30GB
SC30	SCSI internal	2–4MBps	$499	ADR 30GB
SC30	SCSI external	2–4MBps	$599	ADR 30GB
SC50	SCSI internal	2–4MBps	$699	ADR 50GB or 30GB
ADR50 Int	LVD SCSI internal	4–8MBps	$799	ADR 50GB or 30GB
ADR50 Ext	LVD SCSI external	4–8MBps	$949	ADR 50GB or 30GB

OnStream Data also makes an external IEEE-1394 version of its 30GB (2:1 compression) drive but offers it only for the Macintosh platform.

Table 12.6 OnStream ADR² Family Specifications for Windows PCs

Drive Model	Interface	Performance	Retail	Media Used
ADR2.60IDE	ATAPI	2.5–5MBps	$500	ADR² 60GB
ADR2.60usb	USB 2.0	2.5–5MBps	$729	ADR² 60GB
ADR2.60si	SCSI WideUltra2 int.	4–8MBps	$749	ADR² 60GB
ADR2.60se	SCSI WideUltra2 ext.	4–8MBps	$889	ADR² 60GB
ADR2.120si	SCSI WideUltra2 int.	4–8MBps	$999	ADR² 120GB,60GB
ADR2.120se	SCSI WideUltra2 ext.	4–8MBps	$1,149	ADR² 120GB,60GB
ADR2.240sr*	SCSI WideUltra2 rackmt.	8–16MBps	$1,799	ADR² 120GB,60GB

**This model contains two 120GB ADR2.60 tape drives.*

DAT/DDS, AIT, and Other High-Capacity Tape Drive Standards

Although Travan capacities have now reached 40GB compressed, users of today's high-capacity hard drives must turn to larger tape backup standards. In addition to the OnStream ADR, the same tape backup standards long supported by workstation and large network servers can also be used with today's versions of Windows for both individual desktop computers and small network servers. Additionally, new high-capacity technologies are available to support today's larger drives.

4mm digital audio tape (DAT/DSS), 8mm videotape, 8mm AIT, digital linear tape, scalable linear recording (SLR), and Ecrix VXA are the major choices available for users who need higher-capacity backups. An emerging choice for very high-capacity (100GB and up) drives is the Ultrium version of the LTO Technology standard. All these technologies are available in autoloading tape libraries suitable for large networks, as well as single-cartridge drives intended for small network servers or desktop use.

Proprietary Versus Open Standards

If you want a wider variety of choices in drives, media, and pricing, you might prefer to purchase a high-performance drive type that is made by several companies. However, some of the most advanced technologies are controlled by a single vendor.

Drive technologies available from multiple vendors include

- *DAT/DDS.* Introduced and licensed by Sony to numerous manufacturers. Fifth-generation DDS drives are sold by HP and Seagate RSS.
- *AIT.* Introduced and licensed by Sony to numerous manufacturers.
- *DLT.* Originally developed by Digital Equipment Corporation, but was purchased by Quantum in 1994.
- *LTO (Linear Tape-Open).* Developed by HP, IBM, and Seagate RSS.

The following drive technologies are sold by a single vendor:

- *SLR.* Tandberg Data
- *VXA.* Exabyte-Ecrix

However, third-party vendors might sell tape cartridges compatible with even so-called "proprietary" standards.

DAT/DDS Tape Drives

Of the many high-performance tape drives on the market, this author's longtime favorite has been the DAT/DDS tape drive family because of its combination of performance, capacity, reliability, and reasonable price. Four levels of DAT/DDS drive capacity are available:

- *DDS-1.* This entry-level member of the family (2GB native/4GB at 2:1 compression) is now obsolete.
- *DDS-2.* Has the same capacity as drives based on Travan NS8 (4GB native/8GB at 2:1 compression).
- *DDS-3.* Has a slightly larger capacity (12GB native/24GB at 2:1 compression) than Travan NS20.
- *DDS-4.* Has a 20GB native/40GB at 2:1 compression capacity, which is double the capacity of Travan NS20 and equal to Travan 40GB.
- *DDS Fifth Generation.* The newest member of the DAT/DDS family, it has a 36GB native/72GB at 2:1 compression capacity.

Even though DAT/DDS drives are more expensive than Travan drives with similar capacities, the media cost is much lower because of the drive's design. For example, you will pay about three times as much for a Travan NS20 cartridge as for a slightly higher-capacity DDS-3 cartridge. A DDS-4 cartridge, which offers double the capacity of Travan NS20, still sells for about 30% less. DDS drives are more reliable than Travan or earlier QIC-based drives, which is a vital consideration because the most important reason to use a tape backup is to perform a restore. The enhanced reliability of DDS drives is aided by the inclusion of automatic head-cleaning features built into most DDS drives and media.

After Sony announced in April 2001 that DDS-4 tape drives would be the end of the DAT/DDS lineup of drives, the future of DAT/DDS tapes was uncertain. However, in January 2003, HP and Seagate RSS announced the development of a fifth generation of DDS drives with higher capacity and backward read/write compatibility. This new format nearly doubles the capacity of DDS-4 and adds several improvements in reliability as well.

Helical Scan Recording on DAT, 8mm, and AIT Drives

Exabyte 8mm, Sony DAT/DDS, and Sony AIT use helical scan recording. The read/write heads used in helical scan recording are mounted on a drum and write data at a slight angle to the tape, using a mechanism highly reminiscent of that in a VCR (refer to Figure 12.9). The entire surface of the tape is used to store data, enabling more data to be placed in a given length of tape than with the linear recording techniques used by the QIC family of drives.

AIT Unique Features

Sony's AIT has several unique features designed to make backup and restoration faster and more reliable. An optional Memory In Cassette (MIC) chip allows the cartridge to remember which of the 256 on-tape partitions were used for the data you want to restore, so the correct starting point can be located in seconds. AIT drives also have a servo tracking system called Auto Tracking Following (ATF), which is used for accurate data-track writing, and Advanced Lossless Data Compression (ALDC), a mainframe-style compression method that can compress data to a greater extent than other methods. The drives have several other features, including built-in head cleaning that is activated when soft (correctable) errors reach a preset limit, metal-evaporated tape media that avoids head contamination, and a 3 1/2" form factor.

DLT Unique Features

DLT segments the tape into parallel horizontal tracks and records data by streaming the tape across a single stationary head at 100"–150" per second during read/write operations. This is a dramatic contrast to traditional helical-scan technology, in which the data is recorded in diagonal stripes with a rotating drumhead while a much slower tape motor draws the media past the recording head.

The result is a very durable drive and a robust medium. DLT drive heads have a minimum life expectancy of 15,000 hours under worst-case temperature and humidity conditions, and the tapes have a life expectancy of 500,000 passes.

SLR Unique Features

Tandberg's SLR drives use a linear recording method; the tape used by the SLR 40, SLR 60, and SLR 100 is divided into 192 tracks. Twenty-four prewritten servo tracks are used to adjust the position of the read/write head as necessary. This feature is designed to ensure compatibility of SLR tapes between drives, enabling a tape written by one drive unit to be readable by another unit. Six tracks are written at the same time. The entry-level SLR7 uses a simplified recording method that uses two tracks. Both tape types have fault-tolerance features that enable the drive to switch to another track for data recording if the original track fails. SLR media is available from most major tape vendors.

Exabyte VXA Unique Features

The Exabyte VXA drives (originally developed by Ecrix, which merged with Exabyte in November 2001) combine special recording and playback methods. The recording method used somewhat resembles a normal helical scan, but the tape is guided past the magnetic drum with a completely different type of mechanism and the data is recorded at variable speeds that change according to how fast the host can transmit data. This eliminates the need to wind tape backward because of data underruns (back-hitching). Data is recorded in 64-byte groups of 387 data packets rather than in linear blocks. VXA drives use a special read feature called overscan operation (OSO). OSO performs redundant reads of each group of data packets, enabling data to be retrievable even from damaged tapes. The packetizing of data works the same way as on the Internet: Data can be read in any order and reassembled into its original form when all packets are received. In tests, Exabyte and Ecrix have boiled, frozen, and even poured hot coffee over VXA tapes and been able to retrieve 100% of the stored data.

LTO Technology Unique Features

Linear Tape-Open, better known as LTO, is a very high-performance tape backup technology that offers two distinct types of mechanisms:

- *Ultrium*. This implementation of LTO is optimized for very high capacities. For example, Ultrium drives have an uncompressed capacity of 100GB (200GB at 2:1 compression) and transfer rates of 20MBps–40MBps. Ultrium Generation 2 drives have an uncompressed capacity of 200GB (400GB at 2:1 compression) and transfer rates of 40MBps–80MBps. Both types of drives also have special features such as dynamic power-down (protects tapes from damage during a power interruption), intelligent data compression, intelligent media analysis to avoid suspect tape areas, and variable tape speed to minimize back-hitching (moving the tape backward because of a data underrun). Ultrium drives are popular in both single-drive and tape-library formats, although they are quite expensive: Basic single-cartridge units start at around $3,500, with 100GB (uncompressed) cartridges selling for about $80–$90 each.
- *Accelis*. This proposed implementation of LTO is optimized for very high speeds, using a dual-reel cartridge that enables tape to be loaded from the mid-point instead of the beginning. It has a native capacity of 25GB (50GB at 2:1 compression) and features cartridge memory (used to retrieve data about the cartridge's previous use to make locating data faster) and throughput of 20MB–40MB per second. Because Ultrium drives achieve the same speeds at much higher capacities, it's no surprise that Accelis appears to be an on-paper variation at this point, with no drives on the market using this variation on LTO.

Comparing Tape Backup Technologies

As the preceding sections indicate, you have many choices in large, high-performance tape backup. All the drive technologies discussed in this section use various SCSI interface versions and can be

purchased as internal or external drives; some are also available with USB 2.0 or IEEE-1394a interfaces. Even though they are more expensive than Travan or OnStream ADR drives, they offer the capacities needed by today's larger hard drives.

Unlike the confusing backward-compatibility picture for QIC-family drives, the more advanced drives in each family are backward compatible with smaller drives.

Table 12.7 summarizes the performance and other characteristics of these tape technologies and compares them to Travan NS20 and 40GB drives and OnStream ADR and ADR^2 drives. The prices of the tape drives vary tremendously depending on which version of SCSI is selected, whether the drive is internal or external, and whether a single-tape or tape-library drive is selected. The standards shown in Table 12.7 are listed in order by native capacity. All drive interfaces are SCSI, except as noted. Maximum prices listed are for the most expensive single-drive SCSI interface model except as noted; most models of a given drive will be cheaper, depending on the SCSI version supported, whether the drive is sold bare or as a kit, and whether it is internal (less expensive) or external.

Table 12.7 High-Performance Tape Backup Standards Compared

Drive Type	Capacity/2:1 Compressed	Backup Speed (Native/Compressed)	Drive Price Range	Media Cost
Travan NS20	10GB/20GB	1–2MBps	under $400	under $40
DAT DDS-3	12GB/24GB	1.1–2.2MBps	around $600	around $13
ADR 30GB	15GB/30GB	1–2MBps ATA 2–4MBps SCSI	under $300 under $600	around $40
Travan 40GB	20GB/40GB	2–4MBps ATA 1–2MBps USB 2	around $400 around $430	around $45 around $45
DAT DDS-4	20GB/40GB	2–4.8MBps	under $1,500	under $40
Exabyte 8mm (Mammoth)	20GB/40GB	3–6MBps	under $2,700	around $60
SLR7	20GB/40GB	3–6MBps	under $1,000	around $50
DLT 4000	20GB/40GB	1.5–3MBps	under $2,000	around $70
SLR50	25GB/50GB	2–4MBps	around $2,100	around $75
ADR 50GB	25GB/50GB	2–4MBps SCSI 4–8MBps LVD SCSI	around $650	around $50
ADR^2 60GB	30GB/60GB	4–8MBps	around $750	around $65
SLR60	30GB/60GB		around $960	around $65
VXA-1	33GB/66GB	3–6MBps	under $1,200	around $80 (33/66GB); around $50 (20/40GB); around $30 (12/24GB)
AIT-1	35GB/70GB	3–6MBps	under $1,000	around $65
DLT 8000	40GB/80GB	3–6MBps	under $1,400	around $60
SLR100	50GB/100GB	5–10MBps	around $1,500	around $75
AIT-2	50GB/100GB	6–12MBps	under $1,400	around $80
ADR^2 120GB	60GB/120GB	4–8MBps	about $1,000	around $90
VXA-2	80GB/160GB	6–12MBps	around $1,000	around $100

From Table 12.7, you can see that the Travan NS20 drives are among the least expensive SCSI-based drives to purchase, but the cost per MB for media is much lower with DAT/DDS drives. The performance is higher with all 20GB and up drives of other types. For an individual computer or small network server, the ADR50, ADR², DDS-3, DDS-4, SLR7, VXA-1, and VXA-2 drive families represent the best balance of initial cost, performance, and media cost per MB. DLT, Exabyte 8mm, and AIT drives are better choices for larger network server backup, especially if purchased in their more expensive tape-library forms (not listed).

Note

To learn more about DAT, DLT, and Exabyte 8mm tape drives, see *Upgrading and Repairing PCs, 11th Edition*, which is included in printable PDF format on the DVD accompanying this book.

Choosing a Tape Backup Drive

Choosing a tape backup drive can be a simple job if you need to back up a single standalone system with a relatively small hard drive. The decision becomes more complex if the system has a larger hard drive or if you must back up a desktop system as well as a laptop. Choosing a tape backup drive type can be an even more complex program if you must back up a network server's hard drives and perhaps even back up the workstations from the server. As you ponder which backup tape drive you should select, consider the following factors:

- The amount of data you must back up
- The interfaces your equipment supports
- The data throughput you need
- The tape standard that is best for your needs
- The cost of the drive and tapes
- The capabilities and compatibility of the included driver and backup software
- Support for disaster recovery

By balancing the considerations of price, capacity, throughput, compatibility, and tape standard, you can find a tape drive that best meets your needs.

Note

When purchasing a tape backup drive, take the time to look through magazines in which dealers or distributors advertise. Several publications specialize in PCs and carry advertising from many hardware and software distributors. I recommend publications such as *Computer Reseller News* and *Computer Shopper*. CNet's online shopping service (`http://shopper.cnet.com`) can help you locate multiple sources for both popular and rare items quickly.

These publications cater to people or companies willing to go around the middlemen and buy direct. By reading such publications, you can get an excellent idea of the drives available and the price you can expect to pay.

While reading about drive capabilities and prices, don't neglect to read reviews of the software included with each drive. Verify that the software capabilities match your expectations and needs. This is especially important if you intend to use the drive on a non–Windows system because most backup software today is tailored for Windows.

Capacity

The first rule for selecting a tape backup drive is to buy a drive with a capacity large enough for your needs, both now and for the foreseeable future. The ideal is to buy a drive with enough capacity so you can start your backup software, insert a blank tape in the drive, walk away from the system, and find

the backup completed when you return. Because tape backups are generally rated by their maximum (2:1 compression) capacities—which is seldom reached in practice—you should calculate the "true" size of a tape backup drive by multiplying the native (noncompressed) capacity of a drive by 1.5 (equal to rating the drive as 1.5:1 compression). Thus, a so-called "20GB" tape backup might be better described as having a "15GB" capacity (10GB uncompressed times 1.5). Of course, the compressed capacity of a drive depends on the backup software you use, the settings you use, and the type of data you back up. Already compressed data, such as JPEG and GIF and some types of TIFF graphics files, can't be compressed further, whereas text and database files can be compressed significantly. If you find that you have higher or lower compression ratios during backup, use the compression ratio you normally achieve to help estimate your true backup capacity.

You should always ensure that your tape backup medium supports a capacity larger than your largest single drive or partition. This makes automated backups possible because you won't have to change a tape in the middle of a backup. And, even if you don't mind replacing tapes in the middle of a backup, a single-tape backup is safer. If the first tape of a multiple-tape backup is damaged or lost, the entire backup is unusable with most backup systems!

Tape Standards and Compatibility

The next most important consideration, after adequate capacity, is choosing a drive whose tapes meet a standard that is useful to you. If you have existing tapes you want to restore, or you receive tapes from other users that you must read, you need a drive that can work with those tapes. Use the backward-compatibility information listed earlier to help you decide on a drive to purchase if this feature is important to you.

If your ability to work with older tape media is only an occasional issue, you might prefer to buy a high-performance drive for current backups and maintain an older drive that matches the older standard. Most Travan-type and QIC-Wide drives can read QIC-80 tape cartridges, for example.

Tip

It is important that you make a choice you can live with. If you manage a large installation of computers, mixing QIC, Travan, DAT, and 8mm drives among systems is seldom a good idea.

Software Compatibility

Equally important to your consideration is the software required to operate each drive. Currently, most parallel port and ATA drives come with software that runs under Windows operating system versions from 98 to XP. SCSI tape drives usually also support Windows NT, Windows 2000/XP, or Unix. USB-based drives are primarily designed for Windows 98/Me/2000/XP, although Windows 2000/XP might not support as many devices as Windows 9x/Me does. Check the manufacturers' Web sites for operating system compliance if your office's computers use more than one operating system.

Most operating systems have their own software for backing up data to a tape drive. If you intend to use this software, you should verify that the drive you purchase is supported by each piece of software on each system you intend to use with the drive. Third-party programs usually offer more features, but you might need to buy separate programs for the various operating systems your office uses.

Data Throughput

Any of the ATA, IEEE-1394a, or SCSI interface drives covered earlier should provide adequate performance (1MBps or above when backing up compressed data), but performance suffers if you opt for the convenience of USB or parallel port drives. Floppy-interface QIC, QIC-Wide, and Travan drives should be considered obsolete for large-drive backups because of the limitations of the floppy interface and their small capacities.

Cost

You can figure the cost per MB for a drive in two ways: media cost only (which is valid for users with an existing drive) or drive plus media costs (which is a better method for new purchasers). Regardless of your favorite choice(s) in removable storage, be sure to look at the total picture, taking into account the savings from multipack data and the benefits of the extra speed of SCSI and ATA.

Tip

One point worth remembering when you evaluate whether to buy a tape drive is that the cost of the tapes and drive, taken as a whole, is nowhere near as high as the costs (in terms of frustration and lost productivity) of a single data-damaging hard drive problem. Considering that most people are more likely to back up a system if they have a tape drive installed than if they must use another medium for the backup, the cost of a drive and tapes is quite small, even on a standalone PC used mostly for fun.

Support for Disaster Recovery

Disaster recovery, which enables you to create a tape backup and floppy disk set that can be used to reinstall an entire operating system and data file set without installing Windows first, is a function of both the backup software and the drive interface. Disaster recovery is supported with most backup programs, but drives that connect to the USB or IEEE-1394a interfaces cannot support disaster recovery because they use Windows drivers. Because a disaster recovery data restore process starts in the MS-DOS mode, these drives can't be accessed because DOS lacks drivers for these ports.

Tape Drive Installation

Because most tape drives today use the same ATA, SCSI, USB, or parallel-port connection options that are used by other types of storage devices, you should see the appropriate sections of this book for more details about these devices:

- Chapter 14, "Physical Drive Installation and Configuration," provides detailed instructions for installing hard drives, floppy drives, and CD drives.
- Chapter 7 provides exhaustive coverage of the ATA interface.
- Chapter 8 provides detailed coverage of the SCSI interface.
- Chapter 17 provides information on USB and serial interfaces.

Note

For more details about installing the older floppy-interface tape backup drives, see *Upgrading and Repairing PCs, 11th Edition*, available in printable PDF format on the DVD included with this book.

Tape Drive Backup Software

The most important decision you can make after you choose the tape standard and capacity of your backup tape drive is the backup software you will use with it.

The three sources for tape backup software are

- Software bundled with the drive
- Software bundled with the operating system
- Software obtainable from third parties

Use the following checklist to evaluate the software you plan to use with your tape backup drive:

- *Device support.* You might prefer to use tape for most backups, but can you change your mind and use high-capacity removable magnetic or optical storage if you need to? Some backup software bundled with a particular drive will work only with that drive; check whether a full version with more options is available.
- *Compatibility with existing backups.* If you have replaced an older tape drive with a new one, can the backup software as well as the tape drive read your old data?
- *Adjustable compression options.* If you are using a drive without hardware data compression, you should be able to adjust the compression methods used, or even turn them off to make sending the tape to the user of another drive easier.
- *Data safety options.* In addition to verification, good tape software should also include some form of ECC error correction to make recovering the data in case of media damage easier.
- *Disaster recovery.* Many bundled or operating-system-standard backup programs require you to reinstall the operating system before you can restore the contents of a crashed drive. Insist on a disaster recovery feature that will allow you to restore a drive from bootable disks and the tape backup without taking the time to reinstall the operating system first. Keep in mind that you need to use an ATAPI or SCSI drive to have support for disaster recovery as well as software with this feature.

Other useful features to look for include

- *Unattended backup scheduling.* Enables you to schedule a backup for a time when you won't need to use your computer
- *Macro capability.* Use when selecting options and the files to back up
- *A quick tape-erase capability.* Use when erasing the entire contents of a tape
- *Partial tape-erase capability.* Use when erasing only part of a tape
- *Tape unerase capability.* Use when recovering erased data
- *Password-protect capability.* Enables you to protect backup data from access by unauthorized persons

Read reviews, check compatibility, look for trial versions, and be sure to test the backup and restore features as you look for the best tape backup program for your needs.

Tip

Backup software vendor Novastor (`www.novastor.com`) has a unique solution for a major problem caused by moving from an older backup system to a new one: What to do with the data on the older tapes? Its TapeCopy 2.0 software enables you to move data archives from your outmoded SCSI or ATA tape backup to a new SCSI- or ATA-based backup system. You can also use it to make hard disk copies of your tapes and to duplicate a backup tape on a similar drive. If you have extensive backup data and don't want to retain your old tape backup drive, TapeCopy 2.0 might be the answer.

Tape Drive Troubleshooting

Tape drives can be troublesome to install and operate. Any type of removable media is more susceptible to problems or damage, and tape is no exception. This section lists some common problems and resolutions. After each problem or symptom is a list of troubleshooting steps.

Can't detect the drive:

- For parallel port drives, use the tape backup as the only device on the drive and check the IEEE-1284 (EPP or ECP) mode required by the drive against the parallel port configuration.
- For USB drives, be sure you're using Windows 98 or higher and that the USB port is enabled in the BIOS; many systems originally shipped with Windows 95 have this port disabled.

- For ATA drives, ensure that the master/slave jumpers on both drives are set properly.
- For SCSI drives, check termination and Device ID numbers.
- For external drives of any type, ensure that the drive is turned on a few seconds before starting the system. If not, you might be able to use the Windows 9x Device Manager to refresh the list of devices, but if this doesn't work, you must restart the computer.

Backup or restore operation failure:

If your tape drive suffers a backup or restore operation failure, follow these steps:

1. Make sure you are using the correct type of tape cartridge.
2. Remove and replace the cartridge.
3. Restart the system.
4. Retension the tape.
5. Try a new tape.
6. Clean the tape heads.
7. Make sure all cables are securely connected.
8. Rerun the confidence test that checks data-transfer speed with a blank tape (this test overwrites any data already on the tape).

Bad block or other tape media errors:

To troubleshoot bad block or other types of media errors, follow these steps:

1. Retension the tape.
2. Clean the heads.
3. Try a new tape.
4. Restart the system.
5. Try initializing the tape.
6. Perform a secure erase on the tape (previous data will no longer be retrievable from the tape).

Caution

Note that most minicartridge tapes are preformatted and can't be reformatted by your drive. Do not attempt to bulk-erase preformatted tape because this renders the tapes unusable.

System lockup or system freezing when running a tape backup:

If your system locks up or freezes while running a tape backup, follow these steps:

1. Ensure that your system meets at least the minimum requirements for both the tape drive and the backup software.
2. Check for driver or resource (IRQ, DMA, or I/O port address) conflicts with your tape drive controller card or interface; using the floppy drive while making a floppy or parallel port tape backup is a major cause of DMA conflicts.
3. Set the CD-ROM to master and the tape drive to slave if both are using the same ATA port.
4. Check the BIOS boot sequence; ensure that it is not set to ATAPI (tape/CD-ROM) devices if the tape drive is configured as a master device or as a slave with no master.

5. Make sure the hard drive has sufficient free space; most backup programs temporarily use hard drive space as a buffer for data transfer.
6. Hard drive problems can cause the backup software to lock up. Check your hard disk for errors with SCANDISK or a comparable utility.
7. Check for viruses.
8. Check for previous tape drive installations; ensure that any drivers from previous installations are removed.
9. Temporarily disable the current VGA driver and test with the standard 640×480×16 VGA driver supplied by Microsoft. If the problem does not recur, contact your graphics board manufacturer for an updated video driver.
10. Empty the Recycle Bin before attempting a backup. Files in some third-party Recycle Bins can cause backup software to lock up.
11. Disable antivirus programs and Advanced Power Management.
12. Try the tape drive on another computer system and different operating system, or try swapping the drive, card, and cable with known-good, working equipment.

Other tape drive problems:

Other issues that might cause problems in general with tape backups include

- Corrupted data or ID information on the tape.
- Incorrect BIOS (CMOS) settings.
- Networking problems (outdated network drivers and so on).
- A tape that was recorded by another tape drive. If the other drive can still read the tape, this might indicate a head-alignment problem or incompatible environment.

Tape Retensioning

Retensioning a tape is the process of fast-forwarding and then rewinding the tape to ensure that there is even tension on the tape and rollers throughout the entire tape travel. Retensioning is recommended as a preventive maintenance operation when using a new tape or after an existing tape has been exposed to temperature changes or shock (for example, dropping the tape). Retensioning restores the proper tension to the media and removes unwanted tight spots that can develop.

Some general rules for retensioning include the following:

- Retension any tapes that have not been used for more than a month or two.
- Retension tapes if you have errors reading them.
- Retension any tapes that have been dropped.
- In some cases, you might need to perform the retension operation several times to achieve the proper effect. Most tape drive or backup software includes a Retension feature as a menu selection.