

Chapter 7 Notes Storage

What is storage?

There are many types of media and devices that are used to store data and instructions which are called storage.

Storage differs from memory because it stores data and instructions for future use. It is nonvolatile, it does not lose its value when the power is turned off. The CPU also does not directly access data and instructions on storage. They must first be loaded into memory.

Storage is also called **secondary storage, auxiliary storage, permanent storage, or mass storage**.

In chapter 1 we learned that there are two parts to storage. The data and instructions are stored on some type of physical material called the **medium**.

One specification for storage is the capacity which is given by the number of bytes that it can hold at one time, on one set of media. We've already discussed the prefixes kilo, mega, giga, and tera. Peta means quadrillion and exa means quintillion.

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A **storage device** is used to record the data and information on the medium (called writing or output) and to retrieve it (called reading or input).

One specification for a storage device is the speed which is defined by its **access time**, the amount of time taken to locate an individual item by the drive on a medium. The access time of storage devices is much slower than memory with some storage devices having a larger access time (slower speed) than others. However, the cost per byte to store information on devices with slower access times is generally less and certainly less than RAM.

[RAM costs about \$40-\$50 per megabyte. Hard disk storage costs \$.20 per megabyte.]

What is a floppy disk?

With the **floppy disk** or **diskette**, we have a removable inexpensive medium. The original floppy disk in the early 70's was 8 inches wide. The next generation was 5¼ inches wide. Today's floppy is 3½ inches wide and has a hard plastic cover.

A floppy disk is read or written to in a **floppy disk drive**. On a PC, the first drive is generally A and the second one if present is B. Some laptops have an external floppy drive that attaches to the computer with a cable.

A floppy disk is inserted into a floppy disk drive for reading or writing. When you insert the floppy, the drive moves the shutter to expose the medium to the read/write heads. A light is shown through the write-protect notch. If this notch is open, the drive cannot write on the diskette. A spindle connected to a motor spins the medium from the center causing it to spin under the read/write heads. A motor also positions the read/write heads to the correct location within the shutter window (cookie) and then the heads can write to or read from the medium. The read/write heads on a floppy drive actually touch the medium.

The **write-protect notch** on a floppy can be set so that a drive will not write on the floppy. It is write-protected when you can see through the notch. When the notch is closed, you can write on the floppy.

You should take care of a floppy so that it can last as long as possible, seven years or more – depending on how much you use it.

How are floppy disks (and other magnetic disks) organized?

The floppy disk is a **magnet medium**. The surface of the medium contains a magnetic coating made up of magnetic particles that can store binary digits, bits. The more dense this coating, the more data that can be stored on the medium. Most floppies today are **high density (HD)** and store **1.44 MB**.

Before a floppy can be used, the surface must be prepared in a process called **formatting**. The magnetic particles must be aligned and then individual tracks are created. A **track** is a narrow band that makes a full circle around the surface. If you looked at all the tracks, you would have concentric circles.

A track is also broken up into smaller sections called **sectors** which generally hold 512 bytes. A sector is the smallest physical unit that is accessed on a floppy. However, multiple sectors called a **cluster** are generally read or written during the same input or output operation. Clusters are also called allocation units because this is the smallest unit of data that is used to store data. A non-empty file consists of one or more clusters. As a file is written to a disk, the next available cluster is allocated to the file so one file may be scattered across the surfaces of the disk.

Note that the tracks/sectors on the inside near the hub of a disk are a different size than those near the outside edge and yet they hold the same amount of information. The disk spins at a constant speed so the data is stored less dense on the outside tracks.

A HD, high density, floppy has 80 tracks per side, 18 sectors per track, and records on two sides thereby actually yielding 1,474,560 bytes. This is truly 1.44MB or 1440KB which is 1440 X 1024 (1KB). Sectors that are unformattable are marked as bad sectors.

What is a Zip disk?

There are disks that are floppy like the standard diskette but have higher capacities such as the SuperDisk, HiFD, and Zip.

The Imation SuperDisk is downward compatible with floppy disks. Disks are downward compatible when they can use an earlier media. Sometimes drives are completely downward compatible when they will both read and write an earlier media but sometimes they will only read an earlier media. The SuperDisk has a capacity of 120MB or 240MB.

The Sony HiFD (High-Capacity Floppy Disk) is also downward compatible. It has a 200MB capacity.

The Iomega **Zip disk** is the most popular high capacity disk even though it is not downward compatible. The disk is a little larger and thicker than a standard floppy and has capacities of 100MB, 250MB, or 750MB. You can get an internal Zip drive which mounts in an external drive bay or an external Zip drive which connects to a port.

In a Zip drive, there is a cushion of air between the heads and the medium but the medium shapes itself around the head.

What is a hard disk?

Mainframes and minicomputers at the time that PCs were first starting to be used had large **hard disk** drives with removable media. As the technology developed, they were adapted to PCs.

Unlike the plastic material used in a floppy, the material used to hold the magnetic coating in a hard or fixed disk is on circular, non-flexible material, generally aluminum, and is called a **platter**. There are generally multiple platters in a hard disk sometimes called a **pack**. Also unlike the floppy, the medium and the drive are one unit and that unit is sealed to keep out contaminants.

Without the risk of contaminants and with a hard medium, the surface of the medium can contain a denser magnetic coating and can be spun at a higher rate of speed of 5,400, 7,200, or even 10,000 revolutions per minute (RPM). This provides a higher access time 5 to 12 milliseconds (thousandths of a second) and a higher capacity which on today's PC range from 40 to 160 GB.

In the past, Windows could only address a 2GB hard disk. When larger hard disks became available, they were initially formatted into separate logical hard disks called **partitions** or volumes. With partitioning, each partition is assigned a different drive letter. You can also partition a hard disk yourself if you wish to designate different areas of the disk for different files. If you do this with normal hard disk formatting, you erase whatever you have stored on the hard disk. There are some special utilities like Partition Magic that will re-partition your hard disk and preserve the current data.

Parts of the hard disk drive: Sealed case with circuit board, motor, pack of platters, access arm with read/write heads (2 per platter), and head actuator.

A **cylinder** is the location of all of the tracks that can be accessed with the access arm is in one position. The arm moves from one cylinder to another. The electronics select one read/write head to access one track. See <http://www.howstuffworks.com/hard-disk.htm>

The spinning of all of the platters creates a small cushion of air that the head floats on. The magnetic coating is very thin (two millionths of an inch) and if the head touches the surface, it can damage the coating. When this happens we have a **head crash**. In a bad head crash, the head can be knocked off the arm and the arm will plow up the surface of the platter.

Hard disk access time can be improved through the use of a **disk cache** which speeds up access to frequently accessed items on the disk. This cache can exist on the controller card in which case the processor does not have to be involved in the caching process. It can also be a part of RAM set aside by the operating system. In this case, the cache controller instructions for managing the cache are part of the operating system and so the processor cycles are involved in managing the cache. In some new processors, the cache controller is part of the processor which would remove that function from the operating system and make the process quicker.

Most hard disks are **fixed** and non-removable. You can purchase **removable hard disks** in which a disk cartridge is removable from the drive. The heads and the motor remain in the drive. See <http://www.howstuffworks.com/removable-storage.htm>

What is an Internet hard drive?

If you need to back up your data to protect it and save it, and you don't want to buy large capacity removable storage, you might opt to store your data on an **Internet hard drive**. This online storage is disk access and space that is provided by someone on the Web. You can copy files and maintain them on your virtual hard disk. Some sites allow you to share your files with others and may offer other Web based applications.

These companies started out with a lot of free service but most are now fee based or have gone out of business. Checkout www.xdrive.com and briefcase.yahoo.com.

What are CDs and DVDs?

A **CD, compact disc**, and **DVD** is an optical disc (or disk). It does not use magnetic heads for reading and writing data; it uses a laser. It does not store data on a magnetic coated medium; it alters the surface of the medium to store data. The optical medium is actually a plastic coated metal disk that has a diameter of 4.75 inches and a thickness of about one-twentieth of an inch.

The data on a CD or DVD is stored on the shiny side, not the side with the label. Data is stored by using microscopic indentations created with a *high-powered* laser called **pits** in contrast with the otherwise flat surface called **land**. The pits and land are read using a *low-powered* laser. When it shines on the surface where a pit is located, the light is scattered. If it is shown on land, the light is reflected back and detected by the drive.

On a magnetic disk, there are multiple tracks arranged in concentric circles. On a CD, there is one continuous track in a spiral from the center to the outside edge. This track is divided into even sized sectors. This means that the motor must vary the rate at which the CD spins. See <http://www.howstuffworks.com/cd.htm>

While a CD is only claimed to last for 5 years with proper care, it could last 50 years or more. Proper care includes storing the CD in a jewel case when not in use and holding the CD by the edges so that you do not touch the shiny surface.

The most common optical disc is the **CD-ROM** which holds about 650MB and is read only.

The original CD-ROM drives transferred data at about 150KB per second. Today's drive speeds are specified by how many times they are compared to the original CD-ROM. The original CD-ROM would be 1X. 48X is 48 times 150KB per second which is 7.2MBps.

When you get a roll of film developed, you may be able to request a picture CD. A **picture CD** is just a type of CD that holds digital JPG images from a roll of film and can be read in a CD-ROM drive.

With a **CD-R** disc and a CD-R drive, you can create (or burn) your own CDs. However, you cannot erase them.

To be able to erase a CD, you need a **CD-RW** disc and a CD-RW drive.

Speeds for CD-RW are expressed as write speed, rewrite speed, and then read speed. For example, 40/10/52 would be a 40X write speed, 10X rewrite speed, and 52X read speed.

One popular use of CR-Rs and CD-RWs is to store music. You might take a song from an audio CD and through a process called **ripping** convert it to the digital MP3 format. You can copy MP3 files to a CD and then those files can be played on your computer or a portable or car CD player that supports MP3. If you get an MP3 file directly from the Internet it has already been ripped for you and you don't have to go through that process.

The optical disk structure of **DVDs** is similar to CDs with spiral track and pits and land. DVD means **digital versatile disk** or **digital video disk**. However, the pits are closer together and the DVD can have two layers of pits. Some DVDs contain data on both sides. With two layers and two sides we have four times the capacity of a single side, single layer DVD. The figure in the book on page 22 shows the capacities of different types of DVDs.

DVD-ROM is read only. Like CD-R, there is a DVD-R that is recordable but not erasable. Similar to CD-RW is DVD+RW, DVD-RO, and DVD-RAM that can be used multiple times. There have been competing standards which has kept computer makers from adopting rewritable DVDs and has kept prices high.

What is tape?

Magnetic computer **tape** of today is similar to audio tape. It is housed in a cartridge and requires a drive for access. Older mainframes used open reel-to-reel tape.

Magnetic tape is unlike magnetic disk because access to data is limited. Data can only be obtained with **sequential access**. To access a record on the tape, you must read through the records before it.

Magnetic disk and optical disc have **direct or random access** as well as sequential access. You can go directly to the record if you know where the record is located.

What is a PC Card?

Type III PC cards can actually house a small portable hard disk or use memory to simulate a hard disk.

What is miniature mobile storage media?

As we have seen before there are many types of miniature storage media that are used in a wide variety of devices such as laptops, PDAs, phones, cameras, and MP3 players. The USB drive has become popular recently and can store 64MB to 1GB. It plugs into a USB port and the system will recognize it as a disk drive.

What is a smart card?

The smart card is a type of intelligent card that is similar to a credit card but it contains an embedded thin microprocessor. A reader can read information from the smart card and also update it. A smart card can be used to store prepaid amounts and information about the card holder such as account information, medical information, and purchase history. Smart cards are very popular in Europe. In the US, there have been privacy concerns over their use.

When smart cards are used to hold a pre-paid cash balance without identifying the owner, it is called e-money or digital cash. You can add to the amount stored in the card and then use it for purchases as you would cash. There are two concerns: (1) Since the owner is not identified, it can be stolen just like cash. (2) If e-money were allowed to hold large amounts, money could not be traced thereby enabling criminal activities.