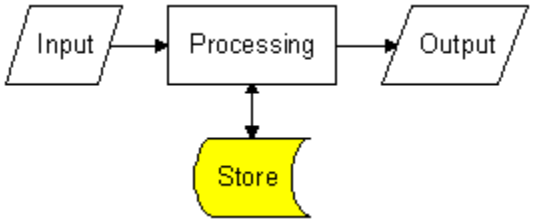
SECTION 3: STORAGE DEVICES AND MEDIA

STORAGE : Introduction

All information systems need to store data. This may be done temporarily whilst inputs are processed to produce outputs or for much longer periods of time.

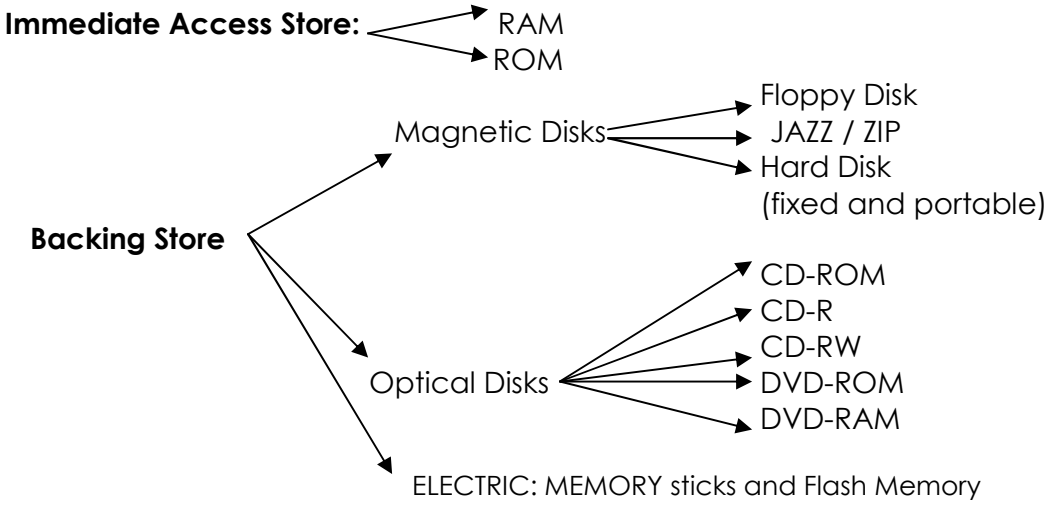


A storage device stores programs and data either temporarily or permanently. All information systems contain two different types of storage :

- **Immediate Access Store** (IAS): Immediate access store holds programs and data that the user is currently working with.
- **Backing Store**: Backing store keeps data and programs when the computer is turned off.

Immediate access store is also known as main store or primary store(RAM). Backing store is also known as secondary store.

The capacity (amount of data) that a storage device can hold varies significantly between different devices. Units such as bytes, kilobytes and megabytes are used to describe a storage device's capacity. Other factors such as speed of data access, cost and portability will also determine which storage device is the most appropriate one to use for a particular application.



Information stored on backing store is placed on a storage medium. The most common media which are used for backing store are: **Magnetic Disks, Magnetic Tapes, Optical Disks** such as CD-ROMs**.**
The data is read from or written to the storage medium by a piece of hardware known as a drive or a **storage device**.
Programs and data can not be used directly from backing store. They must be copied (loaded) into immediate access store (RAM)before they can be used. Any data which needs to be kept must be transferred back to the backing store from the immediate access store before the computer is switched off. This is called saving.

Sometimes data is compressed before it is stored. Compressing data reduces the storage space that a file uses without losing any of its contents.

IMMEDIATE ACCESS STORE (**IAS**) OR MAIN INTERNAL MEMORY (RAM and ROM)

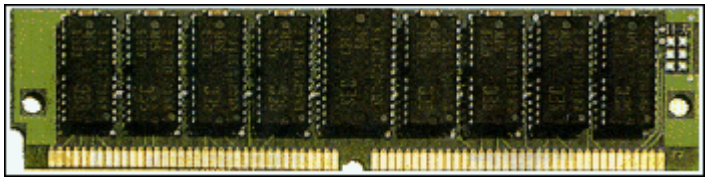
Immediate Access Store (IAS) holds programs and data that the user is currently working with. For example :

- A word processed document that is being edited will be loaded into IAS.
- An email program that is currently transmitting a message will be loaded into IAS.

There are two different types of IAS :

- Read Only Memory (ROM): The contents of ROM is permanent. It can not be altered by the user. The content is written onto the ROM when it is first made. ROM keeps its contents even when the computer is turned off and so is known as non-volatile memory. ROM is also often used in embedded systems where a small built-in computer is used to control a device such as a washing machine. The program that controls the machine is stored on ROM.

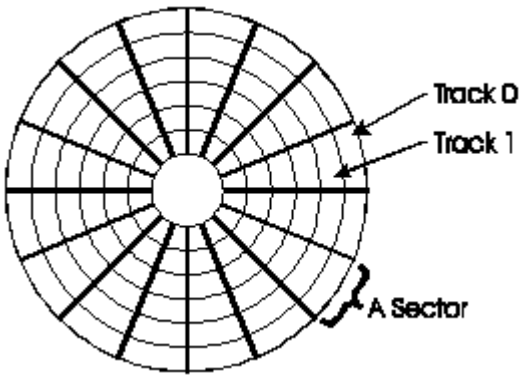
- Random Access Memory (RAM) : RAM is used to store programs and data that are being used by the computer. When the computer is turned on the RAM is empty. Data and programs can be put into RAM from either an input device or backing store. The data in RAM is lost when the computer is turned off so it is known as volatile memory. To keep data the user must save it to backing store before the computer is turned off.



The process of transfering data/programs from backing store into RAM so they can be used is known as **loading**.
The process of transfering data/programs from RAM to backing store so that they will be retained when a computer is turned off is known as **saving**.
It is easy to add extra RAM to a microcomputer by inserting extra RAM cards called SIMM cards.
Main internal memory is located inside the computer. Data can be written to and read from RAM or ROM electronically at **very high speeds**, much faster that it can be written to or from backing store.
IAS is much more expensive to buy per Mb than backing store is.

SECONDARY BACKING STORAGE

MAGNETIC DISKS: *HARD DISK AND FLOPPY DISK*



Magnetic disks are the most common backing storage device. The two main types of magnetic disks are floppy disks and hard disks.

- 1.44Mb floppy disk.
- 120Gb hard disk drive.

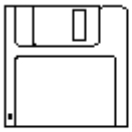
Data stored on disks is arranged along a series of concentric rings called **tracks**. Each track is divided up into a number of **sectors**. Data is read to and written from a disk one sector at a time. A sector usually contains 512 or 1024 bytes of data.
The process of dividing a disk up into tracks and sectors so it can be used on a computer is known as **formatting**. You must format a new disk before you can use it.
Data is read from the disk using a disk head which moves mechanically about the disk (rather like a record player tone arm). The disk head can move directly to any sector on the disk. Because of this a computer system can load a file or a record from a file very quickly. The system can move directly to the location of the record/file and

read it without having to read any other data from the disk. This is known as direct access. For most applications using a direct access medium is much faster than using a serial access medium.

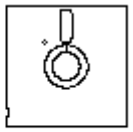
HARD DISKS

Hard disks are magnetic disks. They have much larger storage capacities than floppy disks. Data can be transferred to and from a hard disk much more quickly than from a floppy disk. Hard disks are usually fixed inside a computer and can not be moved between different machines. Some expensive hard disks can be moved between computers. These are called *exchangeable hard drives*.
A hard disk is made of a rigid disk which is coated with a magnetisable material. The magnetic material used is of a much higher quality than that found on floppy disks. Hard disks spin much more quickly than floppy disks and the disk head is positioned very close to the disk (thousandths of a millimetre away). Because the disk head is positioned so close to the disk hard drives can easily be damaged by dust or vibration. Therefore the disk, the drive head and all the electronics needed to operate the drive are built together into a sealed unit. This picture shows a hard disk drive with the case removed.
Typical hard disk capacities for a home PC now start at 80/120Gb and units storing up to 160Gb are available.
Fixed Hard disk: Used to store operating systems, software and working data. Any application which requires very fast access to data for both reading and writing to. Not for applications which need portability. Used for on-line and real time processes requiring direct access. Used in file servers for computer networks.
Portable HARD DISK: Used to store very large files which need transporting from one computer to another and price is not an issue. More expensive than other forms of removable media.
Advantages:
Very fast access to data.
Data can be read directly from any part of the hard disk (random access).
The access speed is about 1000 KB per second.

FLOPPY DISKS



3.5" Floppy



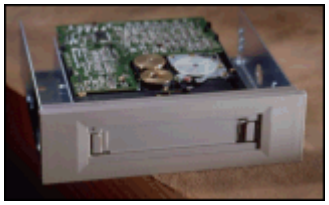
5.25" Floppy

Floppy disks are magnetic disks. They are portable (can be moved between computers) but have a small storage capacity. Reading and writing data from a floppy disk is very slow. The most common type of floppy disk is the 3.5" disk that can store 1.44Mb of data when it is used on a PC (enough to store about 350 pages of A4 text). Older disks were 5.25" or 8" in size but could store much less data.
A floppy disk is manufactured from a flexible plastic disk. This disk is coated with a magnetisable material. For protection the disk is encased in a plastic shell. All sizes of floppy disk have a write protect tab built into the shell. If this tab is set then data can be read from the disk but not written to it. The write protect tab can be used as a security measure to prevent important data being deleted or changed accidentally.
Most disks are now sold already formatted for PC's.
Floppy disks are useful for transferring data between computers and for keeping a back-up of small files.
Advantages/disadvantages:

- They are easily physically damaged if unprotected and magnetic fields can damage the data.
- They are slow to access.
- They have a small storage capacity.

Some hardware companies now produce storage devices which are very similar to floppy disks but can store 100/250Mb (ZIP) or even 1/2 Gb (JAZ) of data. These devices are also much faster than standard floppy disk drives. **ZIP AND JAZ** drives are similar to floppy drives because the individual disks are removable and portable but they hold much larger amounts of data.

MAGNETIC TAPES



Magnetic tape comes in two different forms :
Reels: Large reels of tape (1/2 inch wide and 2400 feet long) which must be loaded into a reel-to-reel tape drive. This type of tape is usually used by mainframe computers.
Cartridges: The tape is supplied in a small cartridge rather like a music tape. The tape is typically 1/4 inch wide and 300 feet long. This type of tape is used on PCs (microcomputers) and the device used to read/write the tapes is called a tape streamer. The picture below is of a tape streamer for a PC. Capacities of cartridges vary from 10Gb to 200Gb.
Often files or records are stored on a tape in a particular order (e.g. sorted alphabetically by a key field). If this is the case then the tape is described as having sequential access. Because locating data on a tape takes a long time, magnetic tapes are not used as general purpose storage devices. They are only useful for a few applications. The two main applications tape is used for are :

- **Backup**: Often a tape streamer is used to make copies of data stored on a hard disk in case the data becomes corrupted. If this happens then the correct data can be restored from the tape. A backup copy of the contents of the hard disk could be made once every week. Tapes are more suitable for making backups than floppy disks or CD-ROMs. This is because the entire contents of a hard disk can be written onto one tape, producing the backup will be much quicker and tapes are cheaper to buy.
- **Batch Processing**: Tapes are preferred to disks in batch processing systems due to their relative low costs and fast read/write speeds.

Advantages/disadvantages:
Accessing data is very slow and you cannot go directly to an item of data on the tape as you can with a disk. It is necessary to start at the beginning of the tape and search for the data as the tape goes past the heads (serial access).
Magnetic tape is relatively cheap and tape cassettes can store very large quantities of data.

OPTICAL DISKS

Optical disks store data by changing the reflective properties of a plastic disk.
Like floppy disks, optical disks can be moved from one computer to another. They have much larger storage capacities than floppy disks but can not store as much data as a hard disk. Data can be read from an optical disk more quickly than from a floppy disk but hard disks are much quicker. As with a hard disk the drive head in an optical drive can move directly to any file on the disk so optical disks are *direct access.*
There are five types of optical disks that are currently in use. They are:
CD-ROM (Compact Disk - Read Only Memory)
This is by far the most widely used type of optical disk. A CD-ROM disk can store up to 650/700Mb of data. The data is written onto the CD-ROM disk before it is sold and can not be changed by the user. Because of this CD-ROMs are often described as Write Once Read Many times (WORM) disks. CD-ROMs are used for applications such as distributing software, digital videos or multimedia products. They are also known as optical disks because the data is read by a laser beam reflecting or not reflecting from the disk surface.
CD's are available in 3 formats:

- CD-ROM's - ROM means Read Only Memory and this means you can only read from the disc, not write or store data onto it. This is the way most software programs are now sold.
- CD-R (Compact Disc - Recordable): A CD-R disk can store up to 650Mb of data. A CD-R disk is blank when it is supplied. The user can write data to it just once. After data has been written to the disk it can not be changed. A special CD-R drive which contains a higher powered laser than a CD-ROM drive is required to write to the disk. CD-Rs are often used for making permanent backups of data and distributing software when only a small number of copies are required. These CDs are

initially blank but you can use a special read/write CD drive unit to store programs and data onto the disc but they can only be written to once.

- CD-RW (Compact Disc - Rewriteable): A CD-RW disk can store up to 650/700Mb of data. CD-RW disks can be read from and written to just like a hard disk. CD-RWs can be used for any application that a hard disk can be used for but the time taken to access data is much longer than that for a hard disk. CD-RW - these are similar to the 'R' type above but you can read, write and delete files from the disc many times, just like a hard disk.

DVD-ROM (Digital Versatile Disk - Read Only Memory):

DVD is the new standard for optical disks. By using a shorter wavelength laser, storing data on both sides of the disk and having more than one layer of data on each side of a disk. DVD disks are able to store much more data than CD disks. The DVD standard includes disk capacities up to 18Gb. Current DVD disks store far less than this. Because of their high capacity, DVD-ROM disks are used to store high quality video such as complete movies. Often extra data such as information about the making of the film or the actors and actresses who star in it are also stored on the disk. Unlike movies recorded on video tape, DVD-ROM movies can be interactive. The user can make selections on the screen and change what they see.

DVD drives are now replacing CD drives in computers due to the huge memory capacity of the disk and the high quality of stored images. A DVD single sided, single layer DVD can store up to 4.7 GB of data, the equivalent of 26 CD-ROMS. This means full-motion films with sound tracks and subtitles in multiple languages can easily be stored on one DVD disk.

A film stored on a DVD has significant advantages over magnetic VHS video tape because the digital images and sound tracks are of a higher quality and do not deteriorate with constant use. The user can also move to any part of the film immediately (random access).

Multi-layer and double sided DVD's can hold up to 17GB of of data.

- DVD-RW drives (writable drives) are still quite expensive but may eventually replace home CD systems and VHS tapes as a way of recording films and music.
- DVD-RAM (Digital Versatile Disk - Random Access Memory): DVD-RAM disks have all of the benefits of DVD-ROM disks and can be written to as well. These very high capacity disks are ideal for producing backups. In the next five years they may replace video tapes for recording television programmes.

FLASH MEMORIES AND MEMORY STICKS

Flash memory: is non-volatile computer memory that can be electrically erased and reprogrammed. It is a technology that is primarily used in memory cards and USB flash drives for general storage and transfer of data between computers and other digital products.

Flash memory is non-volatile, which means that no power is needed to maintain the information stored in the chip. In addition, flash memory offers fast read access times (although not as fast as volatile DRAM memory used for main memory in PCs) and better kinetic shock resistance than hard disks. These characteristics explain the popularity of flash memory in portable devices. Another feature of flash memory is that when packaged in a "memory card," it is enormously durable, being able to withstand intense pressure, extremes of temperature, and even immersion in water.

A USB flash drive is a flash memory data storage device integrated with a USB (universal serial bus) connector. USB flash drives are typically removable and rewritable, much shorter than a floppy disk (1 to 4 inches or 2.5 to 10 cm), and weigh less than 2 ounces (60 g). Storage capacities typically range from 64 MB to 32 GB or more.

USB flash drives offer potential advantages over other portable storage devices, particularly the floppy disk. They are more compact, faster, hold much more data, have a more durable design, and are more reliable for lack of moving parts. Additionally, it has become increasingly common for computers to ship without floppy disk drives.

A flash drive consists of a small printed circuit board typically in a plastic or metal casing and more recently in rubber casings to increase their robustness.

To access the data stored in a flash drive, the drive must be connected to a USB port through either a host controller built into a computer, a USB hub, or some other device designed to access the data, such as an mp3 player with a USB-in port.

MEMORY STICK:

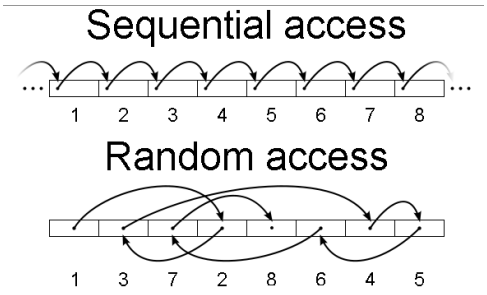
Memory Stick is a removable flash memory card format, launched by Sony, and is also used in general to describe the whole family of Memory Sticks

Typically, Memory Sticks are used as storage media for a portable device, in a form that can easily be removed for access by a personal computer. For example, Sony digital compact cameras use Memory Sticks for storing image files. With a Memory Stick-capable reader (typically a small box that connects via USB or some other serial connection), a user can copy the pictures taken with the Sony digital camera onto his or her computer. Sony uses and has used Memory Sticks in digital cameras, digital music players, PDAs, cellular phones, the PlayStation Portable (PSP), and in other devices, and the Sony VAIO line of personal computers has long included Memory Stick slots.

COMPUTER DATA STORAGE:

Often called storage or memory, refers to computer components, devices, and recording media that retain digital data used for computing for some interval of time. Computer data storage provides one of the core functions of the modern computer, that of information retention. It is one of the fundamental components of all modern computers

TYPE OF ACCESS:



SERIAL or SECUENTIAL ACCESS: sequential access means that a group of elements (e.g. data in a memory array or a disk file or on a tape) is accessed in a predetermined, ordered sequence. Sequential access is sometimes the only way of accessing the data, for example if it is on a tape. It may also be the access method of choice, for example if we simply want to process a sequence of data elements in order.

RANDOM or DIRECT ACCESS: is the ability to access an arbitrary element of a sequence in equal time. The opposite is sequential access, where a remote element takes longer time to access. A typical illustration of this distinction is to compare an ancient scroll (sequential; all material prior to the data needed must be unrolled) and the book (random: can be immediately flipped open to any random page. A more modern example is a cassette tape (sequential—you have to fast-forward through earlier songs to get to later ones) and a compact disc (random access—you can jump right to the track you want).

ACCESS SPEEDS: Main internal memory (RAM or ROM) is located inside the computer. Data can be written to and read from RAM or ROM electronically at **very high speeds**, much faster that it can be written to or from backing store.

BACKUPS : INTRODUCTION

No-one likes losing data that they have entered into a computer. Lost data represents a waste of time and effort. For companies the loss of data can be especially serious. Many companies store essential information such as customer accounts or stock databases on computer. Loss or corruption of this information could cost a company a lot of money.

If data is lost then it will have to be restored from the **backup**

If data is very important then appropriate security measures should be put in place to try and avoid any data loss or corruption. However problems can still occur :

- An employee could accidentally delete a file or a storage device could fail resulting in data being completely lost.

- Data could be changed accidentally. For example an employee may incorrectly update a set of records in a database. A virus could deliberately change the contents of a file.

Therefore extra copies of important data should be made on a regular basis. **These copies are known as backups**. If the original files become corrupt then the data can be restored from a backup copy. A company should have a backup strategy which sets out how backups will be made.

How often should data be backup up ?
Backups should therefore be made as regularly as possible.
Unfortunately backups cost money to produce. Storage media must be purchased and staff time is taken up. Therefore a balance has to be struck between making backups very frequently and keeping backup costs down. As a general rule files which change frequently should be backed up often whereas files which do not change very much can be backed up less frequently.

When should data be backed up ?
Backing up data can tie up a computer so that it can not be used whilst the backup is in progress. Therefore backups are usually made overnight or at weekends when a computer system is less likely to be in use.

What storage medium should the backups be stored on ?
There are a variety of different storage media that backups can be stored on. These include magnetic and optical disks and magnetic tapes. The best medium to use in a particular situation will probably depend upon the volume of data to be backed up and the speed at which the backup must be performed.

- Floppy Disks: Only suitable for backing up small amounts of data (1.44Mb) and very slow. Some high capacity floppy disks which can stored up to 120Mb are know available. These can store more data but are still relatively slow.
- Optical Disks: Optical disks such as CD-RWs can back up much more data than floppy disks but not as much data as a tape. Typical capacities are around 650Mb. They are much faster than floppy disks but not as fast as magnetic tapes in most circumstances.
- Magnetic Tapes: These are suitable for backing up large volumes of data (tens of gigabytes). The backups can be performed very quickly. Tapes are very cheap to buy but the initial cost of the hardware required can be high.

Where should backups be stored ?
Store at least one backup at a site away from the main computer system. If the main system is damaged by a natural disaster such as a fire then the off site backup will be safe. Any backups kept on site may be destroyed.
Control access to backups so that unauthorised personnel can not remove them or steal data from them.
Keep backups in a clean, dust-free environment so that the medium that the backups are stored on will not be damaged.
It is a good idea to make more than one backup copy.