UNIT-II

MANAGING STORAGE DEVICES

Introduction

A memory unit is an essential part of a computer system. A memory unit holds programs and data. It is very important for the computer designer to play attention to the memory unit design because the memory system cost is significant fraction of the cost of the total system. A computer memory can be logically divided into 3 groups.

a. Internal Memory.
b. Main Memory.
c. Secondary memory.

Internal Memory (Processor's Registers):

1. Each processor contains some registers, the operation performed by this registers are very fast.
2. These registers can be used for storing data or Instruction temporarily.
3. These registers memory is also known as processor's memory.
4. The cost of this type of memory is very high.

Main Memory (Physical/Primary Memory):

1. Main Memory is the area of storage in which all the programs are executed.
2. The processor can directly access the data stored in the Main Memory.
3. All the data and programs must be stored in Main memory.
4. Generally the size of main memory is much larger than processor memory.
5. Main memory operating speed is slower then processor memory.
6. The main memory device is RAM it is volatile in nature.
7. Volatile means contents will be lost when the power is lost.

Secondary Memory (Auxiliary/Logical Memory):

1. The primary memory has two limitations. First one it is volatile (i.e) the contents will go if power is lost. Second one it is limited memory.
2. So to provide large, non-volatile memory secondary memories are introduced.
3. Secondary Memory hold data and programs permanently.
4. Secondary storage devices provide huge amount of capacity whenever we save a file that file is stored in secondary memory.
5. Secondary storage devices are magnetic tapes, hard disk drives, CD/DVD drives**.**

2.1 Know About Semiconductor Memories- RAM, ROM on System Board

RAM(Random Access Memory)

RAM stands for Random Access Memory. RAM is the place where your computer temporarily stores its OS, application programs and current data. RAM is a volatile. Volatile means that when you turn off your computer anything in ram disappears or is erased. Computers usually come with 16 or more megabytes of RAM usually increasing in multiples of 8 megabytes. If you use graphic applications you probably have to 32,64 or more megabytes of memory. If you add more RAM to your computer, you reduce the number times your processor must read data from your disk.

RAM types: Two main basic types of RAM used in a PC are SRAM, DRAM and other two types are also present they are used on basis of the systems. The types of RAM are:

1. Static RAM.
2. Dynamic RAM.
3. Parameter RAM.
4. Pseudo-static RAM.
5. Video RAM.

1) Static RAM:

1. SRAM is only refreshed when data is written to it.
2. SRAM that retain information without the need for refreshing as long as the computers power is on.
3. In static ram's data storage elements are flip-flops.
4. Static RAMs are more expensive than dynamic RAMs. so SRAMs are less appears in PC's
5. Static rams maintains data till the power is off.
6. Static RAMs used in cache memory and in PCMCIA memory cards.

2) Dynamic RAM:

1. DRAM needs to be refreshed every few million seconds.
2. DRAM is refreshed by the memory controller.
3. DRAM is slower than SRAM.
4. DRAM is expensive and stores large amount of bits in a small amount physical space
5. The average transfer speeds of 50ns or higher.
6. In current Pc's DRAM is always stored in DIMM and RIMM modules

DRAM has the following types of RAMs:

1. SYNCHRONOUS DYNAMIC RAM
2. DOUBLE DATA RATE DRAM
3. RAMBUS RAM

1. SYNCHRONOUS DYNAMIC RAM(SD RAM):

SDRAM is currently the most popular memory type.

SDRAM operates in synchronous with system clock whereas others all run at a same speed and it works with 66/100/133/150MHz buses. SDRAM is in 3 variations:

1) Regular SDRAM: It runs at the same speed as the system bus and SDRAM data path is 64 bit wide

2) SDRAM 2: Sometimes it is called as double data rate SDRAM. it runs twice fast as regular SDRAM. Instead of processing data for each pulse of the system clock as regular SDRAM does. it process data at when pulse raises and again when it falls doubling the rate of memory

3) Sync link DRAM: It improved on regular SDRAM by increasing the number of memory banks that can be accessed simultaneously from four to sixteen.

2. Double data rate DRAM(DDR DRAM):

1. It is a faster version of SDRAM and it is designed for systems with bus speeds over 200 MHz.
2. It operates at double speed than SDRAM, because it performs a operation for every change in the clock pulse (i.e. for every raise and fall in the pulse) whereas SDRAM performs an operation for every T-sate (raising edge to raising edge or falling edge to falling edge).

3. Direct Rambus Dynamic RAM(DRDRAM):

1. It used the principle of narrow the data path , and improve the rate of speed of data.
2. The data path is 16 bits with this narrows data paths they managed speeds of 400mhz to 800mhz.so this design concept is totally different from others.
3. RDRAM is house on a RIMM and uses a faster system bus.

3) Parameter RAM: Macintosh computers stores their internal configuration data such as the system date and time and other system parameters .that must be stored between system boots in what is called parameter RAM.

4) Pseudo-static RAM: Specially made for use in portable computers and mainly used in note books and other PC's.

5) Video RAM: Used on video adaptor cards for buffering between the PC system and the video display.

Read Only Memory (ROM):

It also known as Non-Volatile memory (NVM) which retains the information when the power supply is off. From ROM you can read from it, but cannot write to it without using special procedures. ROM is where your BIOS is stored.ROM is non-volatile even after you turn off your computer the contents of the ROM remains available.

Different Types of ROM:

1. **MROM: It is a Static** ROM which comes programmed into an IC by its manufacturer.
2. **PROM:** Programmable read only memory requires a special machine called PROM burner to burn the BIOS code in the chip.
3. **EPROM:** Erasable Programmable read only memory also requires a special PROM burner to write the BIOS code but it can be erased by shinning ultraviolet light through a window on the top of the chip.
4. **EEPROM**: Electrically erasable programmable read only memory is erased by applying a slightly higher than normal voltage to the chip. EEROM can be erased a byte at a time rather than all at once and then written to it.
5. **UVROM:** Ultra violet erasable programmable read only memory is erased the data by applying ultra violet rays to update the BIOS.

2.2 Main Memory- SIMMs, DIMMs, Other RAM Technologies

Random access memory (RAM) functions as temporary data storage for the central processing unit (CPU). Common instructions are stored in RAM and can be retrieved in any order to speed up processes. The evolution of RAM technology has resulted in a variety of memory modules. With each new type of memory module, new module slots were designed.

SIMM (SIMMS (Single Inline Memory Module):

1. Memory module with pins on opposite sides of the circuit board that connect together to form a single set of contacts.
2. A SIMM is typically holds SDRAM chips.
3. SIMMS was invented by JAMES CLAYTON of Wang laboratories in 1983.
4. SIMMS is related by speed, measured in nano seconds.
5. Speed is a measure of access time and common speed are 60,70,80 ns.
6. The smaller the speed rating is the faster the chip.
7. SIMMS is available in 30pins, 72pin size.
8. SIMMS has 32 bits of data path.

30-Pin SIMM:

- ✓ 20pins for Row or Column addressing.
- ✓ 8pins for additional bus width.
- ✓ Measures 3.5 inches wide and 1 inch breadth.
- ✓ A notch on edge of package prevents you from improperly inserting a SIMM with bad orientation.
- ✓ Two holes on either side of SIMM allow sockets to latch the module securely in the place.
- ✓ 30 pin SIMMS can transfer 8bits of data at a time.

72-Pin SIMM:

- ✓ Packs 4bytes wide banks on a single module.
- ✓ Notch in the canter of SIMM prevent you from accidentally sliding a 30-Pin SIMM into 72-Pin socket.
- ✓ 72-Pin SIMM won't sit into 30-Pin socket.
- ✓ Notch on left side prevent improper orientation of SIMM.
- ✓ Measures 4.25 inches wide and 0.38 inch thick are often double side to achieve higher capacities.
- ✓ 72-Pin SIMMS can transfer 32bits of data at a time.
- ✓ 72-Pin SIMMS is widely used in INTEL 486, Pentium, Pentium Pro and Pentium-II systems.
- ✓ SIMMS uses FPM and EDO technologies to access data

FPM: Fast page mode is improved on earlier memory types by sending the row address just once for many accesses to memory near that row.

EDO: Extended data out is an improvement over FPM memory. It is faster because it eliminates the 10ns delay while waited before it issuing the next memory address.

DIMMs (Dual Inline Memory Module):

1. Memory Module with pins on opposite sides of the circuit board that do not connect and thus form two sets of contacts.
2. A DIMM typically holds SDRAM chips.
3. Newer DIMMS holds chips that use synchronous DRAM (SDRAM). Which is DRAM that runs is sync with the system clock and thus runs faster than other types of DRAM.
4. DIMM hold between 8MB and 2GB of RAM.
5. DIMM contain 168,184 pins and 240pins.
6. DIMM uses EDO and BEDO technologies to access data.

EDO: Extended data out is an improvement over FPM memory. It is faster because it eliminates the 10ns delay while waited before it issuing the next memory address.

BEDO: Burst extended data out is a refined version of EDO which reduces memory access time than EDO. BEDO is not support it.

RIMM Technologies:

1. Memory module that houses Rambus Dynamic Ram (RDRAM) chips. Which are much faster than synchronous DRAM (SDRAM).
2. RIMM is also called as Rambus Inline Memory Module.
3. It looks almost similar to DIMM but slightly bigger.
4. RIMM transfer data in 16bit and 32bit data path.
5. RIMM available in 168pin or 184pin or 232pin and include long heat sink.

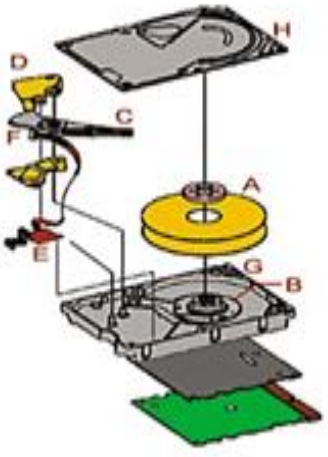
2.3 Hard Drives- Hard Drive Technology- IDE, EIDE, SCSI SATA

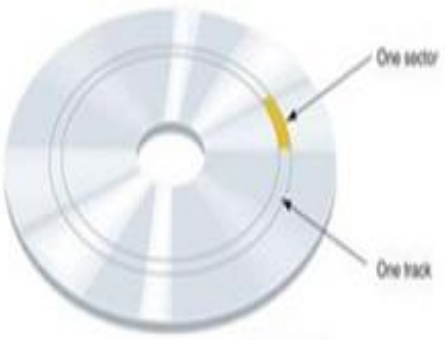
HARD DRIVE:

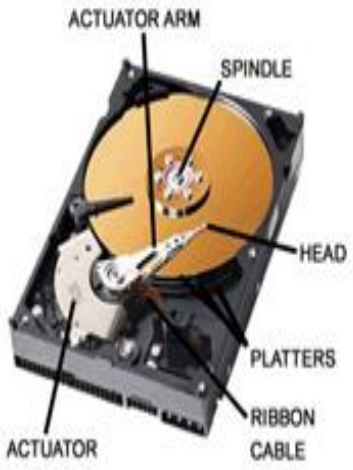
1. The primary computer storage medium which is made of one or more aluminum or glass platters, coated with a Ferro-magnetic material.
2. Most hard disks are fixed disks, which are permanently sealed in the drive.
3. In 1954 when IBM first invented the hard disk, capacity was nearly 5MB.
4. Today's hard disks can hold several gigabytes of data.

The Components of Hard Drive:

1. Disk platters
2. Spindle and spindle motor
3. Read /write heads
4. Head actuators
5. Air filters
6. Logic board
7. Connectors and jumpers







Platter:

Platter is primary unit of hard disk drive as its disk. The disks are the storage media for the disk drive and it is on them that the data is actually recorded. We call them Platters or Disks.

Tracks and Sectors:

The disk is organized into cylinders, tracks, sectors, and clusters as shown in figure: The number of sector per track on a drive is not the same throughout the platter. Tracks near the center have the smallest number of sector per track, and the number of sectors increases as the tracks grow larger.

DC Spindle Motor:

The motor that rotates the spindle and the disk mounted to it is called spindle motor. The spindle motor is always connected directly to the spindle without using belts or gears so that the drive mechanism is free of noise and vibrations. The spindle rotates the platters in union of speeds of 3600RPM, 4800RPM, 5400RPM, and 7200RPM….. And so on. On newer devices it to 10000RPM and 15000RPM.

Read/Write Heads:

These head is used to reads or writes data from or to the platter. Each side of a disk platter has media applied to it that allows it to store data. Each side of a disk platter also has at least one read/write head. The read/write heads are all connected to the same actuator mechanism, which moves the heads in unison in and out from the spindle to the edge of the platter.

Head Arm:

Head arm is used to moves across the disk and positioning the head. Head arm plays major role in reading or writing data from the hard disk.

Head Actuators:

The read/write heads of the hard disk drive are moved into position by the head actuator. This mechanism is used to extend and retract the heads so that data can be read from or written to the disk platter. They are generally divided into two groups

Air Filters: Most drives have two air filters. They are

Recirculating Filter:

The purpose of this filter is to trap any particles of media that may be scraped off the disks by the read/write heads or any small particles that have been trapped in the HAD during manufacturing.

Barometric (or) Breather Filter:

Hard disk assembly has a vent that allows it to equalize the air pressure through a breather filter.

Chassis: Chassis is a cost metal base on which other components are mounted.

Data Connectors: It carries both the data and command signals from the controller and CPU to and from the disk drive.

Jumpers: The jumpers on the disk drive are used to configure the drive.

Power Connectors: It is the standard power connector available from the PC's power supply that supplies the disk with 5V and 12V DC power.

HARD DRIVE TECHNOLOGIES - IDE, EIDE, SCSI, SATA

IDE:-

- ✓ The IDE (integrated device electronics) interface, one of the more popular interface technologies in use today was originally developed as an alternative to the expensive SCSI technology.
- ✓ IDE is also known as AT attachment (ATA) interface.
- ✓ As its name implies, IDE technology integrates the disk controller.
- ✓ IDE drives are usually be connected directly to the motherboard.
- ✓ IDE ensures that the data communication between hard disk & the controller.
- ✓ IDE interface supports hard disk that have size from 40mb-1gb
- ✓ The IDE interface supports hard disks that have rates 3-8mb/sec.

EIDE:-

- ✓ Enhanced IDE are most common drive interfaces found in IBM. Interface compatible computers today.
- ✓ It is current standard for inexpensive &high performance HD's used in PC.
- ✓ The EIDE hard disk is a plug-and –play devices.

IMPROVEMENTS ON EIDE OVER THE IDE:-

1. EIDE supports 500mb-40gb HD's
2. EIDE has transfer rates up to16.6mb/sec

SCSI:-

- ✓ Small computer system interface is a standard for communication between peripherals and the system bus
- ✓ SCSI is like a small LAN inside a computer. the SCSI bus can connect up to 15 devices
- ✓ The number of devices the SCSI bus can support depends on the type of SCSI being used.
- ✓ SCSI bus must be terminated to prevent unclaimed messages from bouncing back to the bus.
- ✓ SCSI type hard disks transfers rate is 5-80mb/sec and supports HD's that have capacity of 20mb-75mb

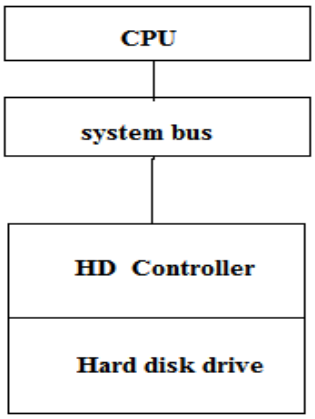


Fig: IDE directly communicates on system bus.

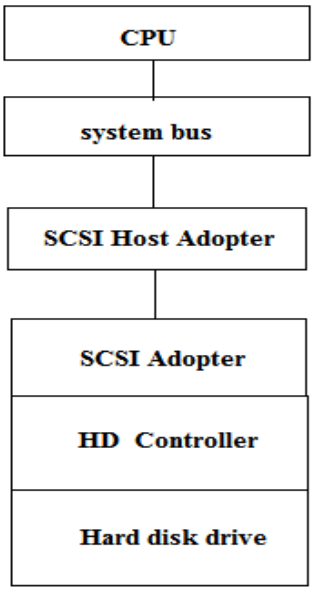


Fig: SCSI hard drive communicates with CPU through SCSI host adapter

SATA:

- ✓ SERIAL ADVANCED TECHNOLOGY ATTACHMENT is a bus interface for connecting hard disk drives
- ✓ Serial ATA was designed to replace the older standards
- ✓ It is able to use the same low level commands, but SATA adapters and devices communicates via a high speed serial cable.
- ✓ The SATA transfers data between hard drive and the system using only 1-bit at a time with the speeds of up to600mb/sec.
- ✓ SATA offers several advantages over the older interface reduce cable-bulk and host faster and more efficient data transfer and hot swapping- Hot swapping is replacing or adding components without stopping or shutting down the system.

2.4 Hard Drive Partitions

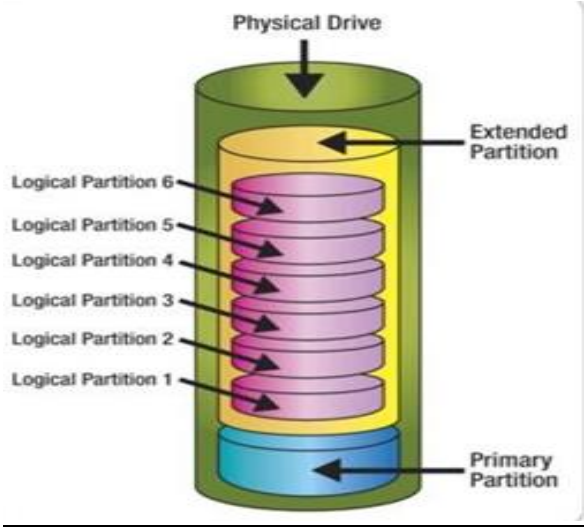
"Disk Partitioning is an act of dividing a hard disk into multiple logical storage units referred to as partitions."

Benefits of partitioning:

1. Separation of Operating system and program files from user files.
2. Multi-boot Setups.
3. Backups of any Operating system or Software.

Disadvantages:

1. Reduces overall disk performance.
2. Increases disk fragmentation.



1. **Primary partition:** this partition is used to store and boot an OS. We can create a primary partition even without an OS on it. We can have at most 4active partitions.
2. **Active Partition:** It is a primary partition that has an Operating system on it. If there is only 1 primary partition then it is regarded as Active.
3. **Extended partition:** It is the second type of partition especially created for storing user data. We cannot install an operating system on this type of operating system. An extended partition can be sub- divided into logical drives .A single extended partition can be sub-divided into a maximum of 24 logical drives.
4. **Logical Partition:** It is created with in an extended partition. Logical partition is a way to extend the initial limitation of 4 primary partitions. Logical partitions are mainly used for storing data.

2.5 Troubleshooting Hard Drives & Data Recovery

Trouble Shooting is used to find out why something does not work and it fix the problem and determines the problem is due to malfunctioning hardware or buggy or out-of-date software.

TROUBLE SHOOTING HARD DRIVE:

1. Symptoms Associated with Hard Disk Drive Failures:

- ✓ The front panel indicator lights are visible, and display is on screen but there is no disk drive action and no boot up.
- ✓ The computer boots up to a system disk in the A drive, but not to the hard drive, indicating that system files are missing.
- ✓ The computer does not boot up when turned on.
- ✓ An IBM-compatible 17XX error code is produced on the display.
- ✓ No motor sounds are produced by the HDD while the computer is running.
- ✓ A HDD controller failure message appears indicates a failure.
- ✓ No boot record found, Invalid system disk message appears.
- ✓ The video display active, but HDD activity light remains on. It indicates that CMOS setup failure.
- ✓ An out of disk space message appears, indicating that the amount of space on the disk is insufficient to carry out the operation.

2. Trouble Shooting Steps:

1. HDD configuration checks:

- ✓ While booting up the system, observe the BIOS's HDD type information displayed on the monitor. Note the type of HDD BIOS installed in system.
- ✓ Possible error message is associated with HDD configuration problems include the Drive mismatch error message and the invalid media type message.

2. Basic HDD Checks:

- ✓ The first task is to determine how extensive the HDD problem is place a clean boot disk or an emergency start disk in the 'A' drive and try to boot the system.
- ✓ If you cannot access the HDD, and its configuration setting are correct. You must troubleshoot the **hardware components** associated with the HDD. These components include the drive, its signal cable and the Hard disk controller on the system board.
- ✓ Check the **HDD signal cable** for proper connection at both ends. Exchange the signal cable for a known good one.
- ✓ Hard disk might have simply lost tracks of where it was and now it cannot find its starting point. In this case, the most attractive option is to **reformat.**
- ✓ If the reformatting procedure is not successful or the system still doesn't boot from the hard drive **replace the hard disk drive** unit with a working one.

Data Recovery:

1. In computing, **data recovery** is a process of retrieving inaccessible, lost, corrupted, damaged or formatted **data** from secondary storage, removable media.
2. This is expensive. So, perform the following yourself.
3. On rare occasions, simply retrying booting up the hard disk solves the problem. Always wait at least 15 seconds after turning off a PC before turning it back on again.
4. Number of data recovery tools are available use them to recover data.
5. The Norton utilities by Symantec stands is the data recovery package on the market today.
6. Finally Contact a data recovery company and ask them for an assessment.

2.6 Optimizing Hard Drive – Disk Cleanup, Disk Fragmentation, Disk Backup:

1. **Disk optimization**:

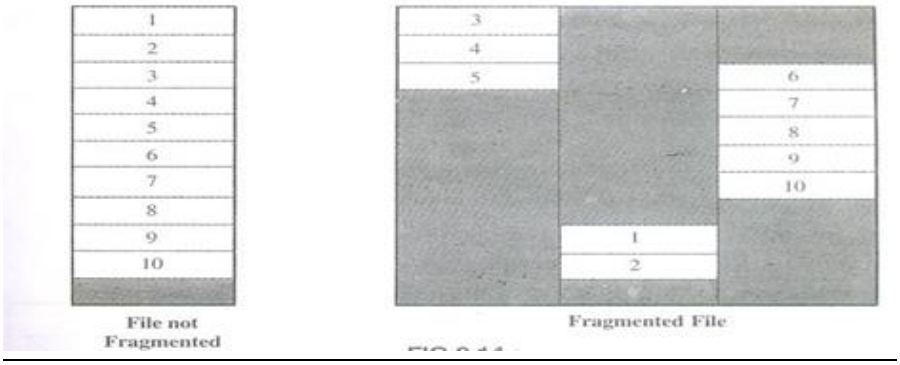
It is a process in which the physical locations of files on a disk are re-arranged in order to improve data access times and minimize time moving a hard drives head.

Optimization Techniques:

- ✓ Disk defragmentation.
- ✓ Disk clean up.
- ✓ Disk back up.
- ✓ Removal of cross linked and lost clusters.
- ✓ Disk compression.
- ✓ Disk caching.

1. Disk Defragmentation:

- Fragmentation is the undesirable placement of single file in several locations that are not side by side.
- So that data access time is increased when the hard disk new and freshly formatted.
- The OS writes the files in consecutive location. But when files are deleted free space is created in between the files OS stores new files in this free space which are created due to deletion of file.



- ✓ When no. of files is created and deleted a file will scatter all over the disk.
- ✓ **Problems with Fragmentation are:**

1. Data accessing takes more time.
2. If a file becomes corrupted recovery becomes more complicated.

- ✓ To overcome the problems that hard disks are to be defragmented periodically.
- ✓ For defragmentation, Defragmenter utility is available.

2. Disk cleanup:

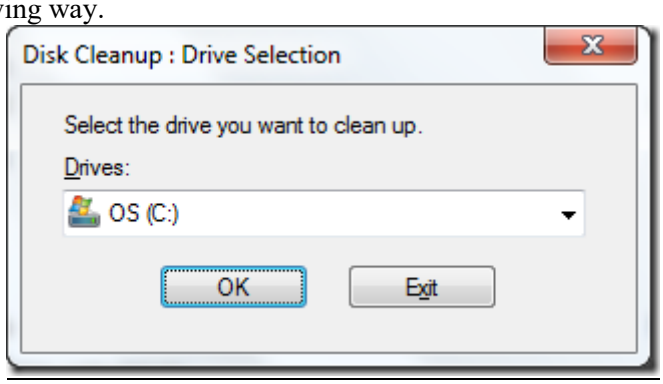
"The disk clean up tool helps you free up space on your HD by searching your disk for files that you can specify safely delete."

Perform any of following tasks to free up space on your HD

- ✓ Remove temporary Internet files.
- ✓ Empty the Recycle bin.
- ✓ Remove Windows temporary files.
- ✓ Remove installed programs that you no longer use.

You can start Disk clean up by doing any of the following:

- ✓ Click Start→all programs→accessories→system tools and then click Disk clean up.
- ✓ Click start and then click run. In the Open box type **cleanmgr** and the click OK.
- ✓ Select drive in following way.



3. DISK BACKUP:

- ✓ Backup lets you back up data to a file or to a tape. When your backup data to a file, you have to designate a file name and a location for the file to be saved.
- ✓ Backup files usually have extension .bkf, but you can change it to any extension.
- ✓ Backup file can be saved to a hard disk, a floppy disk or to any other removable or non-removable media on which you can save a file.
- ✓ The following four steps describe a simple backup operation:

1. Select files, folders and drives for backup.
2. Select storage media or file location for backed-up data.
3. Set back-up options.
4. Start the backup.

2.7 Know About Flash Memories:

"Flash memory is an electronic(solid-state) non-volatile, rewriteable computer storage medium that can be electrically erased and reprogrammed."

- ➢ Flash memory is used for easy and fast information storage in computers, digital cameras and home video game consoles.
- ➢ It is used more like a hard drive than RAM.
- ➢ In fact, flash memory is known as a solid-state storage device, meaning there are no moving parts-everything is electronic instead of mechanical.

Advantages:

- ✓ It is a solid-state, so it's noiseless.
- ✓ It allows faster access.
- ✓ It is durable and requires less voltage.
- ✓ It's smaller in size and lighter.

Types of Flash Memories:

There are two main types of flash memory, which are named after the NAND and NOR logic gates. The internal characteristics of the individual flash memory cells exhibit characteristics similar to those of the corresponding gates.

1. **NAND type** is primarily used in main memory, USB flash drives, solid-state drives, and similar products, for general storage and transfer of data.
2. **NOR type**:
   - ✓ Which allows true random access and therefore direct code execution, is used as a replacement for the older EPROM and as an alternative to certain kinds of ROM applications.
   - ✓ NOR-type flash allows a single machine word (byte) to be written – to an erased location.

Example applications:

- ✓ It includes PDA, Laptops, Digital Audio players, Digital Cameras and Mobile phones.
- ✓ Flash Memories used in Video game hardware.
- ✓ Since flash memory is non-volatile. No power is needed to maintain the information stored in the chip.
- ✓ Flash memory offers fast read access times and better shock resistance than hard disks.
- ✓ Another feature of flash memory is that when packed in a "Memory Card" it is extremely durable.

2.8 Know Functional Units of Optical Memories (CD-ROM, DVD ROM Etc):

1. **Compact disc** is a Digital Optical disc data storage.
2. Compact discs are optional storage media on which data is stored and read using laser light.
3. CD's are available in the following types 1) CD-R. 2) CD-RW.
4. CD-R: We can write data only once. We cannot rewrite the data.
5. CD-RW: We can rewrite data.
6. CD's can store data, audio or video files. Now CD's are coming with 700 MB storage capacity.

CD Drive: CD drives are also two types

1. **CD-ROM**: Drive can only read from CD's.
2. CD-Writer: It can read as well as write on to the CD's.

Advantages:

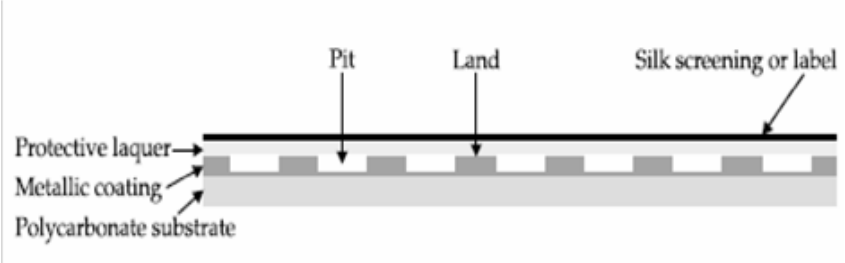
1. Provides good storage capacity.
2. Can be duplicated inexpensively.
3. Removable so they are very suitable for storage as well as for distribution of software or data.

DISADVANTAGE: Accessing time is much more than magnetic disks (HD's).

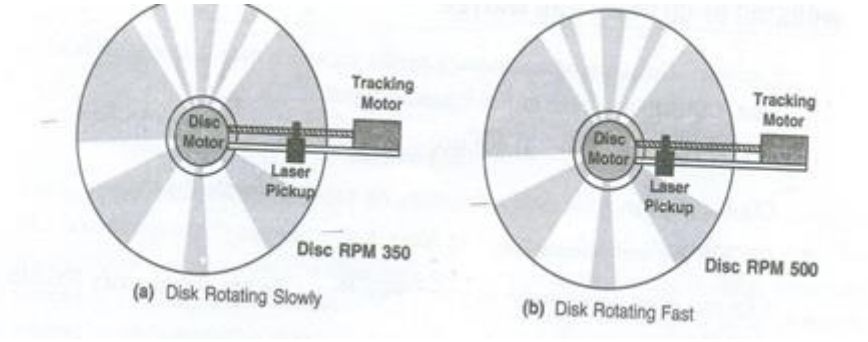
CD-ROM (Compact Disc Read Only Memory):

When a CD is loaded into CD-ROM drive, it spins and **a laser moves over the lands and pits, sensing thousands of them per second.** When the laser hits a land, its light reflects off the metallic coating to a sensor.

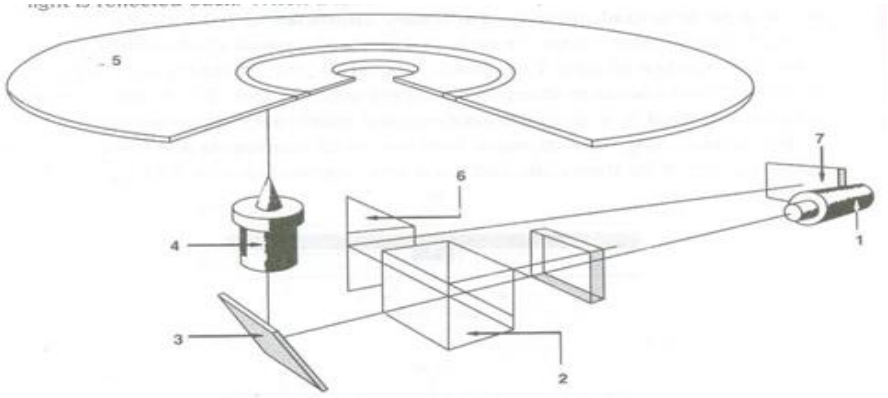
A pit on the CD surface does not reflect the laser back to the sensor. When it hits a pit, the light does not reflect back to the sensor. The sensor sees a reflection or not is represented as a 1 or 0.There are approximately 4to5 million pits per CD.



They are arranged in a single outward-running spiral (track) approximately 3.75 miles(6km) long.CD is a simple circular piece of plastic 12cm in diameter and about 1.2mm thick. CD-ROM drives use constant linear velocity. A CD-ROM drive reads a disk starting at the inner most tracks. Inner tracks are shorter than outer tracks. so, drive travels faster on inner track than on outer look tracks. Observe the rotations or revolution per minute (RPM) in the following figure. The range of RPM is around 200-530.



Inside the CD ROM:



Components of Optical Drive:

1. **Laser Diode:** These produce a highly accurate laser beam that can be targeted to 0.001mm.
2. **Prisms:** The laser beam passes through a system of prisms that refine the beam.
3. **Mirror:** The mirror redirects the incoming light to the read head.
4. **Read Head:** The read head moves across the radius of the disk directing the laser beam to the laser.
5. **Motor to Rotate the Disk:** The disk rotates to bring new data in front of the laser.
6. **Return Journey:** The light is reflected by the surface of the disk directing and returns through the read head. The mirrors, prisms on the return journey, the prism redirect the beam to the photo diode.
7. **Photo Diode:** The light sensitive component translates light reflected back from the disk into binary code and then passes it on to the processor.

2. CD WRITE LASER:

1. The **write laser** is more powerful than the read laser.
2. So, it interacts with the disc differently: It **alters the surface** instead of just bouncing light off it.
3. The write laser moves in exactly the same way as the read laser.
4. It moves outward while the disc spins.
5. By calibrating the rate of spin with the movement of the laser assembly, the burner keeps the laser running along the track at a constant rate of speed.
6. To **record the data**, the burner simply turns the laser writer on and off in sync with the pattern of 1s and 0s.
7. The laser **darkens the material to encode a 0** and leaves it **translucent to encode a 1**.
8. Most CD burners can create CD's at multiple speeds. At 1x the CD spins at about the same rate as it does when the player is reading it. At 2x speed, it would you take about half time.

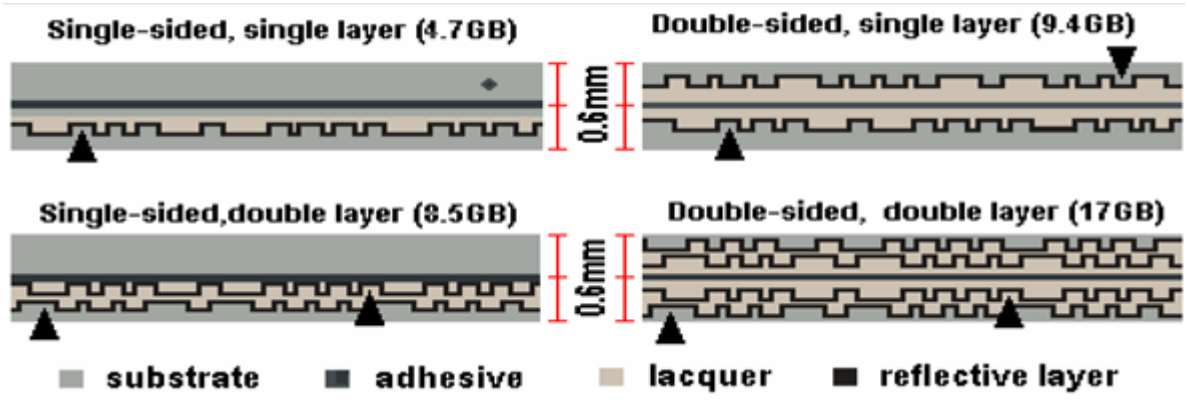
2. DVD ROM:

1. DVD stands for "**Digital Versatile Disc**" or "**Digital Video Disc**".
2. It is an optical storage medium. It also has the same shape and size as the CD-ROM but has a much larger storage capacity.
3. The prices of the DVD media and DVD drives cost more than CD-ROM and their drives.
4. They can store audio and video in addition to other data. Many movies today are coming on DVD because of their low cost and large storage capacity. DVD movies also have superior quality picture and sound.
5. DVD disc can easily be mistaken for a CD both are plastic discs 120mm in a diameter and 1.2 mm thick and both rely on laser to read data stored in pits in spiral track.
6. The minimum pit length of a single layer DVD is 0.4 microns compared to 0.834 micron for a CD.

DVD-ROM:

Reading & writing procedure for DVD drive: The reading and writing procedure for DVD drive is same as the CD-ROM, but the following points illustrate the difference between a CD & DVD.

1. A DVD can store the equivalent of 17GB or about 25 times more than a CD-ROM.
2. A DVD can use both the top and bottom surfaces for data.
3. Because, a DVD uses a shorter wave length laser, it can read smaller, more densely packed pits.
4. In addition, a second layer is added to the DVD, an opaque layer that also holds data and almost doubles the capacity of the disc.
5. Storage of data on DVD
   - ✓ Single-sided, single-layer can hold **4.7GB**.
   - ✓ Single-sided, double-layer can hold **8.5 GB**.
   - ✓ Double-sided, single-layer can hold **9.4 GB**
   - ✓ Double-sided, double-layer can hold **17 GB**



Combo drive: A combo drive is a type of optical drive that combines CD-R & CD-RW recording capability with an ability to read DVD media.

Disc: A disc refers to optical media, such as an audio CD, CD-ROM, DVD-ROM, DVD-RAM, or DVD-Video disc.

Some discs are read-only (ROM), others allow you to burn content (write files) to the disc once (such as a CD-R or DVD-R, unless you do a multisession burn), and some can be erased and rewritten over many times (such as CD-RW, DVD-RW, and DVD-RAM discs).

Disk: A disk refers to magnetic media, such as a floppy disk, the disk in your computer's hard drive, an external hard drive. Disks are always rewritable unless intentionally locked or write-protected. You can easily partition a disk into several smaller volumes, too.