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Auxiliary Storage Devices: Magnetic Tapes, Magnetic Disks, Floppy Disks, Hard Disks and Drives.

CD-ROM, other Optical Devices: WORM, Erasable optical disks, touch Screen optical device**.**

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1. Auxiliary Storage Devices:

The primary types of Auxiliary Storage Devices are:

- Magnetic tape
- Magnetic Disks
- Floppy Disks
- Hard Disks and Drives

These high-speed storage devices are very expensive and hence the cost per bit of storage is also very high. Again, the storage capacity of the main memory is also very limited. Often it is necessary to store hundreds of millions of bytes of data for the CPU to process. Therefore, additional memory is required in all the computer systems. This memory is called auxiliary memory or secondary storage. In this type of memory the cost per bit of storage is low. However, the operating speed is slower than that of the primary memory.

Most widely used secondary storage devices are magnetic tapes, magnetic disks and floppy disks.

•It is not directly accessible by the CPU.

•Computer usually uses its input / output channels to access secondary storage and transfers the desired data using intermediate are a in primary storage.

•Example: Hard disk

1.1. Magnetic Tapes.

Magnetic tape is a medium for **magnetic** recording, made of a thin, magnetisable coating on a long, narrow strip of plastic film. It was developed in Germany, based on **magnetic** wire recording. Devices that record and play back audio and video using **magnetic tape** are **tape** recorders and video **tape** recorders.

Magnetic tape an information storage medium consisting of a magnetic coating on a flexible backing in tape form. Data is recorded by magnetic encoding of tracks on the coating according to a particular tape format.

Characteristics of Magnetic Tapes

- No direct access, but very fast sequential access.
- Resistant to di_erent environmental conditions.
- Easy to transport, store, cheaper than disk.
- Before, it was widely used to store application data; nowadays,
- it's mostly used for backups or archives (tertiary storage).

Magnetic tape is wound on *reels* (or *spools*). These may be used on their own, as *open-reel tape*, or they may be contained in some sort of magnetic tape cartridge for protection and ease of handling. Early computers used open-reel tape, and this is still sometimes used on large computer systems although it has been widely superseded by cartridge tape. On smaller systems, if tape is used at all it is normally cartridge tape.

Magnetic tape is used in a *tape transport* (also called a *tape drive*, *tape deck*, *tape unit*, or *MTU*), a device that moves the tape over one or more magnetic heads. An electrical signal is applied to the *write head* to record data as a magnetic pattern on the tape; as the recorded tape passes over the *read head* it generates an electrical signal from which the stored data can be reconstructed. The two heads may be combined into a single *read/write head*. There may also be a separate *erase head* to erase the magnetic pattern remaining from previous use of the tape.

Most magnetic-tape formats have several separate data tracks running the length of the tape. These may be recorded simultaneously, in which case, for example, a byte of

data may be recorded with one bit in each track (*parallel recording*); alternatively, tracks may be recorded one at a time (*serial recording*) with the byte written serially along one track. For parallel recording and some serial recording, there is a separate head (or set of read and write heads) for each track, assembled into a single multi-track head unit; other mechanisms have a single track head that is moved across the width of the tape to record separate tracks. A third method is helical-scan recording where the heads are mounted in a rotating drum around which the tape is wrapped on the skew, as in a video recorder, so that tracks run diagonally across the tape.

Where write and read heads are close together, the magnetic signals may be read back and checked for correctness as soon as they are written; this is called a *read-while-write check*. Standard open-reel tape is ½ inch wide and carries nine data tracks, recorded in parallel; the most widely used reel is 10.5 inches in diameter holding 2400 feet of tape, and such a *volume* holds up to 140 megabytes of data depending on the tape format. 1200 or 600 foot tapes, on smaller reels, are sometimes used. Other formats are employed for special purposes.

Tape cartridges are much more variable in size and capacity because there are so many different formats; volume capacity varies from a few megabytes to many gigabytes. Magnetic tape has been used for offline data storage, backup, archiving, data interchange, and software distribution, and in the early days (before disk storage was available) also as online backing store.

For many of these purposes it has been superseded by magnetic or optical disk or by online communications. For example, although tape is a non-volatile medium, it tends to deteriorate in long-term storage and so needs regular attention (typically an annual rewinding and inspection) as well as a controlled environment. It is therefore being superseded for archival purposes by optical disk. Magnetic tape is still extensively used for backup; for this purpose, interchange standards are of minor importance, so proprietary cartridge-tape formats are widely used.

Magnetic tapes are used for large computers like mainframe computers where large volume of data is stored for a longer time. In PCs also you can use tapes in the form of cassettes. The cost of storing data in tapes is inexpensive. Tapes consist of magnetic

materials that store data permanently. It can be 12.5 mm to 25 mm wide plastic film-type and 500 meter to 1200 meter long which is coated with magnetic material. The deck is connected to the central processor and information is fed into or read from the tape through the processor. It is similar to cassette tape recorder.

Advantages of Magnetic Tape

- **Compact:** A 10-inch diameter reel of tape is 2400 feet long and is able to hold 800, 1600 or 6250 characters in each inch of its length. The maximum capacity of such type is 180 million characters. Thus data are stored much more compact on tape
- **Economical:** The cost of storing characters on tape is very less as compared to other storage devices.
- **Fast:** Copying of data is easier and fast.
- **Long term Storage and Re-usability:** Magnetic tapes can be used for long term storage and a tape can be used repeatedly without loss of data.

1.2.Magnetic Disks

You might have seen the gramophone record, which is circular like a disk and coated with magnetic material. Magnetic disks used in computer are made on the same principle. It rotates with very high speed inside the disk drive. Data are stored on both the surface of the disk. Magnetic disks are most popular for direct access storage. Each disk consists of a number of invisible concentric circles called tracks. Information is recorded on tracks of a disk surface in the form of tiny magnetic sports. The presence of a magnetic sport represents one bit (1) and its absence represents zero bit (0). The information stored in a disk can be read many times without affecting the stored data. So the reading operation is non-destructive. But if you want to write a new data, then the existing data is erased from the disk and new data is recorded.

A digital computer memory in which the data carrier is a thin aluminum or plastic dis coated with a layer of magnetic material.

Magnetic disks are 180-1,200 mm in diameter and 2.5-5.0 mm thick; Ni-Co or CoW alloys areused for the magnetic coating. Data are recorded magnetically on the disks in concentric tracks onthe working surface and are coded by an address, which indicates the number of the disk and thenumber of the track. There may be a fixed magneti c head for recording or readout on each track or asingle movable head that is common to severaltracks and sometimes to several disks.

A magneticdisk memory usually contains several dozen disks mounted on a comm on axle, whichis turned by an electric motor. One or more disks (a packet) may be replace d, creating disk indexfiles. There may be as many as 100 disks in a memory and 64-5,000 data tracks on each operatingsurface of a disk; the recording density is 20 130 impulses per millimeter. The data capacity ofmagnetic disk memories range from seve ral tens of thousands up to several billion bits, and theaverage access time is 10-100 milliseconds.Magnetic disks appeared during the mid1950's and immediately became widely used because oftheir excellent technical characteristics. In speed of response they a re between immediateaccessmemories and external storages. They can store an adequate v olume of data, thecost per unit ofstored information (bit) is low, and their service reliabilit y is excellentA flat rotating disc covered on one or both sides with magnetisable material.

The two maintypes are the **harddisk** and the **floppydisk**.Data is stored on eith er or both surfaces of discs inconcentric rings called "tracks". Each track is divided into a whole number of "sectors". Where multiple (rigid)discs are mounted onthe same axl e the set of tracks at thesame radius on all their surfaces is known as a" **cylinder**". Data is read and written by a **diskdrive** which rotates thediscs and positions the read/write heads over the desiredtrack(s). The latter radial movement is known as "**seeking**There isus ually one head for each surface that stores data.

The head writes binary data by magnetising small areas or"zones" of the disk in one of twoopposing orientations. Itreads data by detecting current pulses induced in a coil aszoneswith different magnetic alignment pass underneath it.In theory, bits could be read back as a time sequence of pulse(one) or no pulse (zero).However, a run of zeros would gi vea prolonged absence of signal, making it hard toaccuratelydivide the signal into individu al bits due to the variabilityof motor speed.

High speed disks have an **accesstime** of 28 milliseconds orless, and lowspeed disk s, 65milliseconds or more. The higher speed disks also transfer their data faster than the slower speed units.

The disks are usually aluminium with a magnetic coating. Theheads "float" just ab ove thedisk's surface on a current ofair, sometimes at lower than atmospheric pressure in anairtight enclosure. The head has an aerodynamic shape so thecurrent pushes it away fro m thedisk. A small spring pushesthe head towards the disk at the same time keeping the he ad ata constant distance from the disk (about two microns).Disk drives are commonly char acterised by the kind of interface used to connect to the computer

1.3.Floppy Disks

These are small removable disks that are plastic coated with magnetic recording material. Floppy disks are typically 3.5″ in size (diameter) and can hold 1.44 MB of data. This portable storage device is a rewritable media and can be reused a number of times.

Floppy disks are commonly used to move files between different computers. The main disadvantage of floppy disks is that they can be damaged easily and, therefore, are not very reliable. The following figure shows an example of the floppy disk. It is similar to magnetic disk .It is 3.5 inch in diameter. The capacity of a 3.5 inch floppy is 1.44 megabytes. It is cheaper than any other storage devices and is portable. The floppy is a low cost device particularly suitable for personal computer system.

Read/Write head:

A floppy disk drive normally has two-read/write heads making Modern floppy disk drives as double-sided drives. A head exists for each side of disk and Both heads are used for reading and writing on the respective disk side.

Head 0 and Head 1:

Many people do not realize that the first head (head 0) is bottom one and top head is head 1. The top head is located either four or eight tracks inward from the bottom head depending upon the drive type.

Head Movement:

A motor called head actuator moves the head mechanism. The heads can move in and out over the surface of the disk in a straight line to position themselves over various tracks. The heads move in and out tangentially to the tracks that they record on the disk.

Head:

The heads are made of soft ferrous (iron) compound with electromagnetic coils. Each head is a composite design with a R/W head centered within two tunnel erasure heads in the same physical assembly. PC compatible floppy disk drive spin at 300 or 360r.p.m. The two heads are spring loaded and physically grip the disk with small pressure, this pressure does not present excessive friction.

Recording Method:

Tunnel Erasure: As the track is laid down by the R/W heads, the trailing tunnel erasure heads force the data to be present only within a specified narrow tunnel on each track. This process prevents the signals from reaching adjacent track and making cross talk.

Straddle Erasure:

In this method, the R/W and the erasure heads do recording and erasing at the same time. The erasure head is not used to erase data stored in the diskette. It trims the top and bottom fringes of recorded flux reversals. The erasure heads reduce the effect of cross-talk between tracks and minimize the errors induced by minor run out problems on the diskette or diskette drive.

Head alignment:

Alignment is the process of placement of the heads with respect to the track that they must read and write. Head alignment can be checked only against some sort of reference-standard disk recorded by perfectly aligned machine. These types of disks are available and one can use one to check the drive alignment.

1.4 HARD DISKS AND DRIVES

A **hard disk drive** (**HDD**), **hard disk**, **hard drive** or **fixed disk** is a data storage device that uses magnetic storage to store and retrieve digital information using one or more rigid rapidly rotating disks (platters) coated with magnetic material. The platters are paired with magnetic heads, usually arranged on a moving actuator arm, which read and write data to the platter surfaces. Data is accessed in a random-access manner, meaning that individual blocks of data can be stored or retrieved in any order and not only sequentially. HDDs are a type of non-volatile storage, retaining stored data even when powered off.

A hard drive can be used to store any data, including pictures, music, videos, text documents, and any files created or downloaded. Also, hard drives store files for the operating and software programs that run on the computer.

All primary computer hard drives are found inside a computer case and are attached to the computer motherboard using an ATA, SCSI, or SATA cable, and are powered by a connection to the PSU (power supply unit).

The hard drive is typically capable of storing more data than any other drive, but its size can vary depending on the type of drive and its age. Older hard drives had a storage size of several hundred megabytes (MB) to several gigabytes (GB). Newer hard drives have a storage size of several hundred gigabytes to several terabytes (TB). Each year, new and improved technology allows for increasing hard drive storage sizes.

Hard Drive Components

As can be seen in the picture above, the desktop hard drive consists of the following components: the head actuator, read/write actuator arm, read/write head, spindle, and platter. On the back of a hard drive is a circuit board called the disk controller or interface board and is what allows the hard drive to communicate with the computer.

External and Internal hard drives

Although most hard drives are internal, there are also stand-alone devices called **external hard drives**, which can backup data on computers and expand the available disk space. External drives are often stored in an enclosure that helps protect the drive and allows it to interface with the computer, usually over USB or eSATA.

History of the hard drive

The first hard drive was introduced to the market by IBM on September 13, 1956. The hard drive was first used in the RAMAC 305 system, with a storage capacity of 5 MB and a cost of about $50,000 ($10,000 per megabyte). The hard drive was built-in to the computer and was not removable.

The first hard drive to have a storage capacity of one gigabyte was also developed by IBM in 1980. It weighed 550 pounds and cost $40,000. 1983 marked the introduction of the first 3.5-inch size hard drive, developed by Rodime. It had a storage capacity of 10 MB. Seagate was the first company to introduce a 7200 RPM hard drive in 1992. Seagate also introduced the first 10,000 RPM hard drive in 1996 and the first 15,000 RPM hard drive in 2000.

The first solid-state drive (SSD) as we know them today was developed by SanDisk Corporation in 1991, with a storage capacity of 20 MB. However, this was not a flash-based SSD, which were introduced later in 1995 by M-Systems. These drives did not require a battery to keep data stored on the memory chips, making them a non-volatile storage medium.

2. CD-ROM

Compact Disk/Read Only Memory (CD-ROM): CD-ROM disks are made of reflective metals. CD-ROM is written during the process of manufacturing by high power laser beam. Here the storage density is very high, storage cost is very low and access time is relatively fast. Each disk is approximately 4 1/2 inches in diameter and can hold over

600 MB of data. As the CD-ROM can be read only we cannot write or make changes into the data contained in it.

- In PCs, the most commonly used optical storage technology is called Compact Disk Read-Only Memory (CD-ROM).
- A standard CD-ROM disk can store up to 650 MB of data,
  or about 70 minutes of audio.
- Once data is written to a standard CD-ROM disk, the data cannot be altered or overwritten.

CD-ROM SPEEDS AND USES

Storage capacity

1 CD can store about 600 to 700 MB = 600 000 to 700 000 KB

For comparison, we should realize that a common A4 sheet of paper can store an amount of information in the form of printed characters that would require about 2 kB of space on a computer. So one CD can store about the same amount of text information equivalent as 300 000 of such A4 sheets.

Yellow Book standard

- The basic technology of CD-ROM remains the same as that for CD audio, but CD-ROM requires greater data integrity, because a corrupt bit that is not noticeable during audio playback becomes intolerable with computer data.
- So CD-ROM (Yellow Book) dedicates more bits to error detection and correction than CD audio (Red Book).
- Data is laid out in a format known as ISO 960.

Advantages in comparison with other information carriers

- The formats are well standardized and the technology is stable; this ensures a high degree of compatibility.
- The information density is high.
- The cost of information storage per information unit is low.

- The disks are easy to store, to transport and to mail .
- Random access to information is possible.
- CD-ROM systems are easy to use

CD-ROM in local networks: possible advantages

- Easier access to a range of CD-ROMs.
- Ideally, access from the user's own workstation in the office or at home.
- Simultaneous access by several users to the same data.
- Better security avoids damage to discs and equipment.
- Less personnel time needed to provide disks to users.
- Automated, detailed registration of usage statistics to support the management.

CD-ROM in local networks: possible disadvantages

- Costs of the network software and computer hardware.
- Increased charges imposed by the information suppliers.
- Need for expensive, technical expertise to select, set up, manage, and maintain the network system.
- Technical problems when the CD-ROM product is not designed for use in the network.
- The network software component for the workstation side must be installed on each microcomputer before this can be applied to access the CD-ROM's.

CD-ROM XA: description

- CD-ROM XA = CD-ROM extended architecture, is an extension of the CD-ROM Yellow Book format.
- Uses compressed audio + pictures and interleaving, so that text as well as sound, static and moving pictures can appear simultaneously. (Interleaving = mixing of data for text, sound and pictures on the disc-track)
- Introduced by *Philips*, *Sony* and *Microsoft* in 1986.

3. Other Optical Devices:

a) Optical Disk: An optical disk is made up of a rotating disk which is coated with a thin reflective metal. To record data on the optical disk, a laser beam is focused on the surface of the spinning disk. The laser beam is turned on and off at varying rates! Due to this, tiny holes (pits) are burnt into the metal coating along the tracks. When data stored on the optical disk is to be read, a less powerful laser beam is focused on the disk surface. The storage capacity of these devices is tremendous; the *Optical disk* access time is relatively fast. The biggest drawback of the optical disk is that it is a permanent storage device. Data once written cannot be erased. Therefore it is a read only storage medium. A typical example of the optical disk is the CD-ROM.

- **Optical Card :**

The optical card has an optical laser encoded strip which can store approximately 2 megabytes of data. These cards are the size of a credit card. Optical cards find use only in specific areas like storing credit records or medical histories of people.

- **Optical Tape :**

Optical tapes are similar to magnetic tapes in appearance. However optical laser techniques are used to write data on the tapes. Like optical disks optical tapes too are read only storage devices.

Although there are many different types of optical disks, they can be grouped into three main categories.

1. *Read-only memory (ROM) disks*, like the audio CD, are used for the distribution of standard program and data files. These are mass-produced by mechanical pressing from a master die. The information is actually stored as physical indentations on the surface of the CD. Recently low-cost equipment has been introduced in the market to make one-off CD-ROMs, putting them into the next category.

2. *Write-once read-many (WORM) disks:* Some optical disks can be recorded once. The information stored on the disk cannot be changed or erased. Generally the disk has a thin reflective film deposited on the surface. A strong laser beam is focused on selected spots on the surface and pulsed. The energy melts the film at that point, producing a non-reflective void. In the read mode, a low power laser is directed at the disk and the bit

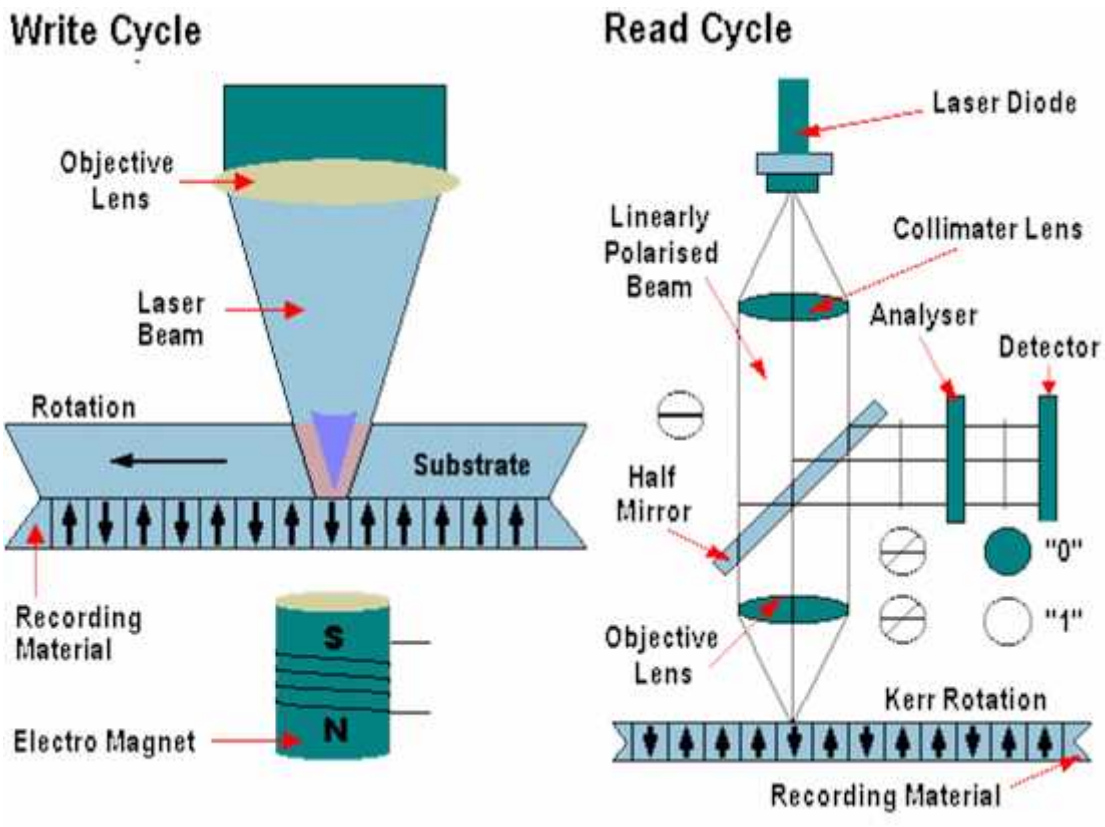
information is recovered by sensing the presence or absence of a reflected beam from the disk.

3. *Re-writeable, write-many read-many (WMRM) disks,* just like the magnetic storage disks, allows information to be recorded and erased many times. Usually, there is a separate erase cycle although this may be transparent to the user. Some modern devices have this accomplished with one over-write cycle. These devicesare also called direct-read-after-write (DRAW) disks.

4. WORM

WORM (*write once, read many*) is a data storage technology that allows information to be written to a disc a single time and prevents the drive from erasing the data. The discs are intentionally not rewritable, because they are especially intended to store data that the user does not want to erase accidentally. Because of this feature, WORM devices have long been used for the archival purposes of organizations such as government agencies or large enterprises. A type of optical media, WORM devices were developed in the late 1970s and have been adapted to a number of different media. The discs have varied in size from 5.25 to 14 inches wide, in varying formats ranging from 140MB to more than 3 GB per side of the (usually) double-sided medium. Data is written to a WORM disc with a low-powered laser that makes permanent marks on the surface.

WORM (Write Once, Read Many) storage had emerged in the late 1980s and was popular with large institutions for the archiving of high volume, sensitive data. When data is written to a WORM drive, physical marks are made on the media surface by a low-powered laser and since these marks are permanent, they cannot be erased.



Rewritable, or erasable, optical disk drives followed, providing the same high capacities as those provided by WORM or CD-ROM devices. However, despite the significant improvements made by recent optical technologies, performance continued to lag that of hard disk devices. On the plus side optical drives offered several advantages. Their storage medium is rugged, easily transportable and immune from head crashes and the kind of data loss caused by adverse environmental factors.

The result is that the relative advantages of the two types of system make them complementary rather than competitive – optical drives offering security, magnetic drives real-time performance. The development of the CD/DVD technologies to include recordable and rewritable formats has had a dramatic impact in the removable storage arena and compatibility is an important and unique advantage of the resulting family of products. Today's market is large enough to accommodate a number of different technologies offering a wide range of storage capacities.

5. ERASABLE OPTICAL DISK

An **erasable optical disk** is the one which can be erased and then loaded with new data content all over again. These generally come with a RW label. These are based on a technology popularly known as Magnetic Optical which involves the application of heat on a precise point on the disk surface and magnetizing it using a laser. Magnetizing alters the polarity of the point indicating data value '1'. Erasing too is achieved by heating it with a high energy laser to a certain critical level where the crystal polarity is reset to all 0's.

A variety of **optical disc**, or type of external storage **media**, that allows the deletion and rewriting of information, unlike a CD or CD-ROM, which are read-only **optical** discs. An **erasable optical disc** allows high-capacity storage (600 MB or more) and their durability has made them useful for archival storage.

7. TOUCHSCREEN OPTICAL DEVICE:

A **touchscreen** is an input and output device normally layered on the top of an electronic visual display of an information processing system. A user can give input or control the information processing system through simple or multi-touch gestures by touching the screen with a special stylus or one or more fingers.[1] Some touchscreens use ordinary or specially coated gloves to work while others may only work using a special stylus or pen. The user can use the touchscreen to react to what is displayed and, if the software allows, to control how it is displayed; for example, zooming to increase the text size.

The touchscreen enables the user to interact directly with what is displayed, rather than using a mouse, touchpad, or other such devices (other than a stylus, which is optional for most modern touchscreens).

Touchscreens are common in devices such as game consoles, personal computers, electronic voting machines, and point-of-sale (POS) systems. They can also be attached to computers or, as terminals, to networks. They play a prominent role in the design of digital appliances such as personal digital assistants (PDAs) and some e-readers.

Types of Touch Screen Technologies

Buttons on electronic devices are now passé: touch screens are rapidly becoming the ubiquitous interface for controlling them.

While many of us have started using touch screens only after they went mainstream in modern smart phones, the technology itself has been around for decades.

Among other places, touch screens are found in handheld devices used in industrial settings, navigational equipment, retail point of sale terminals, vending machines, kiosks and ATMs.

Touch screen technologies can be mainly divided into two types- overlay based and perimeter based.

In overlay based touch screen technologies, the screen is integral to the mechanics of registering input. Touch events are registered when the object touches the screen.

There are two types of overlay based touch screens:

- Capacitive Touch Technology – Capacitive touch screens take advantage of the conductivity of the object to detect location of touch. While they are durable and last for a long time, they can malfunction if they get wet. Their performance is also compromised if a non conductor like a gloved finger presses on the screen. Most smart phones and tablets have capacitive touch screens.
- Resistive Touch Technology – Resistive touch screens have moving parts. There is an air gap between two layers of transparent material. When the user applies pressure to the outer layer, it touches the inner layer at specific locations. An electric circuit is completed and the location can be determined. Though they are cheaper to build compared to capacitive touch screens, they are also less sensitive and can wear out quickly.

Perimeter based touch screen technologies work differently. In this case, the screen is incidental to the main process of registering input. These screens have beam break sensors or cameras embedded in the bezel. These sensors monitor light or acoustic waves emitted by LEDs or transducers, also set in the bezel.

When an object touches the screen, there is a break in the path of the rays. This creates a shadow or a dark area which is detected by the sensors. Using complex mathematical calculations, and in some cases heavy data processing the location of the object can be determined.

There are mainly three types of perimeter based technologies:

- Infrared Touch Technology – This technology uses beams of infrared lights to detect touch events.
- Surface Acoustic Wave Touch Technology – This type of touch screen uses ultrasonic waves to detect touch events.
- Optical Touch Technology – This type of perimeter based technology uses optical sensors, mainly CMOS sensors to detect touch events.

All of these touch screen technologies can also be integrated on top of a non-touch based system like an ordinary LCD and converted into Open Frame Touch Monitors.
ShadowSense is a form of perimeter based technology. It also uses light emitted by LEDs and the shadows thrown by the object to calculate size and location on the screen. However, the implementation is simpler and the screen itself runs without any drivers. ShadowSense touch screens also have numerous other advantages over conventional touch screens.