

MAR GREGORIOS COLLEGE OF ARTS & SCIENCE

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DEPARTMENT OF ELECTRONICS & COMMUNICATION SCIENCE

SUBJECT NAME: ADVANCED ELECTRONICS

SUBJET CODE: TAG6B

SEMESTER: VI

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UNIT I

OPTOELECTRONIC DEVICES – Introduction – Classification of OPTO Electronic Devices – Laser Diode -Photoconductive cells (Photo resistive cell, Photo diode, Avalanche Diode) – PhotoVoltaic Cell (or) Solar Cell – Laser Range Finder - Light-activated SCR (LASCR)OpticalIsolator

UNIT II

MEMS – MEMS Definition – Materials for MEMS Manufacturing (Silicon, Polymers, Ceramics, Metals) - MEMSbasic processes - Deposition processes, Patterning, Etching (Only Introductory Level) – Mentioning of Applications of MEMS.

UNIT III

Smart Phones – Symbian – Symbian- Android (operating system – Apple iPhone - Windows Phone - Palm OS -Bada operating system - Open-source development

UNIT IV

Nanoelectronics – Concept of 3D, 2D & 0D Nano Structures

UNIT V

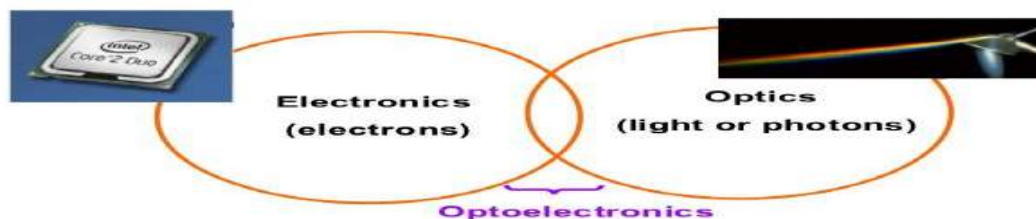
Voice & Data communication - Wired/Wireless - Communication using IP networks, SDH, Routers.

UNIT I

OPTO ELECTRONICS DEVICES

INTRODUCTION

Optoelectronics is the study and application of **electronic** devices that interact with **light**



The term optoelectronics is a specific discipline of electronics that focuses on light-emitting or light-detecting devices.

Light-emitting devices use voltage and current to produce electromagnetic radiation (i.e., light). Such light-emitting devices are commonly used for purposes of illumination or as indicator lights.

In contrast, light-detecting devices, such as phototransistors, are designed to convert received electromagnetic energy into electric current or voltage. Light-detecting devices can be used for light sensing and communication. Examples of these include darkness-activated switches and remote controls. In general terms, light-detecting devices work by using photons to liberate bound electrons within semiconductor materials

Opto-electronics (or **optronics**) is the study and application of electronic devices and systems that source, detect and control light, usually considered a sub-field of photonics. In this context, *light* often includes invisible forms of radiation such as gamma rays, X-rays, ultraviolet and infrared, in addition to visible light. Optoelectronic devices are electrical-to-optical or optical-to-electrical transducers, or instruments that use such devices in their operation.^[1]

Optoelectronics is based on the quantum mechanical effects of light on electronic materials, especially semiconductors, sometimes in the presence of electric fields.

Photoelectric or photovoltaic effect, used in: photodiodes (including solar cells)phototransistors

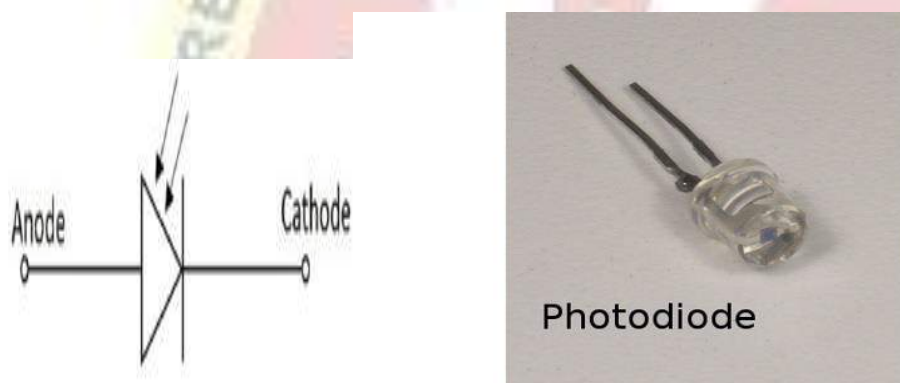
photomultipliersoptoisolatorsNintegrated optical circuit (IOC) elements

Photoconductivity, used in: photoresistors photoconductive camera tubes charge-coupled imaging devices Stimulated emission, used in: injection diodes quantum Radiative recombination, used in: light-emitting diodes or LEDOLEDs Photoemissivity, used in photoemissive camera tube Important applications^[3] of optoelectronics include: Optocoupler Optical fiber communications)

Photo Diode

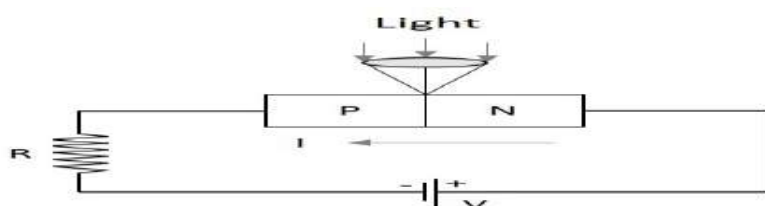
Photo diode, as the name implies, is a PN junction which works on light. The intensity of light affects the level of conduction in this diode. The photo diode has a P type material and an N-type material with an intrinsic material or a depletion region in between.

This diode is generally operated in reverse bias condition. The light when focused on the depletion region, electron-hole pairs are formed and flow of electron occurs. This conduction of electrons depends upon the intensity of light focused. The figure below shows a practical Photo diode.



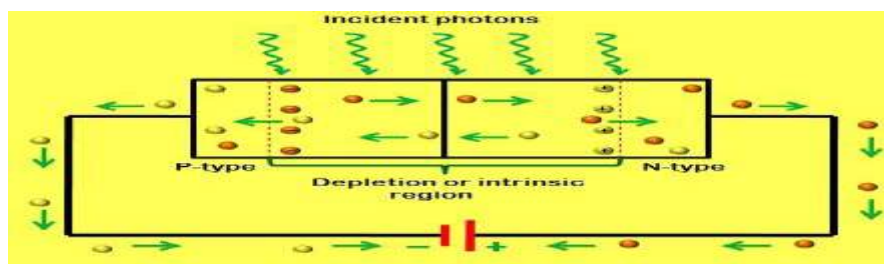
The figure above indicates the symbol for a photodiode.

When the diode is connected in reverse bias, a small reverse saturation current flows due to thermally generated electron hole pairs. As the current in reverse bias flows due to minority carriers, the output voltage depends upon this reverse current. As the light intensity focused on the junction increases, the current flow due to minority carriers increase. The following figure shows the basic biasing arrangement of a photo diode.



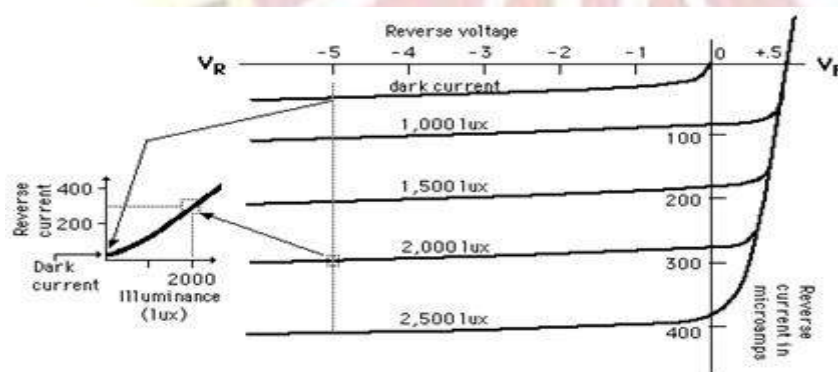
The Photo diode is encapsulated in a glass package to allow the light to fall onto it. In order to focus the light exactly on the depletion region of the diode, a lens is placed above the junction, just as illustrated above.

Even when there is no light, a small amount of current flows which is termed as **Dark Current**. By changing the illumination level, reverse current can be changed.



V-I Characteristics of Photodiode

Photodiode operates in reverse bias condition. Reverse voltages are plotted along X axis in volts and reverse current are plotted along Y-axis in microampere. Reverse current does not depend on reverse voltage. When there is no light illumination, reverse current will be almost zero. The minimum amount of current present is called as Dark Current. Once when the light illumination increases, reverse current also increases linearly.



Advantages of Photo diode..

Photo diode has many advantages such as –

Low noise

High gain

High speed operation

High sensitivity to light

Low cost

Small size

Long lifetime

Applications of Photo diode

There are many applications for photo diode such as –

Character detection

Objects can be detected visible or invisible

Used in circuits that require high stability and speed.

Used in Demodulation

Used in switching circuits

Used in Encoders

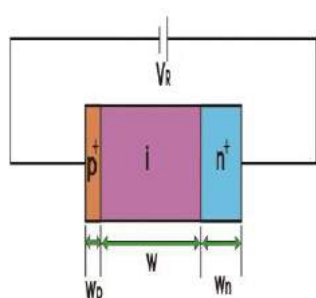
Used in optical communication equipment

PIN Diode

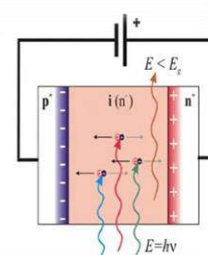
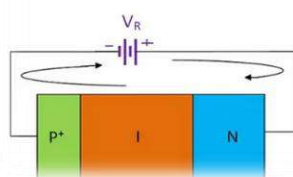
PIN photodiode is a kind of photo detector, it can convert optical signals into electrical signals. There is a p-region an intrinsic region and an n-region. The p-region and n-region are comparatively heavily doped than the p-region and n-region of usual p-n diodes. The width of the intrinsic region should be larger than the space charge width of a normal pn junction.

The **PIN photo diode** operates with an applied reverse bias voltage and when the reverse bias is applied, the space charge region must cover the intrinsic region completely. Electron hole pairs are generated in the space charge region by photon absorption. The switching speed of frequency response of photodiode is inversely proportional to the life time.

The switching speed can be enhanced by a small minority carrier lifetime. For the photo detector applications where the speed of response is important, the depletion region width should be made as large as possible for small minority carrier lifetime as a result the switch speed also increases. This can be achieved **PIN photodiode** as the insertion of intrinsic region the space charge width larger. The diagram of a normal PIN photodiode is given below.



What is a PIN Photodiode?



Avalanche Photodiode

The avalanche photodiode possesses a similar structure to that of the PN or PIN photodiode..

The main difference of the avalanche photodiode to other forms of photodiode is that it operates under a high reverse bias condition. This enables avalanche multiplication of the holes and electrons created by the photon / light impact.

As a photon enters the depletion region and creates a hole electron pair, these charge carriers will be pulled by the very high electric field away from one another. Their velocity will increase to such an extent that when they collide with the lattice, they will create further hole electron pairs and the process will repeat.

The avalanche action enables the gain of the diode to be increased many times, providing a very much greater level of sensitivity.

Avalanche photodiode advantages

High level of sensitivity as a result of avalanche gain

Avalanche photodiode disadvantages:

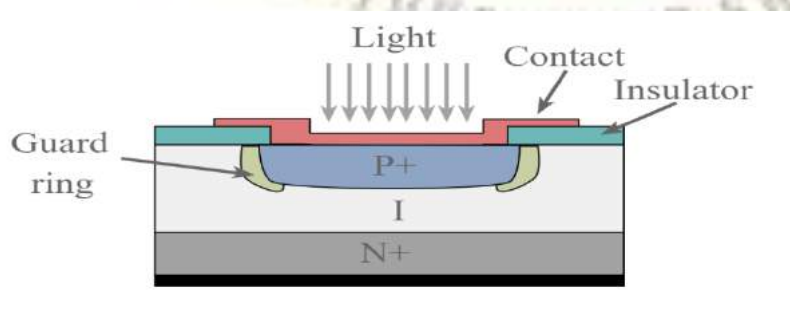
Much higher operating voltage may be required.

Avalanche photodiode produces a much higher level of noise than a PN photodiode

Avalanche process means that the output is not linear

Avalanche photodiode structure

The avalanche photodiode structure is relatively similar to that of the more commonly used PN photodiode structure or the structure of the PIN photodiode. However, as the avalanche photodiode is operated under a high level of reverse bias a guard ring is placed around the perimeter of the diode junction. This prevents surface breakdown mechanisms.



Avalanche diode operation

Light enters the un-doped region of the avalanche photodiode and causes the generation of hole-electron pairs. Under the action of the electric field the electrons migrate towards the

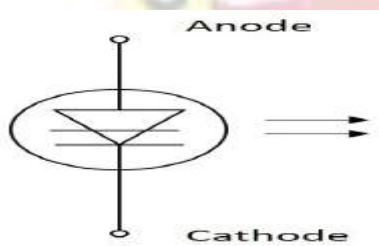
avalanche region. Here the electric field causes their velocity to increase to the extent that collisions with the crystal lattice create further hole electron pairs. In turn these electrons may collide with the crystal lattice to create even more hole electron pairs. In this way a single electron created by light in the un-doped region may result in many more being created.

The avalanche photodiode has a number of differences when compared to the ordinary PIN diode. The avalanche process means that a single electron produced by light in the un-doped region is multiplied several times by the avalanche process. As a result, the avalanche photo diode is far more sensitive. However, it is found that it is not nearly as linear, and additionally the avalanche process means that the resultant signal is far noisier than one from a p-i-n diode.

LASER DIODE

Laser Diode is another popular diode. It is specifically fabricated p-n junction diode. This diode emits laser light when it is forward biased with stimulated process

The name **LASER** implies **L**ight **A**mplification by **S**timulated **E**mission of **R**adiation.



Stimulated Emission

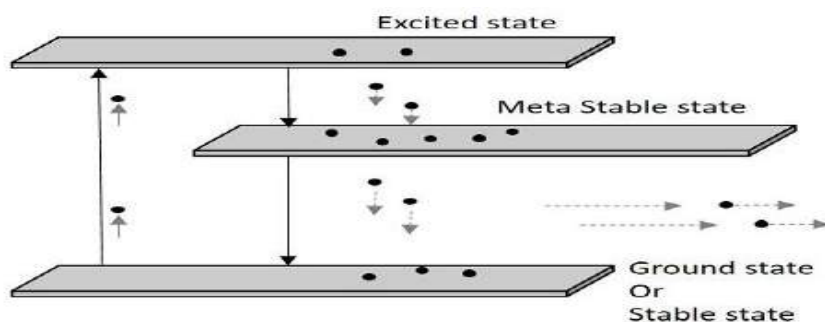
This is a PN junction diode whose action starts when a light ray is incident on it. With a light ray, when photons get incident on an atom, the atom gets excited and it reaches an upper level which can be termed as a **Higher Energy Level**. The atom when shifts from the higher energy level to a **Lower Energy Level**, it releases **two photons** which are **similar in characteristics** to the incident photon and are in **equal phase** to it. This process is called as **Stimulated Emission**. An atom can generally stay in this excited state for **10⁻⁸ secs** of time. So, the above process sets the principle for laser diode.

Principle of Laser

Whenever a photon is incident on an atom, that atom is excited from a lower energy state to a higher energy state and two photons are released in this process. Actually, an atom can generally stay at this excited state for **10⁻⁸ secs** of time. So, in order to achieve amplification,

during this excited process, the atom is made to be placed in another state called **Meta Stable State** which is below the higher energy level and above the lower energy level.

An atom can stay in this Meta stable state for 10^{-3} secs. While the atom gets to the lower state from this, two photons are released. If more number of atoms are there in the excited state, prior to the photons striking the atoms, then we have the **Lasing Effect**.

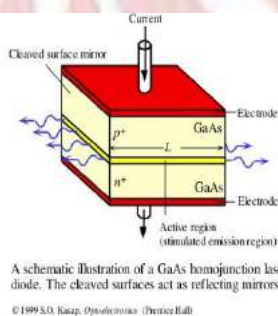


Population Inversion in Laser diode

In this process, we have two terms to understand. Having more number of atoms at Meta Stable state than the lower energy state or ground state is called as **Population inversion**. Then energy that lets the atoms to send from a lower energy state to a higher energy state to achieve the population inversion, is called as **Pumping**. This is **Optical pumping**.



Image showing a practical laser diode

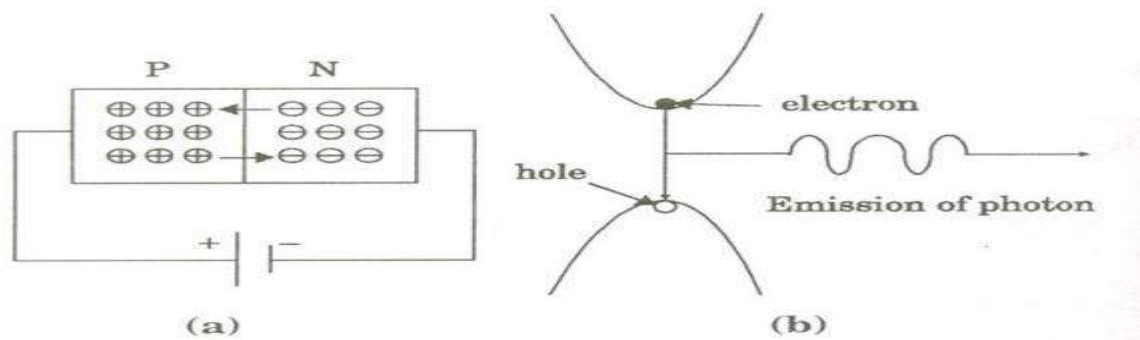


Principle:

When a p-n junction diode is forward biased, the electrons from n – region and the holes from the p- region cross the junction and recombine with each other.

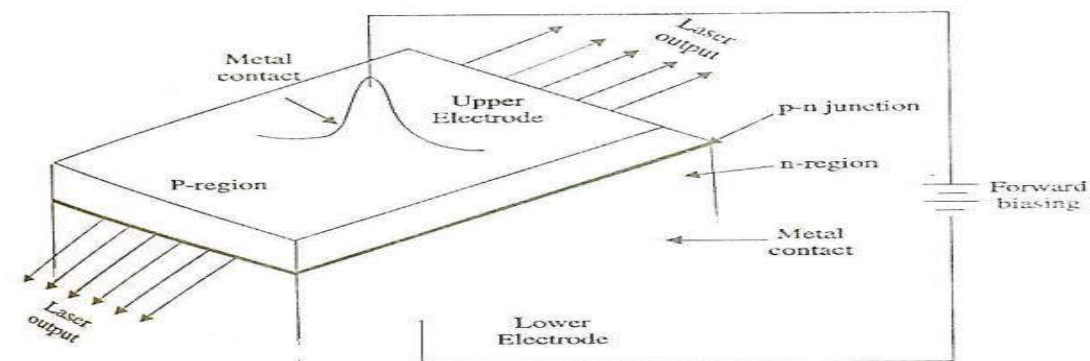
During the recombination process, the light radiation (photons) is released from a certain specified direct band gap semiconductors like Ga-As. This light radiation is known as recombination radiation.

The photon emitted during recombination stimulates other electrons and holes to recombine. As a result, stimulated emission takes place which produces laser.



Construction:

Figure shows the basic construction of semiconductor laser. The active medium is a p-n junction diode made from the single crystal of gallium arsenide. This crystal is cut in the form of a platelet having thickness of $0.5\mu\text{m}$.



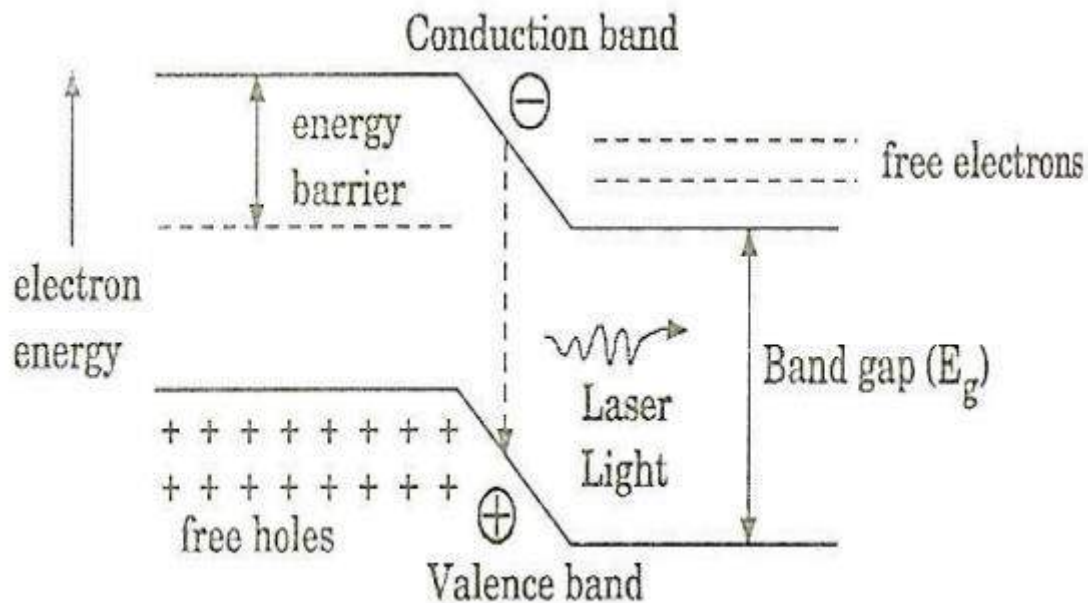
The platelet consists of two parts having an electron conductivity (n-type) and hole conductivity (p-type).

The photon emission is stimulated in a very thin layer of PN junction (in order of few microns). The electrical voltage is applied to the crystal through the electrode fixed on the upper surface.

The end faces of the junction diode are well polished and parallel to each other. They act as an optical resonator through which the emitted light comes out.

Working:

Figure shows the energy level diagram of semiconductor laser.



When the PN junction is forward biased with large applied voltage, the electrons and holes are injected into junction region in considerable concentration

The region around the junction contains a large amount of electrons in the conduction band and a large amount of holes in the valence band.

If the population density is high, a condition of population inversion is achieved. The electrons and holes recombine with each other and this recombination's produce radiation in the form of light.

When the forward – biased voltage is increased, more and more light photons are emitted and the light production instantly becomes stronger. These photons will trigger a chain of stimulated recombination resulting in the release of photons in phase.

The photons moving at the plane of the junction travels back and forth by reflection between two sides placed parallel and opposite to each other and grow in strength.

After gaining enough strength, it gives out the laser beam of wavelength 8400\AA . The wavelength of laser light is given by

$$E_g = h\nu = h \frac{c}{\lambda}$$

$$\lambda = \frac{hc}{E_g}$$

Where E_g is the band gap energy in joule.

Characteristics:

1. **Type:** It is a solid state semiconductor laser.
2. **Active medium:** A PN junction diode made from single crystal of gallium arsenide is used as an active medium.
3. **Pumping method:** The direct conversion method is used for pumping action
4. **Power output:** The power output from this laser is 1mW.
5. **Nature of output:** The nature of output is continuous wave or pulsed output.
6. **Wavelength of Output:** gallium arsenide laser gives infrared radiation in the wavelength 8300 to 8500o A .

Advantages:

1. It is very small in dimension. The arrangement is simple and compact.
2. It exhibits high efficiency.
3. The laser output can be easily increased by controlling the junction current
4. It is operated with lesser power than ruby and CO2 laser.
5. It requires very little auxiliary equipment
6. It can have a continuous wave output or pulsed output.
7. Power used by laser diodes is much less
8. Higher ON/OFF switching speed
9. More Compact
10. Less expensive
11. They are cheaper than laser generators
12. Less chances of providing electrical shocks

Disadvantages:

1. It is difficult to control the mode pattern and mode structure of laser.
2. The output is usually from 5 degree to 15 degree i.e., laser beam has large divergence.
3. The purity and monochromaticity are poorer than other types of laser
4. Threshold current density is very large (400A/mm^2).
5. It has poor coherence and poor stability.

More divergent rays and hence quality is not so good

Their life time is less compared to LED.

Prone to damage during unstable power supplies

Applications

There are many applications of Laser diode such as –

Used as pump-laser and seed-laser

Used in optical data storage devices

Used in laser printers and laser fax machines

Used in Laser pointers

Used in bar-code readers

They are used in DVD and CD drives

Used in HD DVD and BLU RAY technology

Has many industrial purposes such as heat treating, cladding, seam welding etc.

Has got many uses in communication technology such as data linking and transmission.

Optocoupler

An optocoupler uses an LED optically coupled to a photodiode or a phototransistor in a single package.

Two basic types are LED-to-photodiode and LED-to-phototransistor, as shown in Figure.

Optocoupler

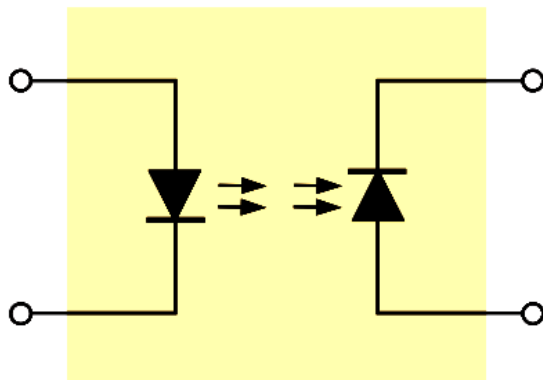


Fig a : LED to Photodiode

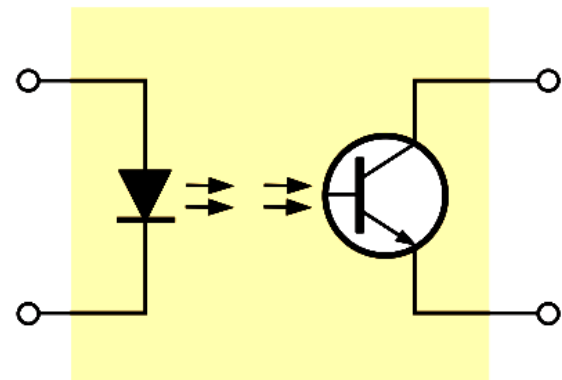


Fig b : LED to Phototransistor

Optocoupler Principle

Optocouplers are used to isolate sections of a circuit that are incompatible in terms of the voltage levels or currents required.

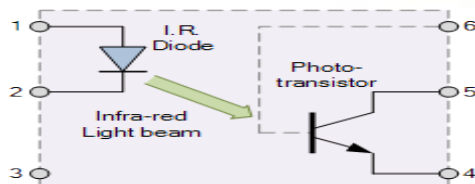
For example, they are used to protect hospital patients from shock when they are connected to monitoring instruments or other devices.

They are also used to isolate low-current control or signal circuits from noisy power supply circuits or higher-current motor and machine circuits.

The basic design of an optocoupler, also known as an **Opto-isolator**, consists of an LED that produces infra-red light and a semiconductor photo-sensitive device that is used to detect the emitted infra-red beam. Both the LED and photo-sensitive device are enclosed in a light-tight body or package with metal legs for the electrical connections as shown.

An optocoupler or opto-isolator consists of a light emitter, the LED and a light sensitive receiver which can be a single photo-diode, photo-transistor, photo-resistor, photo-SCR, or a photo-TRIAC with the basic operation of an optocoupler being very simple to understand.

Phototransistor Optocoupler



Assume a photo-transistor device as shown. Current from the source signal passes through the input LED which emits an infra-red light whose intensity is proportional to the electrical signal.

This emitted light falls upon the base of the photo-transistor, causing it to switch-ON and conduct in a similar way to a normal bipolar transistor.

The base connection of the photo-transistor can be left open (unconnected) for maximum sensitivity to the LEDs infra-red-light energy or connected to ground via a suitable external high value resistor to control the switching sensitivity making it more stable and resistant to false triggering by external electrical noise or voltage transients.

When the current flowing through the LED is interrupted, the infra-red emitted light is cut-off, causing the photo-transistor to cease conducting. The photo-transistor can be used to switch current in the output circuit. The spectral response of the LED and the photo-sensitive device are closely matched being separated by a transparent medium such as glass, plastic or air. Since there is no direct electrical connection between the input and output of an optocoupler, electrical isolation up to 10kV is achieved.

Optocoupler Applications

Optocouplers and opto-isolators can be used on their own, or to switch a range of other larger electronic devices such as transistors and triacs providing the required electrical isolation between a lower voltage control signal, for example one from an Arduino or micro-controller, and a much higher voltage or mains current output signal.

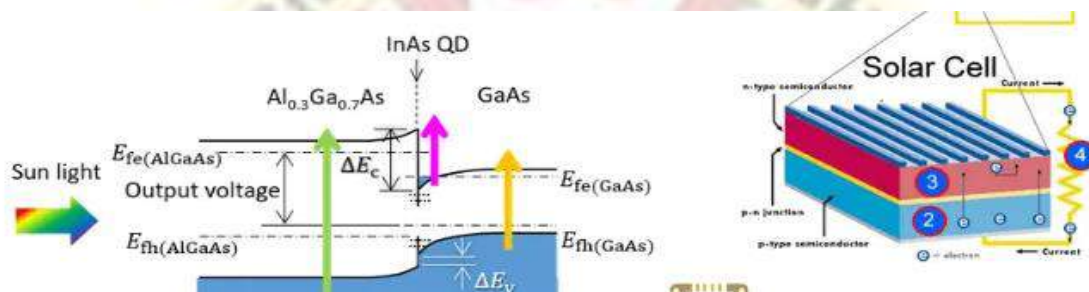
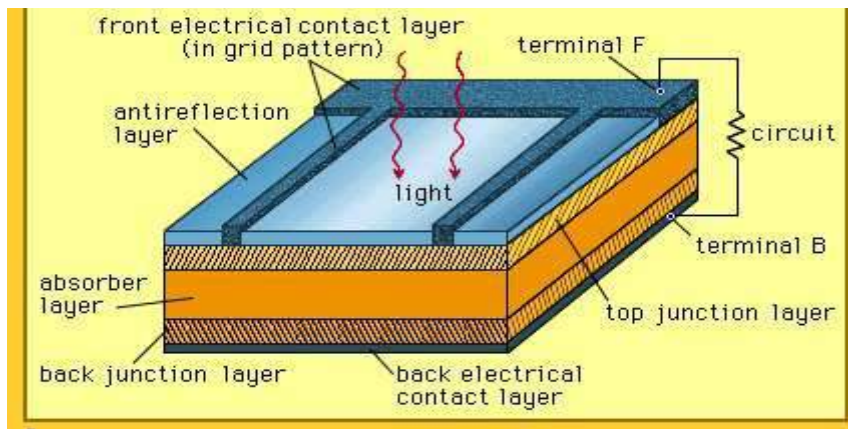
Common applications for opto-couplers include microprocessor input/output switching, DC and AC power control, PC communications, signal isolation and power supply regulation which suffer from current ground loops, etc. The electrical signal being transmitted can be either analogue (linear) or digital (pulses).

In this application, the optocoupler is used to detect the operation of the switch or another type of digital input signal. This is useful if the switch or signal being detected is within an electrically noisy environment. The output can be used to operate an external circuit, light or as an input to a PC or microprocessor.

Solar cell

Solar cell, also called **photovoltaic cell**, any device that directly converts the energy of light into electrical energy through the photovoltaic effect. The overwhelming majority of solar cells are fabricated from silicon—with increasing efficiency and lowering cost as the materials range from amorphous (noncrystalline) to polycrystalline to crystalline (single crystal) silicon forms. Unlike batteries or fuel cells, solar cells do not

utilize chemical reactions or require fuel to produce electric power, and, unlike electric generators, they do not have any moving parts.



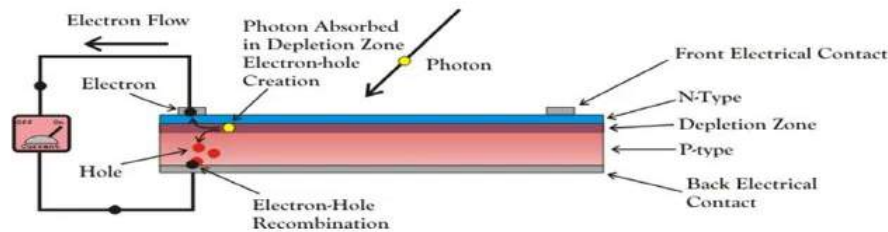
A **solar cell** (also known as a photovoltaic cell or PV cell) is defined as an electrical device that converts light energy into electrical energy through the photovoltaic effect. A solar cell is basically a p-n junction diode. Solar cells are a form of photoelectric cell, defined as a device whose electrical characteristics – such as current, voltage, or resistance – vary when exposed to light.

Individual solar cells can be combined to form modules commonly known as solar panels. The common single junction silicon solar cell can produce a maximum open-circuit voltage of approximately 0.5 to 0.6 volts. By itself this isn't much – but remember these solar cells are tiny. When combined into a large solar panel, considerable amounts of renewable energy can be generated.

Construction of Solar Cell

solar cell is basically a junction diode, although its construction it is little bit different from conventional p-n junction diodes. A very thin layer of p-type semiconductor is grown on a relatively thicker n-type semiconductor. We then apply a few finer electrodes on the top of the p-type semiconductor layer.

These electrodes do not obstruct light to reach the thin p-type layer. Just below the p-type layer there is a p-n junction. We also provide a current collecting electrode at the bottom of the n-type layer. We encapsulate the entire assembly by thin glass to protect the **solar cell** from any mechanical shock.



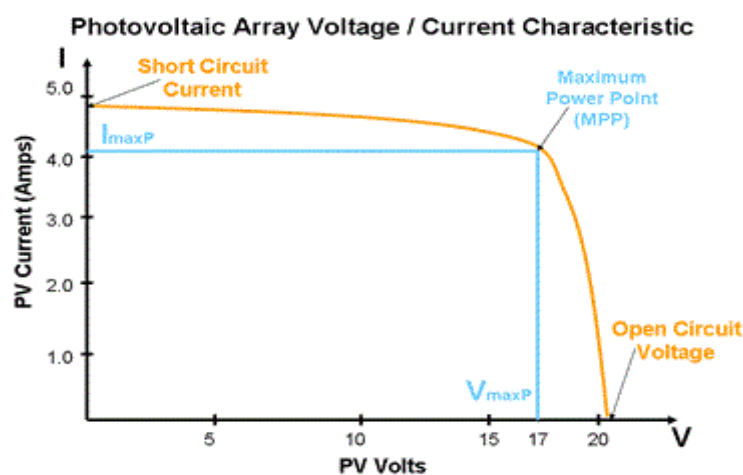
Working Principle of Solar Cell

When light reaches the p-n junction, the light photons can easily enter in the junction, through very thin p-type layer. The light energy, in the form of photons, supplies sufficient energy to the junction to create a number of electron-hole pairs. The incident light breaks the thermal equilibrium condition of the junction. The free electrons in the depletion region can quickly come to the n-type side of the junction.

Similarly, the holes in the depletion can quickly come to the p-type side of the junction. Once, the newly created free electrons come to the n-type side, cannot further cross the junction because of barrier potential of the junction.

Similarly, the newly created holes once come to the p-type side cannot further cross the junction because of same barrier potential of the junction. As the concentration of electrons becomes higher in one side, i.e. n-type side of the junction and concentration of holes becomes more in another side, i.e. the p-type side of the junction, the p-n junction will behave like a small battery cell. A voltage is set up which is known as photo voltage. If we connect a small load across the junction, there will be a tiny current flowing through it

V-I Characteristics of a Photovoltaic Cell



Materials Used in Solar Cell

The materials which are used for this purpose must have band gap close to 1.5eV.

Commonly used materials are-

Silicon.

aAs.

CdTe.

CuInSe₂

Criteria for Materials to be Used in Solar Cell

Must have band gap from 1eV to 1.8eV.

It must have high optical absorption.

It must have high electrical conductivity.

The raw material must be available in abundance and the cost of the material must be low.

Advantages of Solar Cell

No pollution associated with it.

It must last for a long time.

No maintenance cost.

Disadvantages of Solar Cell

It has high cost of installation.

It has low efficiency.

During cloudy day, the energy cannot be produced and also at night we will not get solar energy.

Uses of Solar Generation Systems

It may be used to charge batteries.

Used in light meters.

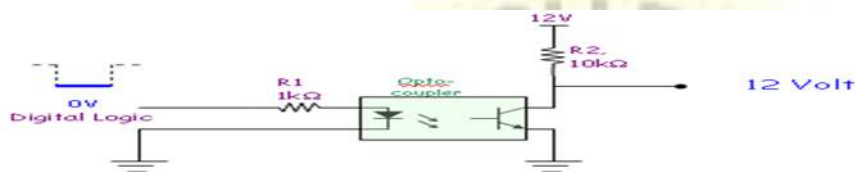
It is used to power calculators and wrist watches.

It can be used in spacecraft to provide electrical energy.

Conclusion: Though **solar cell** has some disadvantage associated with it, but the disadvantages are expected to overcome as the technology advances, since the technology is advancing, the cost of solar plates, as well as the installation cost, will decrease down so that everybody can afford to install the system

WHY LIDAR ?

- It is used for generating precise and directly geo-referenced spatial information.
- Lasers produce a coherent light source.
- It is Active sensor , do not require sunlight, they can be used either during the day or at night.
- LIDAR is popularly used as a technology used to make high resolution maps.



LIDAR:

- Acronym for Light Detection And Ranging (sometimes Light Imaging, Detection, And Ranging).
- The LASER system, employed for monitoring the nature of environment is called LIDAR.
- It is an active remote sensing technology that measures distance by illuminating a target with a laser and analyzing the reflected light.
- Similar to RADAR, but uses laser light pulses instead of radio waves.
- LIDAR uses ultraviolet rays , visible rays and near infrared rays to image object.
- By illuminating the target using laser beam ,a 3-D point cloud of the target and it's surrounding can be generated.
- Three types of information can be obtained:
 - a) Range to target (Topographic LIDAR, or Laser Altimetry)
 - b) Chemical properties of target (Differential Absorption LIDAR)
 - c) Velocity of target (Doppler LIDAR)

LET YOUR LIGHT SHINE

Components of LIDAR System:

- **Component of lidar system-LASER :**

Frequency: 50,000 (50k) to 200,000 (200k) pulses per second (Hz) (slower for bathymetry)

Wavelength:

Infrared (1500 – 2000 nm) for meteorology

Near-infrared (1040 - 1060 nm) for terrestrial mapping

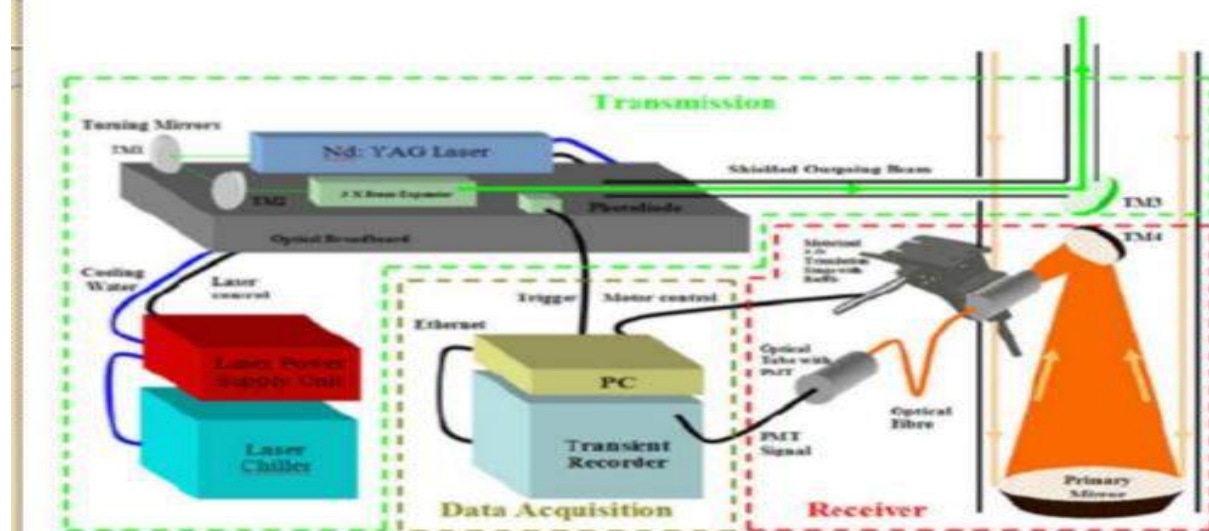
Blue-green (500 – 600 nm) for bathymetry

- **LIDAR Transceiver-** Generates laser beam and captures laser energy scattered/reflected from target.
- **Scanner-** A laser scanner has three sub-components: the opto mechanical scanner, the ranging unit, and the control processing unit

Components of LIDAR System:

- **POS(IMU & GPS)-** Measures “sensor” position and orientation. Inertial measurement systems also contain accelerometers to measure the velocity.
- **Operator-** Permits operator interaction (control/monitor) with system
- **Data storage -** Captures all AIRBORNE system data required for generation of x , y , z “target” coordinates.
- **Computer-** Integrates/controls interaction of all of the above.

Components of LIDAR System:



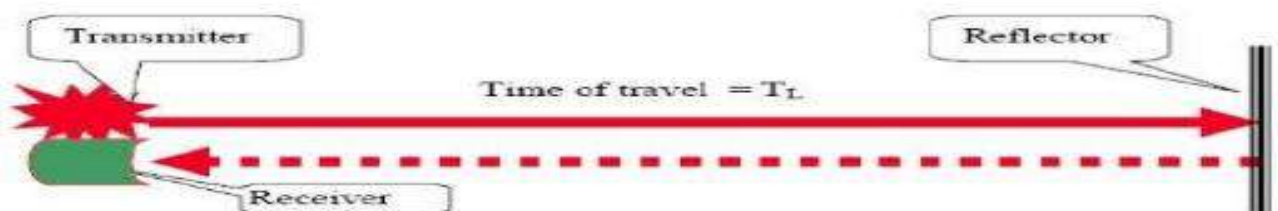
Working Principle:

- Laser generates an optical pulse.
- Pulse is transmitted , reflected and returned to the receiver.
- This return beam/pulse is collected and processed to obtain property of target.
- Receiver accurately measures the travel time.
- X,Y,Z coordinates can be computed from
 1. Laser range
 2. Laser scan angle
 3. Absolute location of sensor

Working Principle:

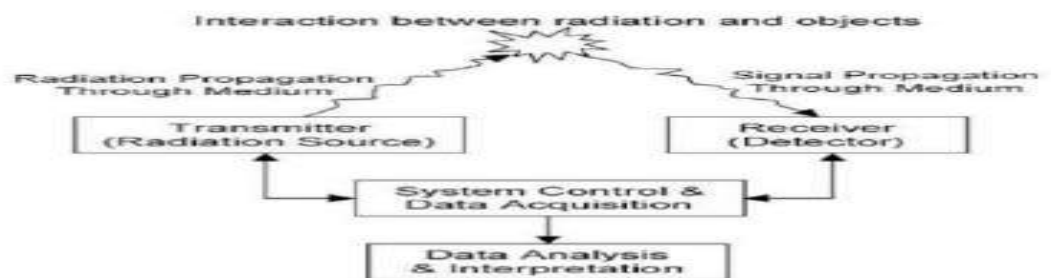
- Calculate Distance :-

$$\text{Distance} = (\text{Speed of Light} * \text{Time of flight}) / 2$$



Working Principle:

Physical picture in LIDAR remote sensing:



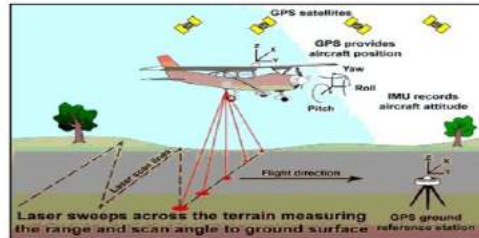
SATELLITE(space borne):

- Mapping of remote areas for scientific purpose.
- It has 3 sub parts:
 - Geostationary
 - Polar
 - Sun synchronous



AERIAL/AVIATION platform:

- Used for topographic mapping and engineering application.
- It has 3 sub parts:
 - Laser scanning
 - Fixed wing platform
 - Rotary wing platform



TERRESTRIAL(ground spaced):

- Produce detailed 3D models of buildings, bridges, streetcapes, factories and other man-made infrastructure.
- It has 3 sub types:
 - Short range
 - Medium range
 - Long range



Bathymetric Mapping System:

- **Bathymetry** is the study of underwater depth of lake or ocean floors. In other words, bathymetry is the underwater equivalent to hypsometry or topography.
- It uses blue-green laser that can penetrate water and provide returns of underwater objects or bottom.
- Effective collection of near shore bathymetry.



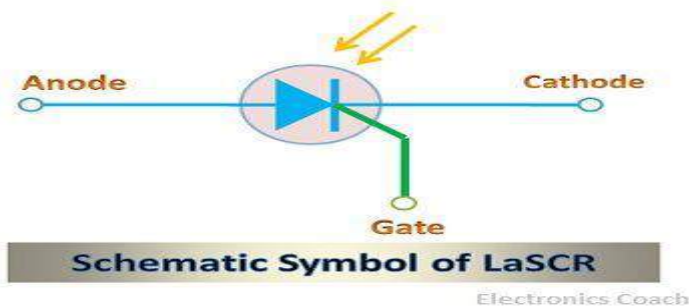
- **Agriculture** : Create a Topographical map of the fields and reveals the slopes and sun exposure of the farm land.
- **Autonomous vehicles**: Autonomous vehicles use LIDAR for obstacle detection and avoidance to navigate safely through environments.
- **Geology and soil science**: ICE Sat (Ice, Cloud, and land Elevation Satellite).
- **Law enforcement**: LIDAR speed guns
- Surveying, Transport, wind farm optimization and many more.
- Atmospheric Remote Sensing and Meteorology.

Light Activated SCR

Definition: LASCR or **light activated SCR** is a semiconductor device which turns ON when it is exposed to light. The constituent element of SCR is silicon, and it works like a rectifier, and thus, it is termed as **Silicon Controlled Rectifier**. The LASCR is a type of thyristor which is triggered by photons present in the light rays.

It is a three terminal device, consists of **cathode**, **anode** and **gate** terminal. The gate terminal is used when the electrical triggering is supplied to the **LASCR**. The advantage of using triggering of the thyristor by light is prevention from electrical noise disturbances. Thus, LASCR is considered to be one of the best devices.

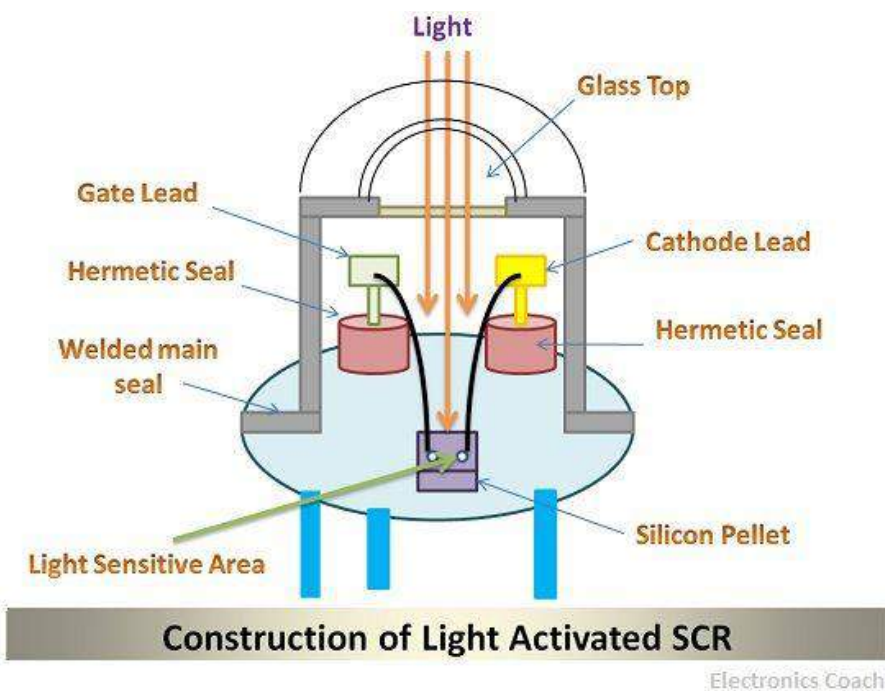
The symbolic representation of LASCR is shown below:



Construction of LASCR

The LASCR is made up of **silicon material**, and the glass lens in the LASCR is used to focus the light from the external source on the semiconductor material. The silicon pellet is used in the bottom of the device, and the light intensity dislodges electrons in the semiconductor crystal and contributes to conduction.

The constructional architecture of the LASCR is described below in the diagram.



Working of LASCR

The **LASCR** works on the principle of **photoconduction** that is conduction due to photon striking the semiconductor surface. The LASCR is basically a thyristor; it is made up of

semiconductor material. The light rays falling on the device are focused at one place to intensify it.

The more the intensity of light, the more will be the current through the LASCR. The internal architecture of LASCR consists of two transistors in such a way that the collector of one transistor is connected to the base of another transistor.

The light falling on the light activated SCR generates the electron from the valence band, and these electrons will enter conduction band. The electrons will move from collector of one region to base of another region, and then the cascading effect can be seen.

The best thing about **Light Activated SCR** is that they do not turn off even when the supply of external light is ceased. If you want to turn off the SCR, then you need to reverse the properties of electrodes.

The **light-activated SCR (Silicon Controlled Rectifier)** is also termed as **light triggered thyristor (LTT)**. This is because the thyristor is triggered by the supply of light from the external source. Although, the combination of light source and the electrical signal is also used sometimes to trigger the thyristor. But in this, the electrical signal is applied through the gate terminal. And the light is incident directly to semiconductor crystal.

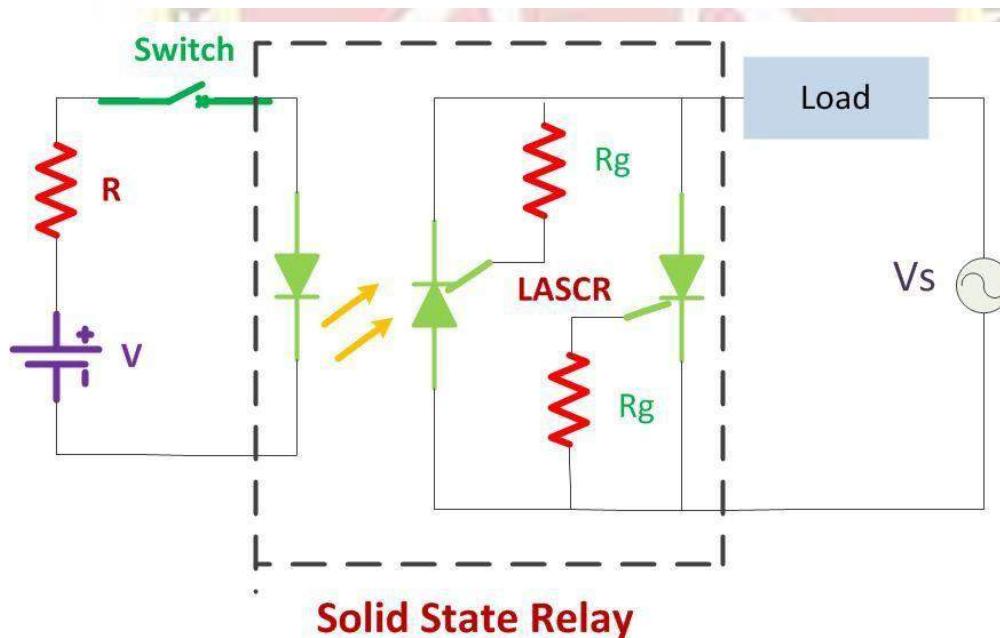
Operation of LASCR in the presence of light and electrical signal

The LASCR is a light-triggered device, but the combination of light signal and the electrical signal can also be used for its operation. In that case, two conditions will arise and that are as follows:-

1. When the electrical signal of lower strength is applied to the gate terminal, then the intensity of the light required to dislodge electrons from the semiconductor crystal will be high.
2. When the electrical signal of higher strength is applied to the gate terminal, then the intensity of the light required to dislodge electrons from the semiconductor crystal will be low.

Applications of the Light Activated SCR

1. **Low Power Applications:** The Light activated SCR are generally used for the application which requires low power to operate. This is because power generated by SCR is low in magnitude.
2. **Motor Control:** The Light Activated SCR finds applications in the working of Motor Control.
3. **Computer Applications:** The components used in the computer system also require LASCR for meeting power requirements.
4. **Optical light Controls:** The optical light control use the principle of photoconduction for generating the control signals. Therefore, the LASCR finds extensive application in Optical light control.
5. **Solid State Relay:** In solid state relays, two LASCR are connected in reverse parallel so that they can generate power in both the half cycle of AC. The construction architecture of solid state relay can be understood with the help of the below diagram.

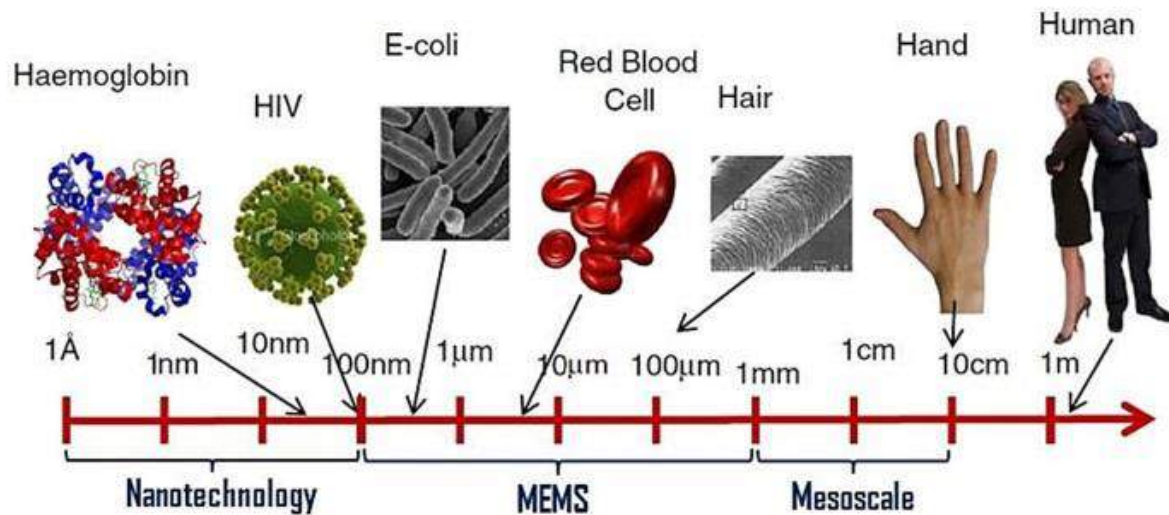


Electronics Coach

These relays find significant application in high voltage devices. In those devices, relays are used to couple voltage signal to high voltage equipment. This is very essential for coupling devices.

UNIT II – MEMS

MEMS stands for microelectromechanical system. It is also known by other affiliated names such as microsystems technology (MST) or micromachines. MEMS is an umbrella term for a wide range of microfabrication designs, methods and mechanisms that involves realising moving mechanical parts at microscopic scale.



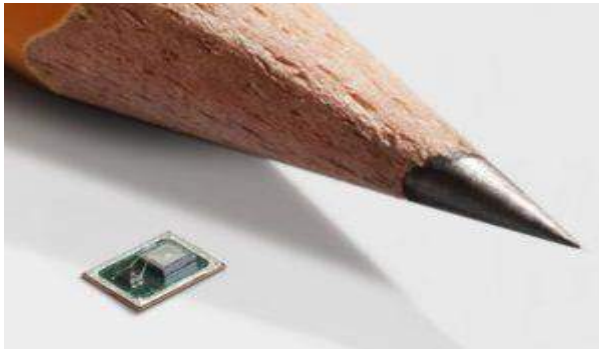
In a nutshell, MEMS is concerned with transforming the traditional bulky mechanical systems into miniature, better performing and highly mass producible alternatives, analogous to what the integrated circuit and semiconductor technologies have done to the electrical and electronics systems.

MEMS structure

The formation of MEMS is completed only when the microelectronics, microsensors and microactuators merges with integrated circuits in a common silicon substrate. The other micromechanical devices are formulated using “**micromachining**” process. This process involves either selective etching of silicon wafers or depositing of extra layer for the fabrication of mechanical or electromechanical devices. MEMS can also be merged with various other technologies like photonics or nanotechnology which provides wider market opportunities.

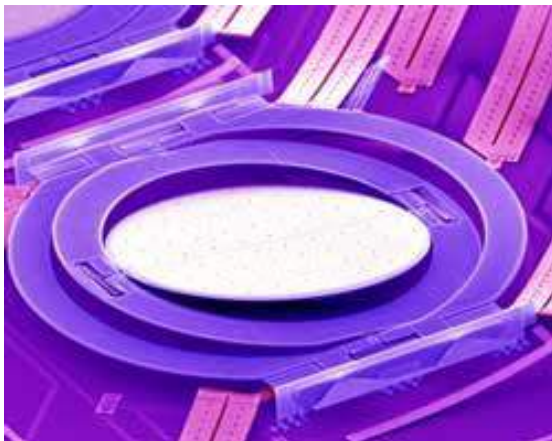
Uses of MEMS

MEMS are used in a wide range of sensors, actuators, generators, energy sources, biochemical and biomedical systems and oscillators. Some examples of MEMS applications include:



MEMS microphones

- Sensors such as MEMS accelerometers, MEMS gyroscopes, MEMS pressure sensors, MEMS tilt sensors and other types of MEMS resonant sensors
- Actuators such as MEMS switches, micro-pumps, micro-levers and micro-grippers
- Generators and energy sources such as MEMS vibration energy harvesters, MEMS fuel cells and MEMS radioisotope power generators
- Biochemical and biomedical systems such as MEMS biosensors, lab-on-chips, and MEMS air microfluidic and particulate sensors
- MEMS oscillators for accurate time keeping and frequency control applications

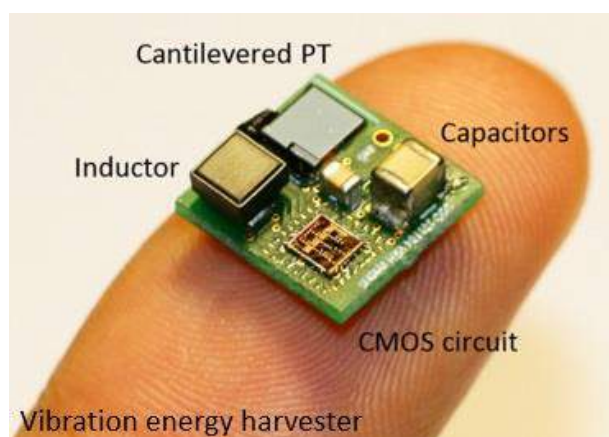


MEMS optical switch

At an even smaller nanometre scale, the fabrication technology morphs into nanoelectromechanical system (NEMS). Furthermore, where MEMS is integrated with other technologies, various combinatory embodiments can take form, such as, bioMEMS where biochemical and biomedical systems are realised on microfabricated devices, micro-opto-electro-mechanical system (MOEMS) or OptoMEMS where optical systems such as micro-mirrors are integrated to manipulate or sense light at the microscopic scale, radio frequency microelectromechanical system (RFMEMS) typically involves close integration with semiconductor microelectronics to provide RF transduction and switching capabilities.

Technological advancement of MEMS

The first laboratory demonstration of MEMS devices came about in the 1960's in the form of a MEMS pressure sensor. Academic research gained momentum in the 1980's, while the commercial development and manufacturing took off in the 1990's. Today, everyone carries MEMS devices on themselves in the form of smartphones, smart watches and fitness trackers. In the past, an aeronautic gyroscopic system used to determine roll, pitch and yaw in the cockpit of aircrafts weighed several kilograms and measured several inches in length, whereas nowadays, MEMS gyroscopes in our smartphones weigh less than a milligram and is equivalent in size to a grain of sand. With miniaturisation in size, also comes significant reduction in manufacturing cost and improved scales of economy. This is like the continued miniaturisation and reduction in cost seen in the semiconductor industry.



MEMS Vibration energy harvester

Furthermore, MEMS devices also offer lower power consumption and higher sensitivity that traditional mechanical counterparts simply cannot physically achieve. For instance, a

MEMS resonating strain gauge consumes micro-watts of power while offering sensitivity in the nano-strain range. This compares with the hundreds of milli-watts of power consumption for conventional foil strain gauges that can only measure down to a few microstrains at the best. Another example is that conventional microbalances are limited to a precision of a few tens to a few hundreds of micrograms whereas MEMS microbalances can get down to picograms or even femtograms of resolution.

Advantages and disadvantages of MEMS

Advantages of MEMS

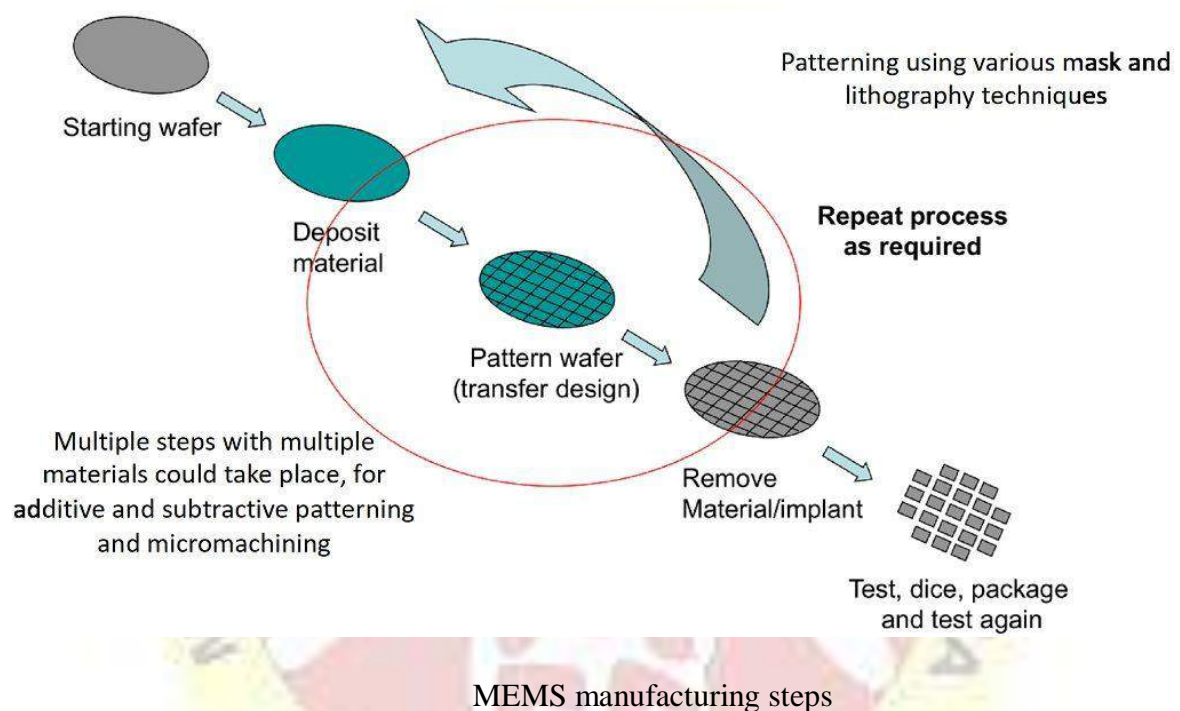
- Extremely scalable in manufacturing, resulting in very low unit costs when mass produced
- MEMS sensors possess extremely high sensitivity
- MEMS switches and actuators can attain very high frequencies
- MEMS devices require very low power consumption
- MEMS can be readily integrated with microelectronics to achieve embedded mechatronic systems
- Scaling effects at microscopic levels can be leveraged to achieve designs and dynamic mechanisms otherwise not possible at macro-scales

Disadvantages of MEMS

- Very expensive during the research and development stage for any new MEMS design or devices
- Very expensive upfront setup cost for fabrication cleanrooms and foundry facilities
- Fabrication and assembly unit costs can be very high for low quantities. Therefore, MEMS are not suitable for niche applications, unless cost is not an issue
- Testing equipment to characterise the quality and performance can also be expensive

MEMS fabrication

MEMS are classically micromachined from silicon. Various types of silicon wafers exist, and silicon can be doped to varying levels of conductivity. Additional functional materials can be added to provide various capabilities, such as electrode layers or piezoelectric layers. MEMS design and fabrication involves a series of steps and cycles, which can be summarised into:

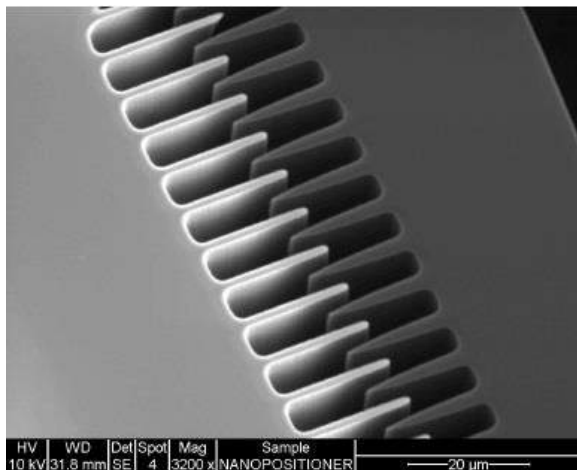


- Design, modelling and simulation (using analytical, numerical, CAD and FEA methods)
- Layout and wafer tape-out (using Layout Editor)
- Starting wafer substrate (such as silicon, glass, quartz, stainless steel, plastics)
- Microfabrication process (cycling through the following steps until desired design is achieved)
 - Additive (material deposition: chemical vapour, sputtering, evaporation, oxidisation)
 - Pattern (masks, photolithography, contact lithography, projection lithography)
 - Subtractive (material etching: wet chemical, dry ion or plasma, DRIE)
- Die dicing (laser, diamond saw, plasma etch)

- Wire bonding (to connect to interface circuitry)
- Packaging and encapsulation (hermetic seal, plastic/ceramic/metal seal, wafer-level packaging)

Types of MEMS transducers

In order to interact with the world, MEMS devices can employ various types of transduction mechanisms. Usually, these are mechanical-to-electrical transducers and vice versa, so that we can control the MEMS devices and their interactions with the mechanical world through interface circuits. Additionally, a number of other types of transducers can also be used to interact with chemical, light, magnetic, RF (Radio Frequency) and other domains.



Electrostatic comb drive in a MEMS device

Conventionally, electrostatic is the most popular transducer in silicon MEMS. This is because no additional specialist material is required and micromachined silicon can be doped to provide conductivity. By establishing an electric field across a pair of capacitive parallel plates, an electrostatic force can be sustained. When mechanical motion changes the distance between the parallel plates, an electrical signal can be measured across the parallel plates. Alternatively, by applying a dynamic electrical signal, the parallel plate can be actuated. Comb finger designs are very popular amongst MEMS electrostatic transducers in order to maximise the capacitive surface area of the transducer.

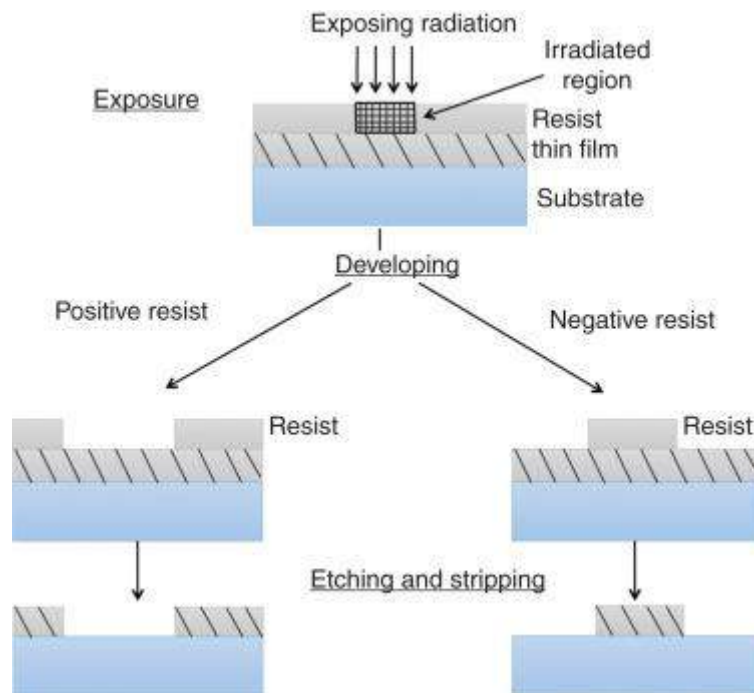
Material used to manufacture MEMS devices

The most important requirement to manufacture MEMS devices is the material which must be a semi-conductor and follow the basic techniques of deposition, photolithography and etching. Let us find out few suggested materials used in this process.

- **SILICON** is always considered as the most useful material to build the circuit oriented integrated systems as it is a perfect Hookean material which when flexed does not dissipate any energy. Manufacturing cost also goes down by using silicon material.
- **POLYMERS** are also one of the important materials used for building different MEMS devices because it is cheaper than crystalline silicon and it has a huge variety of material characteristics required for the technique.
- **METALS** can also be used for the formation of these devices because metals have high degree of reliability than silicon or polymers. But metal does not have some mechanical properties in term of silicon.
- **CERAMICS** are the widely used material in MEMS fabrication because of its huge variety of combined material properties. These properties are derived from the combination of different semiconductor materials like silicon, aluminum, titanium, silicon carbide and other ceramics.

Photolithography

Photolithography is one of these methods, often applied to semiconductor manufacturing of microchips. Photolithography is also commonly used for fabricating micro-electro-mechanical-systems (MEMS) devices. A typical lithography process contains several steps to fabricate device from layer grown on substrate (wafer). These steps are shown in the below figure and can be summarized as follows:



1. Cleaning of surface layer.
2. Heating to drive off any moisture that may be present on the wafer surface.
3. Application of photoresist by spin coating.
4. Exposure of photoresist by pattern of intense light. The exposure to light causes a chemical change that allows some of the photoresist to be removed by a special solution, called “developer” by analogy with photographic developer. Positive photoresist, the most common type, becomes soluble in the developer when exposed; with negative photoresist, unexposed regions are soluble in the developer.
5. Etching.
6. Photoresist removal.

Thus lithography process requires two most crucial steps: (1) exposure and (2) etching. Etching is removal of photoresist from layer. A simple and cost effective approach of etching is done using chemicals and known as chemical etching . Now a days various methods are utilized for etching procedure. These methods are plasma etching , reactive ion etching , and ion beam milling . These approaches are commonly known as dry etching, however, chemical etching procedure is known as wet etching.

Other major step is exposure. Generally, the nature of radiation used for exposure defined the category of lithography. When ultra-violet radiation is used for exposure, then such a process is known as Photolithography.

Applications of MEMS and Nano-technology

1. Biotechnology: There are numerous discoveries in bio-science and engineering which have been initiated with the help of MEMS and nano-technology, both working together. Few examples are:

- Scanning tunneling-tip microscope
- **Biochips** for detecting chemical reactions occurring inside living body
- Polymerase Chain Reaction
- Capillary Electrophoresis and many more.

2. Medicine: The most important example where MEMS and nanotechnology plays an important role is the formation of MEMS pressure sensors. MEMS pressure sensors are used in the following purposes.

- Intrauterine pressure during birth is measured with the MEMS sensors.
- Pressure sensors are used to monitor blood pressure, respiration and ventilation is another invention of MEMS sensors.
- It is used during eye surgery to control vacuum level.
- During kidney dialysis, MEMS pressure sensor is used to monitor the blood pressure and regulate the rate of flow of dialysis solutions.

The contribution of MEMS and nano-technology in the field of medical science is innumerable and remarkable.

3. Inertial Sensing: MEMS inertial sensors attain great success in the market for creating sensor oriented applications like accelerometer and gyroscope. These sensor apps are nowadays also used in smartphones like Apple iPhone and Nintendo Wii.

4. Communications: The performance of communication circuits is improving, as the high frequency circuits are gaining benefit from the discovery of RF-MEMS technology.

UNIT III SMART PHONE

History

- 1995 The first smartphone, the IBM Simon
- 1996 Nokia launched Nokia 9000
- In early 2000, the Ericsson R380 was released by Ericsson Mobile Communications, and was the first device marketed as a "smartphone"
- The first catalyst of the expansion of the smart phone market was the release of RIM's Blackberry series in 2001.
- The impetus for the expansion of the smartphone market was the release of Apple's innovative iPhone in July, 2008.
- ✦ 1996 First Windows CE Handheld PC devices are introduced.
- ✦ 2000 Symbian becomes the first modern mobile OS on Ericsson R380.
- ✦ 2002 Microsoft's first Windows CE (Pocket PC) smartphones are introduced.
- ✦ 2007 Apple iPhone with iOS is introduced as an iPhone.
- ✦ 2008 OHA releases Android 1.0 with the HTC Dream
- ✦ 2009 Samsung announces the Bada OS with Samsung S8500.
- ✦ 2010 Windows Phone OS phones are released.
- ✦ 2013 BlackBerry released BlackBerry 10.
- ✦ 2013 Google release Android Kitkat.
- ✦ 2014 Microsoft release Windows Phone 8.1 in February 2014.
- ✦ 2014 Apple release iOS 8 in September 2014.



Advance Features

- WiFi/NFC/BLUETOOTH
- Rear/Front Camera with P
- Advance Operating System
- High mAh Battery
- Extended RAM Memory
- 3G / 4G
- Micro or Nano SIM card
- Fingerprint Scanner
- Wireless Print & Fax
- Advance Sensors
- Screen Mirroring

Future Features

- Flexible Screens
- In-Built Projector
- Future NFC

- Wireless recharging
- Prediction
- IPS



Advantage of Smartphone → Helpful on Education → Improve Communication Skills → Use of Internet → In emergency situations → Multiple Uses

Disadvantage Of Smartphone → Privacy and Security → Road accident → Brain Cancer

Difference between Smartphone and Normal Phone

Key Difference: Smartphones are any mobile phones that are similar to a mini computer. Smartphones offer a variety of features that allows advanced computing capability and connectivity. A normal phone has the primary purpose of only calling and sending text messages. A normal phone is a simple phone that is used mainly by people that only require telephony services.

With the smartphone boom in today's world, many people today only purchase smart phones. Smartphones started from cellphones, which were advanced to incorporate the technology today and convert them into smartphones. Cell phones were basically a telephony device that allowed users to send/receive calls and text messages. As technology developed, it incorporated additional capabilities such as internet browsers, multimedia text messages, games, applications, etc. This further developed into a mini computer that we now know as a smartphone. A smartphone is a phone has computing capabilities and an operating system powering the device. A normal phone is a phone that supports basic calling features and internet capabilities.

Smartphone is a mobile phone that operates on an operating system, similar to a mini computer. Smartphones are basically that – a mini computer. They offer a variety of features such as calling capabilities, computing capabilities, video conferencing, online surfing, cameras, media players, GPS navigation units, etc. Any mobile phone that lets you do the work of a computer is considered as a smartphone. Smartphone are powered by operating systems such as Android, iOS, Windows Mobile, etc. The term 'smartphone' was introduced into the market by Ericsson in 1997, when it used the word to describe its GS 88 'Penelope' concept as a smartphone. There is no clear distinction that decides which phones are smartphone and which phones are not. However, with the increasing technology and offerings in a phone, the category has expanded to include all the new features that are currently available in the market.

A normal phone has the primary purpose of only calling and sending text messages. A normal phone is a simple phone that is used mainly by people that only require telephony services. A normal phone can be referred to as a cell phone and may also include simple

features such as calendar, alarm, games, monophonic ringtones, basic camera, WAP browser, etc. It does not support an operating system, Wi-Fi or any other ‘technologically advanced’ features that are offered in smartphones. Normal phones are a step above basic phones and also include downloading applications provided by carrier, browsing websites that are altered for the WAP browser, a numeric keypad, etc.

Smartphones and normal phones are two different categories of cell phones. With the smartphone boom, normal phones have taken a backseat and have become limited with many companies focusing on developing smartphones. The Normal Phones category does not exactly have a set definition, as the term changes with the upgrade in technology each time. The term has also been adapted depending on the companies that are trying to promote their ‘smartphones’. Normal phones are still existent in small numbers catering to the market of users that do not require the high-end features of a smartphone.

MOBILE OPERATING SYSTEM

A mobile operating system, also known as a mobile OS, mobile software platform or a handheld operating system, is the operating system that controls a mobile device or information appliance (Smart Phone , Tablet , PDA , or others) Similar in principle to an operating system such as Windows, Mac OS X, or Linux distributions that controls a desktop computer or laptop. PDA - Personal Digital Assistant

MOBILE OPERATING SYSTEM PLATFORMS

There are many mobile operating systems. The followings demonstrate the most important ones:

- ◆ Java ME Platform
- ◆ Symbian OS
- ◆ Linux OS
- ◆ Windows Mobile OS
- ◆ iPhone OS
- ◆ Plam OS
- ◆ Google Android Platform

INTRODUCTION

Much like the Linux or Windows operating system controls your desktop or laptop computer, a mobile operating system is the software platform on top of which other programs can run on mobile devices.

Which is responsible for determining the functions and features available on your device, such as thumbwheel, keyboards, WAP, synchronization with applications, email, text messaging and more

WHAT IS MOBILE OS

An operating system (OS) is an interface between hardware and user. It manages the hardware and software resources of the system.

The operating system that controls mobile device is called Mobile OS. They are simple and deal with the wireless versions of broadband and local connectivity, mobile multimedia formats and different input methods etc.

A layer structure showing where operating system is located



JAVA ME PLATFORM



- J2ME platform is a set of technologies, specifications and libraries developed for small devices like mobile phones, pagers, and personal organizers.
- Java ME was designed by Sun Microsystems. It is licensed under GNU General Public License.



❖ What is symbian OS?

- Symbian is a **mobile operating system (OS)** and computing platform designed for **smartphones**.
- The Smartphone operating system Symbian OS is produced by the **software development and licensing company Symbian Ltd.**
- Symbian Ltd was established in **June 1998** and is headquartered in Southwark in the UK, and the current CEO is **Nigel Clifford**.
- Designed to be used on higher-end mobile phones (also known as smartphones).
- Owned and licensed by most major phone makers

Mobile Application

Applications in mobile computing fall into the following three broad categories:

- 1) **Stand-alone Applications**- run entirely on mobile terminals in disconnect (detached) mode.
- 2) **Simple Client-Server (C/S) applications**-The connection time for C/S interactions is short.
- 3) **Advanced mobile applications** - (groupware and distributed multimedia) - information exchanged is time critical (i.e., real time)



Mobile Application Evolution

- ❖ The functionality of the mobile terminals has evolved tremendously over **last 15 years**.
 - ❖ **Voice Transmission**
 - Short Message Service (SMS) and Web Browsing
 - ❖ **Interaction with Vending Machine and Multimedia Message Service (MMS)**
 - ❖ **Video Conferencing and Interaction with the surrounding physical environment**
 - Object-to-Object Communication
 - Machine-to-Machine Communication
- Because of all above requirement symbian OS came in to picture to develop new and advance applications.**

Evolution in the various versions

- ❖ **EPOC32 (Electronic Piece Of Cheese)**: Graphical operating system. (1998)
- ❖ **Symbian OS 6.0 and 6.1**: Bluetooth was added for exchanging data over short distances from fixed and mobile devices. (2001).
- ❖ **Symbian OS 6.2**: (2002)
- ❖ **Symbian OS 7.0**: This version added EDGE support and IPV6. (2003)
- ❖ **Symbian OS 7.0**: Multimedia framework (2003)
- ❖ **Symbian OS 8.0**: There are not great evolution has shared some API's to support 3G. (2004)
- ❖ **Symbian OS 9.1**: Change of version 1.2 for the Bluetooth has version 2.0 where the difference is the introduction of an Enhanced Data Rate (EDR) for faster data transfer.
- ❖ **Symbian OS 9.3**: The WiFi 802.11 and the HSDPA (High Speed Downlink Packet Access) appear on Symbian OS.
- ❖ **Symbian OS 9.5**: This last version includes native support for mobile digital television broadcasts in DVB-H and ISDB-T formats and also location services.

1. Symbian 5.0 Ericsson MC218 (1999)



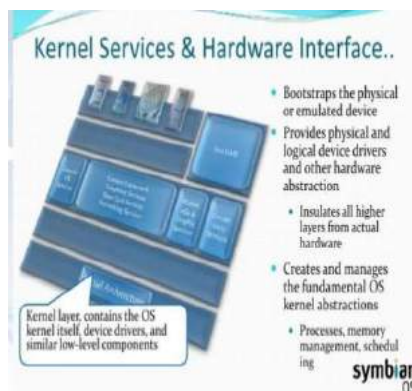
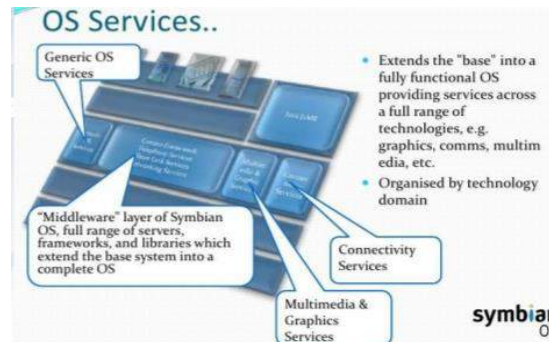
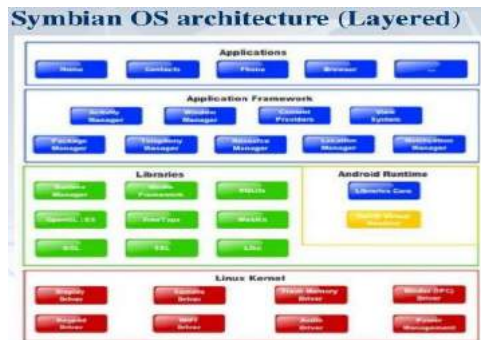
- Symbian 5.0 released in 1999 failed to receive much attention at that time.
- With Symbian 5.0 devices like users could not only surf the Internet with mobile web browser, send emails or add contacts but also run some apps on the basis of JAVA support.

2. Symbian 6.0 Nokia 9210 (2001)



3. Symbian 7.0 Nokia 3230 (2003)





Programming languages

- Symbian OS offers a choice of programming languages to the developer. Symbian OS written in C++, and this is therefore regarded as its primary programming language.

```

class Example
{
public:
    Example(int data):
        m_data(data) {}
    ~Example():
        m_data = 0 {}
    void operation()
    {
        m_data = m_data + 1;
    }
};
    
```

Features of Symbian OS

- Java 2nd** the most important programming language on Symbian OS.
- Browsing:** full web browser support and WAP stack for mobile browsing
- Messaging:** Support SMS, MMS, EMS, POP3, IMAP4, SMTP, Standard attachment, fax.
- Multimedia:** shared access to screen, keyboard, font and bitmap, audio recording and playback, image related functionality.
- Communication protocol:** TCP, IP version 4, IP version 6, USB, bluetooth.
- Mobile telephony:** abstract API for cellular system.
- Data synchronization:** support USB and bluetooth links. Transfer file and document.
- Security:** full length encryption and certification management, certificate based application management.
- Most secured and customized and open source operating system.**
- Support different version of mobile 2G, 2.5G, 3G.
- integrated multimode Mobile telephony
- Application environment:** wide range of application using C++ and Java.
- Multi tasking:** Multitasking. Kernel to support multi tasking.
- Robustness:** Data integrity and accept data from user quickly.
- Flexible user interface design:** Easy to use and understand.

Others programming languages which are use on Symbian: JavaScript, Assembler, WML Script, C#, Visual Basic, OPL and so on...

ADVANTAGES

- Greater range of applications.
- High quality games.
- Better inbuilt wap browser.
- Connectivity is lot more easier and faster.
- Real Player, Smart movie player etc. sort of application are not available with java phones.
- You can install software and applications of any system
- You can download big files through your phone easily with 3G around.

Introduction PALM OS

Since the advent of the personal desktop computer in the 1980's personal computing has advanced and adapted to fill new roles for consumers. One of these new roles is the personal digital assistant. PDA's are small computing devices that serve as personal organizers and mobile computing platforms for several million people around the world. The number one operating system for PDA's is Palm OS.

Palm OS was not the first operating system for PDA's but it was the first one to properly address the requirements for a mobile computing device that could accommodate the needs of the majority of its potential customers. Its central values have been efficiency, speed, and simplicity. In its 5th iteration, Palm OS 5, the operating system has grown larger and more complex but it has held true to its core mission and has not outpaced the capabilities of the hardware it runs on. Its core hardware architecture, memory management, and task management continue to support its mantra, simpler is better.

PALM OS 

- Palm OS is a proprietary mobile operating system, designed in 1996 by Palm Computing, Inc.
- Palm OS is designed for ease of use with a touch screen-based graphical user interface.

Some of the Key Features of Palm OS

- Simple, Multi-tasking environment
- Handwriting recognition input system
- TCP/IP network access

Software development

- Language: C/C++
- IDEs: CodeWarrior Development Studio, PRC-tools based gcc.



□ The key features of Palm OS

□ A single-tasking OS:

- Palm OS Garnet (5.x) uses a kernel developed at Palm, but it does not expose tasks or threads to user applications. In fact, it is built with a set of threads that can not be changed at runtime.
- Palm OS Cobalt (6.0 or higher) does support multiple threads but does not support creating additional processes by user applications.

Palm OS Device Architecture

At the highest level, the architecture of the Palm OS device, and most other PDAs, can be broken down into three layers (Figure 1): Application, Operating System, and Hardware.

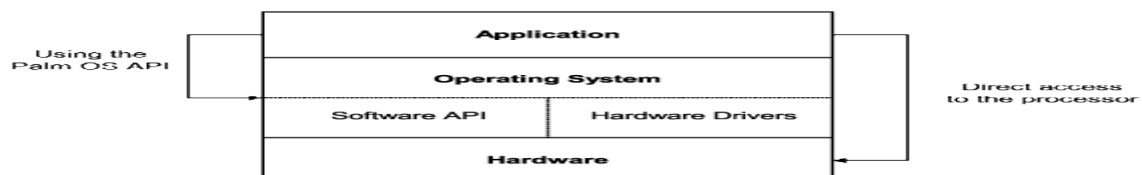


Figure 1: Typical layered architecture of a PDA

Use of the Palm OS Application Programming Interface (API) provides the application developer with a notion of hardware independence and provides a layer of abstraction. If the

API is used properly, recompiling of the application is all that is necessary in order to run on Palm OS devices based on different hardware. Therefore, it is important to examine weaknesses and attack vectors that can be found at the programming interface to the operating system.

Directly accessing the processor by avoiding the interface put forward by the operating system allows the developer to have more control of the processor and its functionality. A risk of legitimate use of direct processor access is the loss of compatibility for future models. For example, older Palm OS devices did not support a grayscale LCD palette through the Palm OS API, even though the underlying hardware possessed this capability. Bypassing this interface and tapping into the functionality of the processor directly will remedy this [13]. Ideally, to provide some semblance of access control and security, only the operating system should have access to the underlying hardware. Allowing applications to directly access hardware provides an avenue for malicious attack Hardware

Design Requirements

The Palm Handheld is very different from desktop computers such as Windows or Apple because the requirements and constraints of a small mobile device are very different. Palm's success stems from realizing this and not attempting to make Palm OS a clone of a desktop operating system.

The first consideration for the Palm OS is screen size. Since it is obvious that most Palm Handheld screens are small, usually 160x160 pixels, thus, is a limited amount of information that can be displayed. While this minimalist approach borders on being inadequate, it forces software developers to be very conservative and focused with their user interfaces.

The second consideration is quick turnaround time. On a PC, users usually do not mind waiting a few seconds while an application loads because they plan to use the application for an extended amount of time. However, the average handheld user uses a applications frequently but in short bursts, usually just a few seconds. Speed is therefore a critical design objective for handhelds and is not limited to execution speed of the code. The total time needed to navigate, select, and execute commands can have a big impact on overall efficiency. Palm's hierarchy of menus is designed to be quick and intuitive, and many

features, such as non-volatile secondary storage, were eschewed in order to maintain speed.

The third consideration of the design of the Palm architecture is PC connectivity. By offloading some of the computing burden to PC such as text data entry and persistent storage, the PDA can be kept lighter and simpler. The Palm system uses a construct called a conduit to share data between the handheld's application and the base station desktop application. A conduit is a plug-in to the HotSync Technology that runs when a person presses the HotSync button while the PDA is docked. It synchronizes data between the application on the desktop and application on the handheld.

The fourth consideration is input method. It is clear that there is not mouse and keyboard, which is connected to the Palm Handheld, therefore, when users enter data into the handheld, they need to use either pen or finger. On the handheld screen, they should either write Graffiti strokes or use the keyboard dialog. However, it is apparent that users should not have to input a lot of data since either way of input is not as convenient as using external keyboard or mouse. Recently, it happens that some handheld support external keyboards, but they are still sold separately.

The fifth consideration is power. Handheld has the similar problem as notebook on the issue of power, but Palm powered handhelds tend to run less time consuming programs. Computationally intensive tasks can be passed off to the desktop counterpart of a Palm program so that power is saved.

The sixth consideration is memory. Palm Handhelds have limited heap space and storage space, and different versions of the handheld have between 512K and 8MB total of dynamic memory and storage available. Moreover, the handheld does not have a disk drive.

The seventh consideration is the file system. Palm OS does not use a traditional file system because of the limited storage space, and so it can make synchronization with the desktop computer more efficient. Data is stored in databases, which operate similarly to paged memory. This provides a speed and cost benefit (see Memory).

The eighth consideration is backward compatibility. Through the development of Palm Handheld, the central hardware enhancement is improvement of the processor. Recently, Palm Handheld has changed its processor from 68K processor to ARM processor, which itself is a type of 4-byte RISC processor. Since the newest version of Palm OS uses ARM processor alone, its latest developed API function runs at the full speed of the ARM processor. It causes old 68K software applications to operate in very low speed for many

software applications are not designed for ARM processors. In order to improve the speed and solve the compatibility issues, the latest version of Palm Handheld implement Palm Application Compatibility Environment(PACE) on ARM. PACE allows existing 68K applications to run on the ARM processors in an emulation mode. Many old software applications perform excellently on PACE. Therefore, these software applications do not need to be re-written for the ARM. PACE is performed as a compatibility layer between 68K applications and ARM processors.

The ninth and most important part of Palm Handheld consideration is program concepts. Generally, software applications in Palm Handheld OS run in single-thread, and normally they are event-driven programs. Only one program should run at one time. Therefore, there are several guidelines of designation.

Palm programming is similar to the C/C++/Java in the way that it has PilotMain function, which is analogous to Main function in other languages. To launch an application, the system calls PilotMain and sends it a launch code. The launch code may specify that the application is to become active and display its user interface, or it may specify that the application should simply perform a small task and exit without displaying its user interface. Palm OS applications contain an event loop because of the event-driven concept. However, this event loop is only started in response to the normal launch. Users application may perform work outside the event loop in response to other launch codes.

Generally, most Palm Handheld applications contain a user interface made up of form, which are analogous to windows in a desktop application. The user interface normally consists of predefined UI elements and custom UI elements.

In order to implement a certain feature of Palm Handheld OS functions. Palm OS has several managers, and these mangers work in the way that integrate functions to implement a feature.

The tenth consideration is compiling older application with the latest SDK. The rationale of software application designation is that all Palm OS applications implemented in an earlier version of OS should run error-free on the latest release. Therefore, there are two ways of compiling the older application. One is to change the function name to keep using the old API, and another way is to update the applications to use the new API.

The Palm architecture adequately addresses all of the major constraints presented by the PDA computing problem. By utilizing minimalist solutions in most cases, the Palm

operating system has been able to aggressively meet the needs of its consumer base. This is the major reason for its success.

Palm OS 5.0 – New Hardware Functionality

Multimedia Features

Palm OS 5 incorporates a set of high-density APIs that double the screen resolution of a Palm Powered device — from 160 x 160 pixels to multiples of 160x160 pixels. These high-density APIs are compatible with software written for a 160 x 160 screen. In addition to these video enhancements, audio capabilities have been improved with a new set of APIs for playing and recording 16-bit audio files. Licensees and developers can harness these new multimedia resources to further improve the video and audio solutions that exist on the Palm OS platform today, and to deliver the multimedia devices and applications in the future.

Wireless Connectivity

The upcoming Palm OS 5 handhelds will be capable of connecting and communicating with networks and other devices unlike some of its previous models. The use of Palm Powered devices has grown far beyond personal information management (PIM) to a position where they play a critical role in the enterprise. The ability to access information over a wireless connection, to deliver the right information at the right time, has become an increasingly important function for these devices.

Palm OS 5 extends the existing wireless capabilities of the Palm OS platform by incorporating a set of APIs and drivers that support 802.11b solutions at the system level. With the addition of these capabilities to the existing support for Bluetooth, GSM, CDMA, and 2.5G/3G networks, Palm OS 5 offers a consistent programming interface for wireless connectivity and an increase in processing power that improves connection speeds significantly. Employing these new capabilities, businesses and developers are therefore able to choose the wireless technology that suits their needs. Its capability of multi-tasking and multi-threading allows development of peer-to-peer applications.

Security

As the most widely deployed handheld platform for the enterprise, the Palm OS continues to deliver on the promise of providing a stable, scalable platform with a wide range of security

options. The introduction of Palm OS 5 raises the bar even higher, incorporating a suite of robust security options without sacrificing the Palm OS tradition of flexibility, openness, and ease of use.

Palm OS 5 offers system-wide strong encryption (128-bit) as a standard feature. Through a partnership with RSA Security, the leading encryption provider in the security industry, Palm OS 5 includes RC4, SHA-1, and signature verification using RSA-verify. This partnership with RSA Security ensures that best-of-class security services are available within Palm OS. An integral component of these security features is a plug-in cryptographic architecture, which allows the addition of other algorithms, such as Advanced Encryption Standard (AES), to meet specific market needs. Palm OS 5 also offers 128-bit Secure Sockets Layer encryption services (SSL 3.0/TLS 1.0) for secure end-to-end connections. Palm OS 5 will encompass a system-wide authentication and authorization system that has an extensible architecture and that will allow businesses and developers to use any of a number of methods to restrict access, including such authentication methods as biometric verification handwriting, voice recognition, fingerprints, and smart cards.

With these new security capabilities as a standard feature of the Palm OS 5, developers can create applications that use system-wide encryption services to protect user data. This will help licensees and leaders in the handheld and smart phone markets to develop enterprise-specific devices that will meet the performance and security demands of their customers.

Compatibility

Palm OS 5 makes these advances while protecting the ease of use, flexibility and openness for which Palm Powered products have always been known. Despite its major advances, Palm OS 5 will continue to be backwardly compatible with most existing Palm OS applications. For users with advanced needs, Palm OS 5 will give a smooth growth path into the future of mobile computing.

BADA OS

What is BADA?

Its Mobile operating system designed for Smart Phones by Samsung Electronics. The name ,Bada which means ocean in Korean, was chosen to convey the limitless variety of potential applications which can be created using the new platform. It is one of the most developer-friendly environments available, particularly in the area of applications using Web services.

Samsung bada also represents the fresh challenges and opportunities available to developers, as well as the entertainment which consumers will enjoy once the new platform is open.

Behindthebar

Samsung did a survey of consumers mobile software demands. Results were found to be extremely encouraging for mobile application developers. This was identified as a great opportunity for new development. Even with the current feature set provided by the smart phones available in market, 42% of the current smart phone users surveyed would pay to download applications, if they could.

This illustrates the scale of the potential revenues available for developers by extending the market of downloadable application for smart phones.

As of now, Apple, RIM (Research In Motion – BlackBerry) and Google dominate the Smart Phone OS and Mobile Application Market. Samsung which is the second largest manufacturer of mobile phones also want the pie of this lucrative high end mobile application market. Recent statistics available show that smart phones will account for 16% of cell phone market this year, which makes more room for Samsung in this sector.

Through the launch of Bada Samsung wants to help the developers who want to capitalize on the market opportunity. The aim of Bada platform is to make smart phone features accessible to everyone, so that developers can reach larger audiences and the variety and creativity of apps can be enjoyed by many. They want consumers to have a fun and diverse mobile experience that really adds value to their lives, by providing them with high-quality application and mobile services.

Key Features

Extensiblecore

functions

A call dialer, messaging and address book, which Bada applications can freely use. Bada will give developer the chance to access phones' accelerometers, tilt, weather, proximity and activity sensors, so they can build apps that respond to tilting the phone.

Smart phones for everyone

More and more people want the rich and connected application-experiences that are currently only available for smart phone consumers. Samsung has developed bada to make these exclusive smart phone experiences available to everyone

Tools

The new UI tool includes the ability to embed the AdobeFlashPlayer and WebKit Internet Browser directly into native Bada applications. Also Bada map Control can be used for

mapping in applications. Also Eclipse and GNU tool-chain can be used as IDE for development purpose.

Feature-rich developerplatform

The new OS will deliver simple, instinctive, and innovative visual design using Next Generation UI Framework. Bada supports motion sensor and face detection. Also it provides mechanism to develop sensor based and context-aware applications.

Service Oriented Features

Developers can create service-centric applications like social networking applications for managing user profiles, location applications for mapping etc.

And all the bada handsets will have some common features:

3G / Wi-Fi

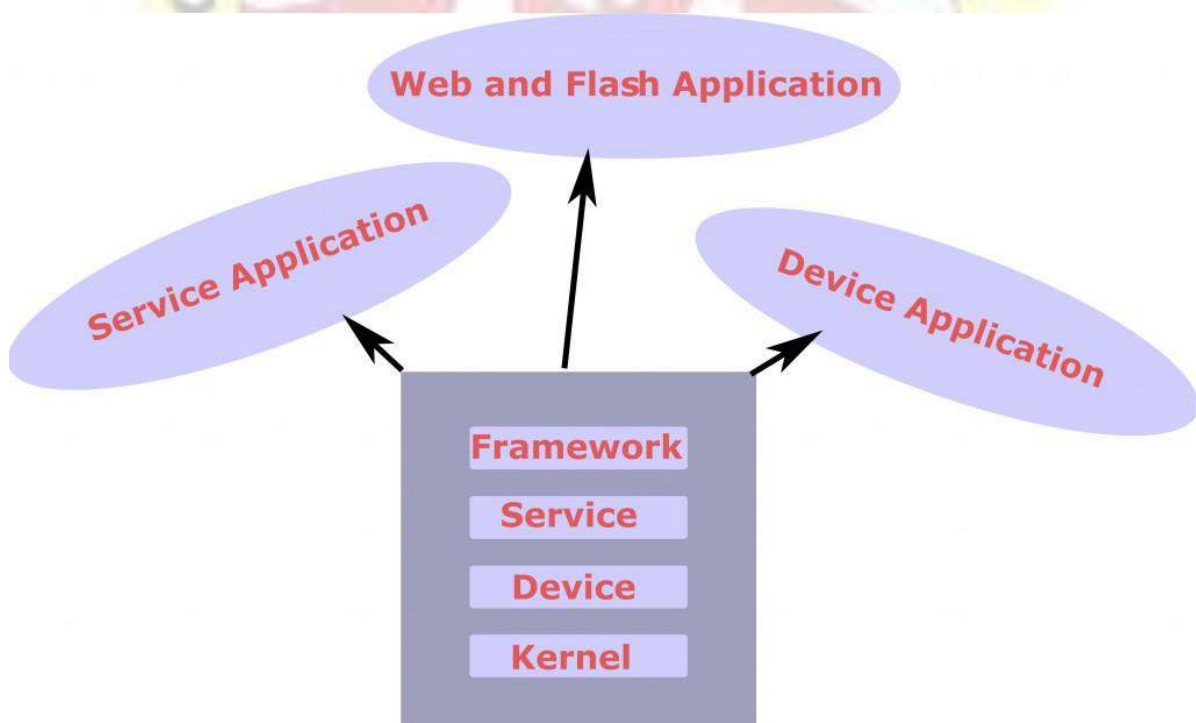
GPS / Motion Sensor

WVGA/WVGA screen

Multipoint touch

Bada supports third party services like Twitter and Facebook through its APIs.

Architecture



Bada Architecture Stack

The Architecture is made up of four layers

I. Kernel Layer

This is based on real-time Operating System or Linux kernel based depending on hardware

configuration. Speculation is that it can be linux based system

II. Device Layer

This provides the core functions of a device platform that are provided by OS, such as graphics and multimedia, and communication components.

III. Service Layer

Service-centric functions that are provided by application engine like messaging and contact management.

IV. Framework Layer

Open API framework that consist of an application framework and functions exported by underlying layers. One can create innovative application on Bada using C++

Bada / Android

Android mobile phone industry has gradually becoming center of attraction. Since Android supports java which has big community support. HTC, Motorola, Sony Ericsson has now adopted Android platform in their newly launched handsets.

Where as Bada is proprietary of Samsung so the Bada will be inbuilt in Samsung smart phones but there are less chances of adaptation of Bada by other Mobile Manufacturers as it is direct threat to them. However Samsung is the second largest mobile manufacturer. This will increase the chances of success of Bada. Also the Games developers CAPCOM, EA Mobile, and Gameloft are supporting Bada.

Android OS & Its Features

The Android operating system is most frequently used on different mobile platforms around the world. It is occupied approximately 75% of shares in the worldwide market by the end of 2020. A company like Open Handset Alliance has developed the first Android that depends on the customized version of the Linux kernel as well as other open-source software. At the initial stage of 2005, Google sponsored the project & it obtained the entire company. In September 2008, the first Android device was released in the market to dominate the mobile industries due to several features like user friendly, the support of the community is huge, customization, manufacturing of android devices in large companies. Consequently, the market examines the demand to develop Android-supported devices with smart developers. So, the Android operating system became a complete set of operating systems for different devices like wearables, mobiles, notebooks, smart TVs, tablets, set-top boxes, etc.

What is an Android Operating System?

Android is a Linux-based operating system it is designed primarily for touch screens mobile devices such as smartphones and tablet computers. The operating system has developed a lot in the last 15 years starting from black and white phones to recent smartphones or mini computers. One of the most widely used mobile OS these days is android. The android is software that was founded in Palo Alto of California in 2003.

Android is a powerful operating system and it supports a large number of applications on Smartphones. These applications are more comfortable and advanced for users. The hardware that supports android software is based on the ARM architecture platform. The android is an open-source operating system that means that it's free and anyone can use it. Android has got millions of apps available that can help you manage your life one or another way and it is available at low cost in the market for that reason android is very popular.

Android development supports the full java programming language. Even other packages that are API and JSE are not supported. The first version 1.0 of the android development kit (SDK) was released in 2008 and the latest updated version is a jelly bean.

Features of Android Operating System

The unique features/**characteristics of the android operating system** include the following.

Near Field Communication (NFC)

Alternate Keyboards

IR Transmission

No-Touch Control

Automation

Wireless App Downloads

Storage & Battery Swap

Custom Home Screen

Widgets

Custom ROMs

Headset layout

Storage

Connectivity: GSM/EDGE, IDEN, CDMA, Bluetooth, WI-FI, EDGE,3G,NFC, LTE,GPS.

Messaging: SMS, MMS, C2DM (could to device messaging), GCM (Google could messaging)

Multilanguage support

Multi-touch

Video calling

Screen capture

External storage

Streaming media support

Optimized graphics

Android Architecture

The android is an operating system and a stack of software components which is divided into five sections and four main layers that is

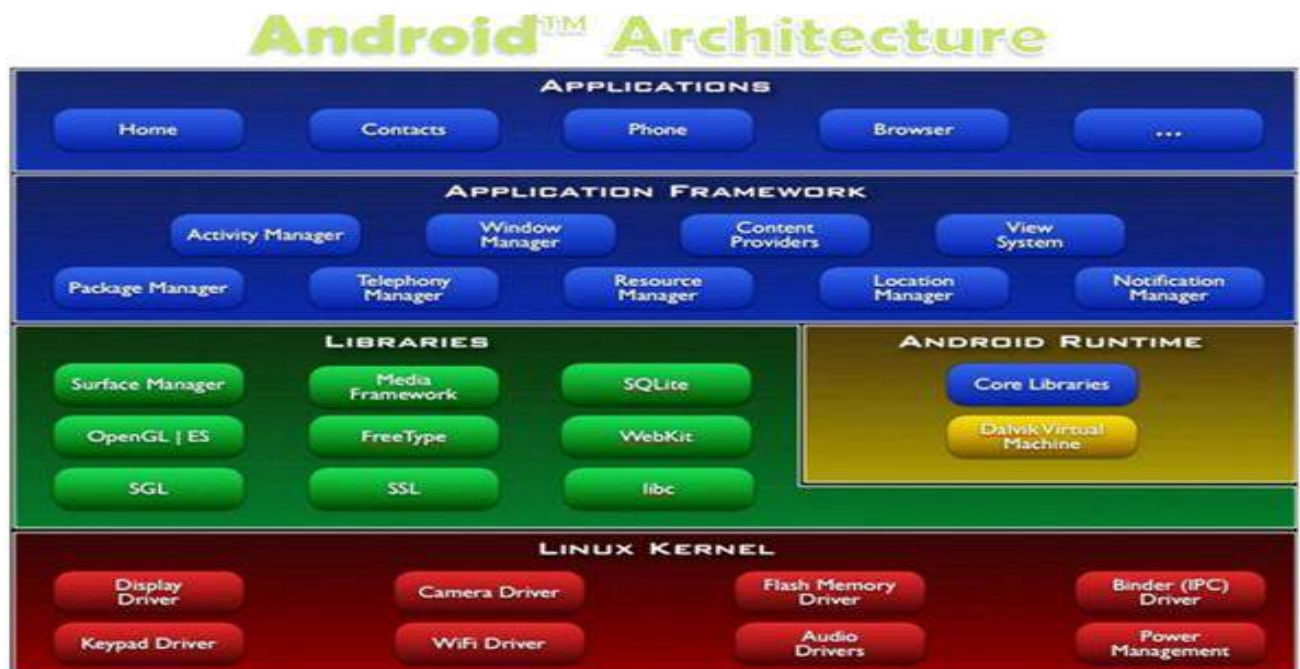
Linux kernel

Libraries

Android runtime

Application Framework

Applications



Linux Kernel

The android uses the powerful Linux kernel and it supports a wide range of hardware drivers. The kernel is the heart of the operating system that manages input and output

requests from the software. This provides basic system functionalities like process management, memory management, device management like camera, keypad, display, etc the kernel handles all the things.

Linux is really good at networking and it is not necessary to interface it to the peripheral hardware. The kernel itself does not interact directly with the user but rather interacts with the shell and other programs as well as with the hardware devices on the system.

Libraries

The on top of a Linux kernel there is a set of libraries including open-source web browsers such as WebKit, library libc. These libraries are used to play and record audio and video. The SQLite is a database that is useful for the storage and sharing of application data. The SSL libraries are responsible for internet security etc.

Android Runtime

The android runtime provides a key component called Dalvik Virtual Machine which is a kind of java virtual machine. It is specially designed and optimized for android. The Dalvik VM is the process virtual machine in the android operating system. It is software that runs apps on android devices.

The Dalvik VM makes use of Linux core features like memory management and multithreading which is in java language. The Dalvik VM enables every Android application to run its own process. The Dalvik VM executes the files in the .dex format.

Application Framework

The application framework layer provides many higher-level services to applications such as windows manager, view system, package manager, resource manager, etc. The application developers are allowed to make use of these services in their applications.

Applications

You will find all the android applications at the top layer and you will write your application and install it on this layer. Examples of such applications are contacts, books, browsers, services, etc. Each application performs a different role in the overall applications.

Android Emulator

The Emulator is a new application in the Android operating system. The emulator is a new prototype that is used to develop and test android applications without using any physical device.

The android emulator has all of the hardware and software features like mobile devices except phone calls. It provides a variety of navigation and control keys. It also provides a

screen to display your application. The emulators utilize the android virtual device configurations. Once your application is running on it, it can use services of the android platform to help other applications, access the network, play audio, video, store, and retrieve the data.

Android Versions

The different **android versions** from the beginning to the present are mentioned below from 1.0 to 2.0. Here is the **android operating system list**.

Android Versions from 1.0 – 1.1

The first Android version like 1.0 was released in the year 2008 but it didn't have any codename.

Android Version – 1.5

In the year 2009, the 1.5 android version was released which is named Cupcake.

Android Version – 1.6

The Android version – 1.6 was released in the year 2009 which is called Donut. The ability of this version is, it operates on different screen sizes as well as resolutions.

Android Versions from 2.0 – 2.1

Éclair 2.0 version was released after six weeks of the Donut version.

Android Version – 2.2

After four months of 2.1 version invention, the Android 2.2 version was released which is called Froyo.

Android Version 2.3

The first true visual identity of Android version 2.3 was released in the year 2010 namely Gingerbread.

Android Version from 3.0 – 3.2

In the year 2011, the versions from 3.0 – 3.2 were released which is named Honeycomb

Android Version 4.0

Android 4.0 was released in the year 2011 which is called Ice Cream Sandwich.

Android Versions 4.1 – 4.3

Android Versions 4.1 to 4.3 were released between 2012 to 2013 which is called Jelly Bean.

Android Version 4.4

Android Version 4.4 was released in Late-2013's which is called KitKat.

Android 5.0

The version of Android 5.0 was launched in the year 2014, Nov in the Nexus 6 device which is called Lollipop

Android 5.1

This version of Android 5.1 was released in March 2015 called Lollipop

Android 6.0

Android 6.0 Version like Marshmallow was released in Oct 2015.

Android 7.0

Android 7.0 version was released by Google in Aug 2016 called Nougat.

Android 7.1, 7.1.1 & 7.1.2 Nougat

Android 7.1 version was released in Oct 2016, called Nougat

Android 8.0

Android 8.0 version was released in Aug 2017 called Oreo.

Android 8.1.0

Android 8.1.0 version was released in Dec 2017, called Oreo

Android Version 9 Pie

Android version 9 Pie was released in Aug 2018

Android Version 10

Android version 10 was launched in September 2019

Android Version 11

Android version 11 was released recently on September 8th, 2020

Advantages

The **advantages of the Android operating system** include the following.

Android is a Linux based open-source operating system, it can be developed by anyone. Easy access to android apps. You can replace the battery and mass storage, disk drive, and UDB option. It supports all Google services.

The operating system is able to inform you of a new SMS and Emails or the latest updates.

It supports Multitasking

Android phone can also function as a router to share the internet

It's free to customize

Can install a modified ROM

It supports 2D and 3D graphics

We can install Millions of apps-

Backup and restore of apps can be possible

It supports Third-party apps

Addition & removal of unwanted features:-

High job demands for Android developers

Notifications can be displayed very clearly

Huge community support

The Internet can be shared from device to device

It is an Open source

Different types of mobile models you can select

Add/ Remove Unwanted

Internal memory is Expandable

Cloud storage

It supports big screens at a reasonable price

Foldable Android devices

Different apps can run at the same time

Several widgets on display

The **disadvantages of the Android operating system** include the following.

Apps work in the background

Battery discharges easily due to a lot of processes within the background.

Requires Google account

Less security, so fake apps can be easily installed to steal your data from strange resources

Mobiles with low specification run very slow

Generally, you require additional code on Java language as compared to Objective-C.

Android developers have a critical time

Difficult layouts & animations are tough to code within Android.

Protection of Virus is required

For developers of the app, Google is strict

Several ads within apps

Some apps quality is not good

For elders, it is not friendly

IOS Mobile Operating System

Introduction of iOS Mobile Operating System

iOS, just like Android is a popular mobile operating system. It is developed by Apple Inc. for its devices and work only for Apple hardware. The close ecosystem works great for Apple as it ensures high stability and portability among different Apple devices such as iPad, iPhone, and iPad touch. It ranks behind Android concerning popularity, but have a vibrant ecosystem where app developer can make more money compared to the Android.

iOS mobile operating system came into life in 2007 with the first iPhone 2G. It extended to support other Apple devices such as iPod, iPad etc.. It is programmed in C, C++, Objective-C. Apple doesn't license iOS for installation on non-Apple hardware and had been growing steadily from the point. The first Apple device that got the OS is the iPod Touch in September 2007. In Jan 2010, it came to iPad and also made to other devices such as Apple TV, iPad Mini later in its lifespan.

The ecosystem surrounding iOS is also great. It is one of the most active and offers 1.4 million iOS application to date. When seen from the viewpoint of downloads, the apps are downloaded with over 100 billion times. That's amazing!

History of iOS

Apple's founders The Apple was founded in April 1st 1976 & released with the first APPLE(I) computer. Steve Jobs □ Steve Woznick □ Ronald Wayne.

Apple Inc. is a formerly known as Apple Computer Inc. It's a American multi-national corporation that designs & markets consumer electronics, computer software & personal computers. The company's best known hardware products include the iPhone, the iPod, & the iPad

Just like any other technology that is a decade old, iOS has seen a lot of changes. Let's list the biggest and important milestones in iOS technology.

Apple's iOS first SDK was released on March 6, 2008.

The initial release was named iPhone OS which was later changed to iOS on June 7, 2010.

iPhone OS 1 was released on March 6, 2008, and is the first version of the popular operating system. The support for iPhone OS 1 ended after two years, i.e., 2010.

iPhone OS 2, as the name suggest, is the 2nd big release for the iOS. The release was done in conjunction with iPhone 3G, and anyone with the previous version can easily upgrade to the latest version. Also, this version introduced the App store, which becomes the hub for installing new apps. New SDK was also released for developers with support ending in 2011.

The third big release was Apple iOS 3. It came into existence in June 2009 with support ending in late 2012. New features such as copy, paste, etc. are added to the OS.

The next version is iOS 4 and is released on June 21, 2010. Clearly, this is one of the big releases for iOS as it dropped old device support instead of supporting the latest devices with multitasking features.

iOS 5 was released on June 6, 2011. It brought support for iPad Touch (3rd generation) and iPad (1st generation).

iOS 6 went live on September 19, 2012, for the 4th generation Apple devices. Ios 6 features
 Maps Siri Passbook Facetime Mail Safari Shared photo streams Accessibility etc..

iOS 7 was released for public on September 18, 2013. It supported two new phones by Apple, the Apple iPhone 5S and iPhone 5C. iOS 7 Features Block unwanted callers Auto Focus Air drop iTunes Radio Notification centre Multi-tasking Gesture Control Undelete emails Turn off automatic app update Look at Most Visited Areas

Just like the old release, iOS 8 released for public on September 9, 2014, with support for their best phone devices, the iPhone 6 and iPhone 6 Plus. They dropped support for older devices.

The latest version of Apple iOS is the iOS 9 which was made public on September 16, 2015. Apple changed how they support legacy hardware and iOS 9 became the first Apple OS that supported 22 devices.

iOS Tools

Here are the ten (10) best Obj-C/Swift (iOS) productivity tools, plugins, and libraries recommended by Education Ecosystem engineers:

XCODE The Xcode IDE is at the center of the Apple development experience. Tightly integrated with the Cocoa and Cocoa Touch frameworks, Xcode is an incredibly productive environment for building apps for Mac, iPhone, iPad, Apple Watch, and Apple TV.

SWIFTJSON JavaScript Object Notation, or JSON for short, is a common way to transmit data to and from web services. It is simple to use and human-readable, which is why it's so incredibly popular. SwiftJSON is the better way to deal with JSON data in Swift..

PhoneGap is an open source solution for building cross-platform mobile apps with standards-based Web technologies like HTML, JavaScript, CSS.

GHUnit is a test framework for Mac OS X and iOS. It can be used standalone or with other testing frameworks like SenTestingKit or GTM.

Scout: is an excellent testing tool that helps you find bugs in your application.

Eureka is a library to create dynamic table-view forms from a DSL specification in Swift. This DSL basically consists of Rows, Sections and Forms. A Form is a collection of Sections and a Section is a collection of Rows.

RX SWIFT Rx is a generic abstraction of computation expressed through Observable interface. Like the original Rx, its intention is to enable easy composition of asynchronous operations and event/data streams.

OBJECTMAPPER ObjectMapper is a framework written in Swift that makes it easy for you to convert your model objects (classes and structs) to and from JSON.

REFACTORATOR Refactorator is an Xcode plugin for refactoring Swift & now Objective-C code. It will rename public or internal vars, functions, enums etc. For private and local entities use Xcode's existing "Edit All in Scope" functionality.

SPRING Spring is a library to simplify iOS animations in Swift. It has grown into a full-blown animation library that supports every View, Transitions, Loading Animation and a lot more.

iUI is a framework consisting of a JavaScript library, CSS, and images for developing advanced mobile webapps.

IOS Technology Layers In Ios,

there are four abstraction layers. The Core O.S Layer. The Core Services Layer. The Media Layer. The Cocoa Touch Layer



Core O.S Layer → The Core O.S Layer manages the Virtual memory, threads, the filesystem, the network, interprocess communication with the frameworks in the core o.s layer

Core Services Layer □ Core Services Layer contains the fundamental interfaces for ios, for accessing files, network sockets and so on. □ These interfaces are mostly C – based.

. Media Layer □ Media Layer allow you to create the best multimedia experience available on the mobile device with frameworks. □ It uses both C and Objective - C

. Cocoa Touch Layer □ Implementation of a graphical event-driven application in ios with the frameworks is performed in the cocoa touch layer □ This layer uses objective - C

ADVANTAGES OF IOS

Easy to use:

iOS has a simple interface that helps its users to use the mobile device easily. If you have an old iPhone and you want to move to a new iPhone device then you will not feel any major change in the UI (user interface).

Ideal for app developers:

Android has a vast range of devices with different screen sizes and it becomes very difficult for app developers to make the app for different screen sizes. But iOS has few devices and developers can make apps easily.

Heat generation:

Apple iPhone generates less heat while you are using the phone. The apps in iPhone use the battery more efficiently and thus generates less heat.

Google maps:

Apple users say that they have good experience using Google maps and android lacks some features of Google maps.

Gaming:

iPhone users have great experience in playing games. The games are built by top-notch companies and all games have to go through app approval teams. Only those games are approved which have no problem in their code and which can run smoothly in the device.

Used for business:

There are various apps available in the app store that can help in running your business. You can store your important documents on the iPhone/iPad. You can edit/view your documents by using Office365 app.

Media:

You can use media like images, animated gifs, videos, and vines in your device and your time will be spent well. iOS devices give enough storage to store your media files. iPhone 11 pro gives you storage of 64GB, 256GB and 512GB that is enough for storing any kind of media files. You can also get more space by using iCloud services.

Performance:

The overall performance of iOS is good. Whether you are playing games or using any other app, your device will not hang. New iOS versions are getting better than before and their performance is improving.

Security:

As apps in the Apple app store have to go through a strict approval process so only apps with better security are approved. You cannot expect your phone is in danger and there are very fewer chances that your phone gets any virus or malicious code inserted. You can secure your phone by using face detection or using the fingerprint sensor.

Supports multi-language:

You have the choice to choose any language in your device. There is plenty of language support for your device. iOS currently supports 21 languages including Spanish, Chinese and Portuguese.

Jailbreaking:

Jailbreaking is the process by which you can install apps in your iPhone without authorizing apps from Apple app store. You can customize your iPhone by doing jailbreaking.

Many apps:

There are more than 2 million apps available in Apple app store and you can choose any app that suits your needs. All apps give users a better experience. You can either choose free apps like Youtube, Facebook or use any paid apps like Minecraft, Monopoly etc.

Better camera:

iOS provides a better camera experience. You can edit live photos and there are also QR detection codes supported by iOS. Cameras in iOS use less power and give a high-speed performance.

Gestures:

There are a lot of gestures supported by iOS. For example, you can shake your device to undo the things you did recently.

Communication between devices:

You can connect your iPhone to AirPlay, Apple TV and HDTV and stream videos easily.

Multitasking:

You can do multiple tasks at one time in iOS. You can listen to your music and typing in any document easily.

Disadvantages of iOS**Same icons:**

iPhone has similar icons on the home screen and these icons have the same design as previous versions. The home screen looks the same when you upgrade iOS to new version i.e you will see the same style of icons on the home screen.

Very simple:

iOS devices are very simple in look and you cannot use as your computer. But if you compare this with android devices then you can perform your computer work in devices also.

Apps are costly:

The apps are costly in price and there is no widget support for the apps. If you compare apps with android then most of the android apps are free to use.

Limited devices:

iOS only runs on Apple devices and users have to keep stick with similar look and feel of the UI. As you know android has a vast range of devices and each device has its custom UI due to customization of android.

Not open source:

iOS is not open-source that mean you cannot customize and cannot use iOS on devices other than Apple devices. If you consider android then it can be customized easily by any mobile company like Samsung, Huawei or HTC.

App approval:

It is very difficult for the app to get approved. Developers have to wait for at least 7 days for app approval and most of the time app doesn't get approved.

No SD card:

iPhone and iPad do not provide SD card. If you want to increase your storage then you have to buy a new device that has more storage.

Battery timing:

If you use 3G/4G on your iPhone device then your battery will vanish quickly. This is because apps like Instagram and Pinterest use high data and thus consumes more battery.

Repairing is expensive:

If your device gets any hardware or software problem then it is very expensive to repair the device. The reason behind this is there are few repair shops for iPhone devices.

Supports single sim:

Apple devices only support single mobile sim. If you have more than one mobile sim then it you have replaced the sim again and again.

Large apps size:

The apps in iOS have high file size and consume high space in the device. Most of the gaming apps have download size in GB (gigabytes).

NFC and radio:

iOS does not provide NFC and radio support. NFC provides communication between nearby devices but it is not supported by iOS. If you want to listen to the radio then you have to download radio apps and radio is not built-in in iOS devices. On android, radio comes built-in in devices.

Addictive UI:

The UI of Apple device is very addictive to use. If you have used any Apple device like iPhone, iPad, iWatch you cannot move to other devices because the look and feel of the devices are very addictive.

Changing ring tunes:

It is not possible to change your ring tunes in iOS and you have to stick with default ring tones. You can use any alternative method for changing ring tunes.

OPEN SOURCE

The term open source refers to something people can modify and share because its design is publicly accessible. Open source software is software with source code that anyone can inspect, modify, and enhance.

"Source code" is the part of software that most computer users don't ever see; it's the code computer programmers can manipulate to change how a piece of software—a "program" or "application"—works. Programmers who have access to a computer program's source code

can improve that program by adding features to it or fixing parts that don't always work correctly.

Difference Between Open-Source Software And Other Types Of Software

Some software has source code that only the person, team, or organization who created it—and maintains exclusive control over it—can modify. People call this kind of software "proprietary" or "closed source" software.

Only the original authors of proprietary software can legally copy, inspect, and alter that software. And in order to use proprietary software, computer users must agree (usually by signing a license displayed the first time they run this software) that they will not do anything with the software that the software's authors have not expressly permitted. Microsoft Office and Adobe Photoshop are examples of proprietary software.

Open source software is different. Its authors make its source code available to others who would like to view that code, copy it, learn from it,

What Is Open Source Software?

Open source software (OSS) is software that is distributed with its source code, making it available for use, modification, and distribution with its original rights. Source code is the part of software that most computer users don't ever see; it's the code computer programmers manipulate to control how a program or application behaves. Programmers who have access to source code can change a program by adding to it, changing it, or fixing parts of it that aren't working properly. OSS typically includes a license that allows programmers to modify the software to best fit their needs and control how the software can be distributed.

What Is The History Of OSS?

The idea of making source code freely available originated in 1983 from an ideological movement informally founded by Richard Stallman, a programmer at MIT. Stallman believed that software should be accessible to programmers so they could modify it as they wished, with the goal of understanding it, learning about it, and improving it.¹ Stallman began releasing free code under his own license, called the GNU Public License. This new approach and ideology surrounding software creation took hold and eventually led to the formation of the Open Source Initiative in 1998.ⁱ

How does OSS work?

Open source code is usually stored in a public repository and shared publicly. Anyone can access the repository to use the code independently or contribute improvements to the design and functionality of the overall project.

OSS usually comes with a distribution license. This license includes terms that define how developers can use, study, modify, and most importantly, distribute the software.ⁱⁱⁱ According to the Synopsys Black Duck® KnowledgeBase, five of the most popular licenses are:

MIT License

GNU General Public License (GPL) 2.0—this is more restrictive and requires that copies of modified code are made available for public use

Apache License 2.0

GNU General Public License (GPL) 3.0

BSD License 2.0 (3-clause, New or Revised)—this is less restrictive^{iv}

When source code is changed, OSS must include what was altered as well as the methods involved. Depending on the license terms, the software resulting from these modifications may or may not be required to be made available for free.ⁱⁱⁱ

What are some examples of OSS?

GNU/Linux

Mozilla Firefox

VLC media player

SugarCRM

GIMP

VNC

Apache web server

LibreOffice

jQuery

What are the advantages and disadvantages of open source software?

Advantages

Open source software is free.

Open source is flexible; developers can examine how the code works and freely make changes to dysfunctional or problematic aspects of the application to better fit their unique needs.

Open source is stable; the source code is publicly distributed, so users can depend on it for their long-term projects since they know that the code's creators cannot simply discontinue the project or let it fall into disrepair.

Open source fosters ingenuity; programmers can use pre-existing code to improve the software and even come up with their own innovations.

Open source comes with a built-in community that continuously modifies and improves the source code.

Open source provides great learning opportunities for new programmers.^v

Disadvantages

Open source can be harder to use and adopt due to difficulty setting it up and the lack of friendly user interfaces.

Open source can pose compatibility issues. When attempting to program proprietary hardware with OSS, there is often a need for specialized drivers that are typically only available from the hardware manufacturer.

Open source software can pose liability issues. Unlike commercial software, which is fully controlled by the vendor, open source rarely contains any warranty, liability, or infringement indemnity protection. This leaves the consumer of the OSS responsible for maintaining compliance with legal obligations.

Open source can incur unexpected costs in training users, importing data, and setting up required hardware.^{vi}

Open-source software development can be divided into several phases. The phases specified here are derived from *Sharma et al.*^[31] A diagram displaying the process-data structure of open-source software development is shown on the right. In this picture, the phases of open-source software development are displayed, along with the corresponding data elements. This diagram is made using the meta-modeling and meta-process modeling techniques.

Starting an open-source project

There are several ways in which work on an open-source project can start:

An individual who senses the need for a project announces the intent to develop a project in public.

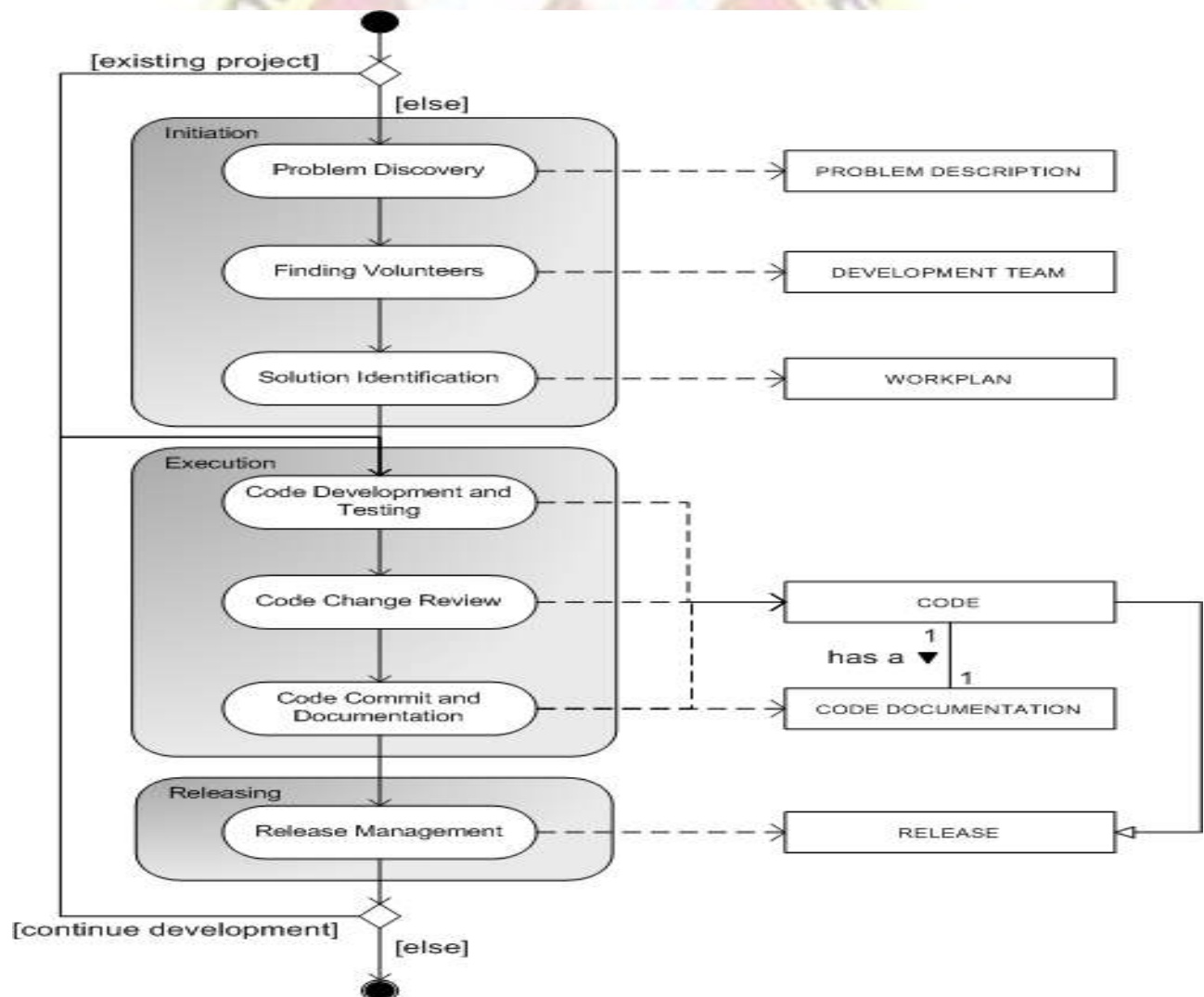
A developer working on a limited but working codebase, releases it to the public as the first version of an open-source program.

The source code of a mature project is released to the public.

A well-established open-source project can be forked by an interested outside party.

Eric Raymond observed in his essay *The Cathedral and the Bazaar* that announcing the intent for a project is usually inferior to releasing a working project to the public.

It's a common mistake to start a project when contributing to an existing similar project would be more effective (NIH syndrome)^[citation needed]. To start a successful project it is very important to investigate what's already there. The process starts with a choice between the adopting of an existing project, or the starting of a new project. If a new project is started, the process goes to the Initiation phase. If an existing project is adopted, the process goes directly to the Execution phase.



Open Source Development Model

The **Open Source Development Model** also involves an interconnected OSS Community Development Process in which each stage or phase plays a vital role in building the ethics of the community, keeping contributions of each developer in mind, working with the latest technologies, keeping a track on the version control system and fixing the bugs in the software.



Let's Discuss the role of each phase in an OSS Community Development Process,

Assert Requirements Design

This phase is all about the need for the software that is being proposed to the community for development and also the requirements during the development process are kept in mind in this phase. Along with it the design or the approach to be followed during the development is also a part of this phase.

Develop OSS Code

The requirements are fulfilled; the need has been understood and the design is ready. Now, it's time for the contributors to start developing the backbone or the skeleton of the software by the means of Coding.

Manage Configuration

Once the basic OSS Code is developed it is necessary to provide an initial configuration too is that its integration works perfectly fine along with all the features provided with that particular version.

Download and Install

Once the initial version is ready and configured properly it is ready to go in the markets for general use.

End-Use

The users who require the software to fall into this phase and use the OSS daily to provide experience and feedback to the developers or for personal benefits.

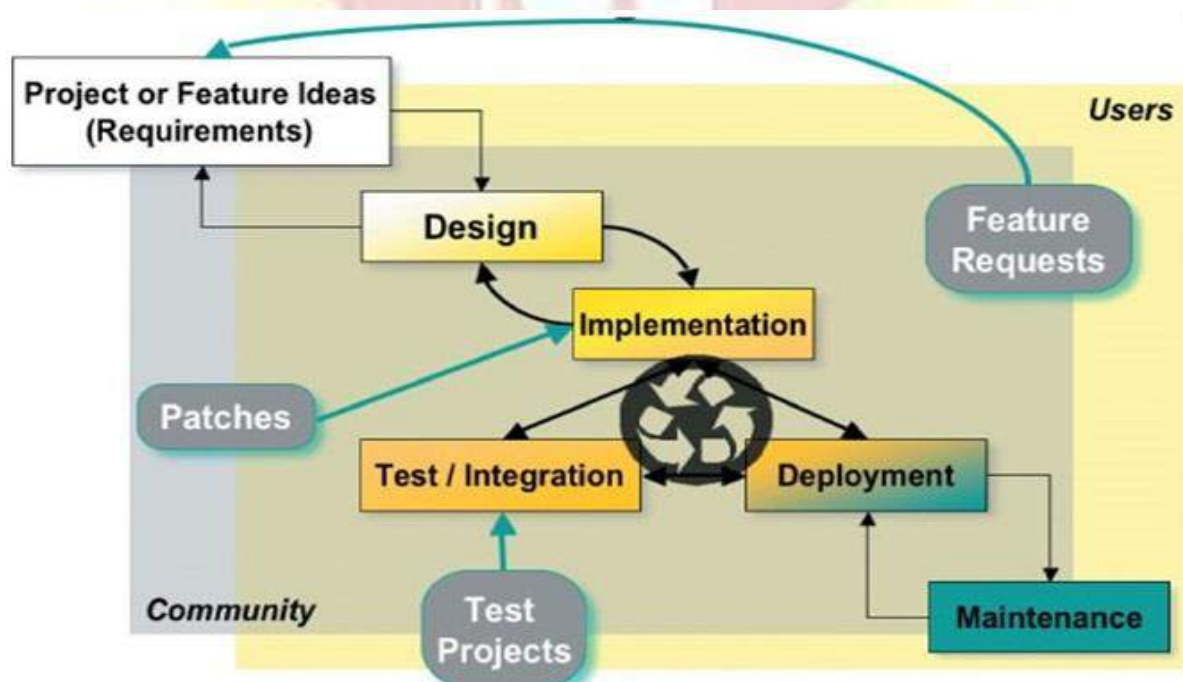
Communicate Experience

Once it is deployed in the market, the users share their experience with the OSS and give feedback, suggestions, and reviews on the functions that are good to be intact and also on the features that could be enhanced or added in the later versions of the software.

Read, Analyze and Redesign

Once the feedbacks are registered, it all comes back to the developers to work on the feedbacks, keep updating their Software and also track control of version.

Here comes the Open Source Project Development Model, this model is followed when a request is made to the developers to build a product to best suit their needs to which the developers keep in mind certain factors and phases to deliver a fully functional and a product with no compromises to the client.



The Phases involved here are,

Requirements: Which as discussed earlier in the same document, is the needs and features requested by the client in the particular product to utilize their organizational needs to the best of purpose.

Design: Again, the basic agenda after knowing the client requires to prepare a design in which development will take place along with the successful integration factor keeping in mind.

Implementation: The phase where the design is implemented or we can generalize this term also the CODING PHASE.

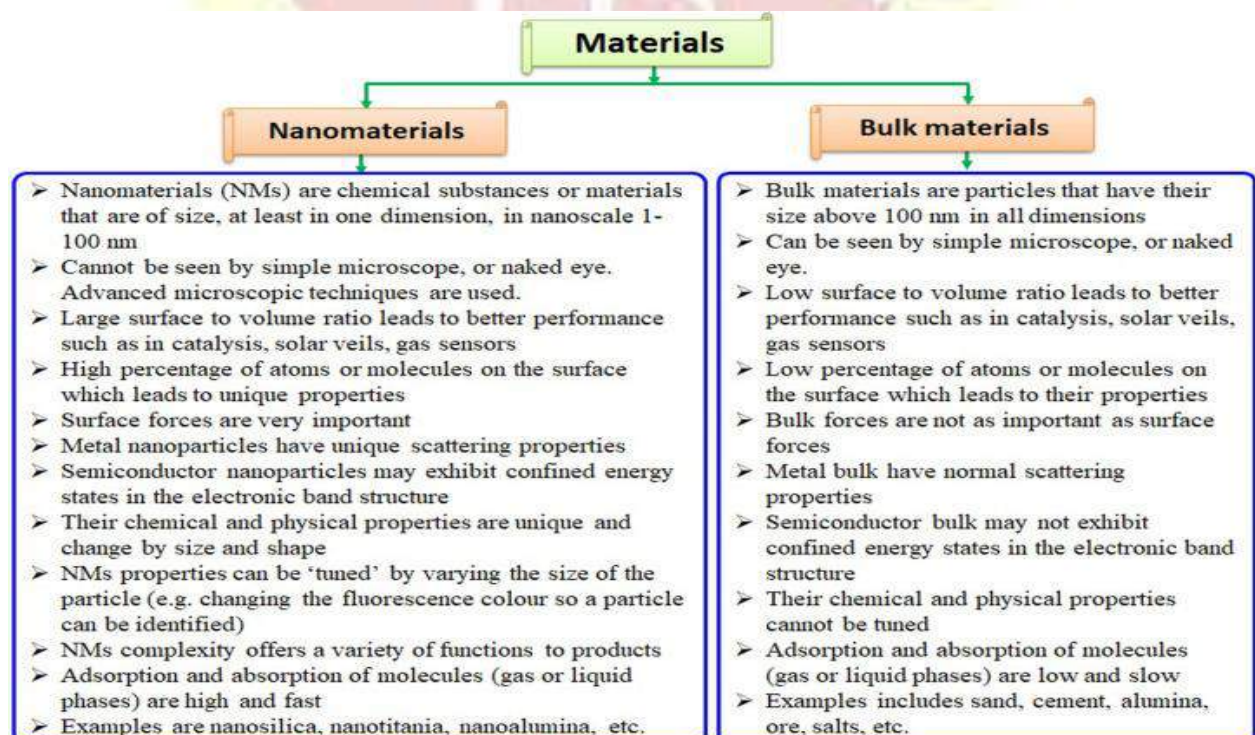
Test/Integration: Once Developed, the code or the product is integrated and tested with various tools to provide the user with a 100% satisfactory product with the least chances of failures.

Deployment: Deployment is the phase when your product is ready and you deliver it to the clients.

Maintenance: After the successful deployment, it is the duty of the developers as per the contract to provide the clients with proper maintenance to the product in which security enhancements, bug fixes, and add-ons can be carried out.

UNIT IV - NANOELECTRONICS

Nanotechnology in Electronics



- The term *nanoelectronics* refers to the use of nanotechnology in electronic components. These components are often only a few nanometers in size. However, the tinier electronic components become, the harder they are to manufacture.
- Nanoelectronics covers a diverse set of devices and materials, with the common characteristic that they are so small that physical effects alter the materials' properties on a nanoscale – inter-atomic interactions and quantum mechanical properties play a significant role in the workings of these devices.
- At the nanoscale, new phenomena take precedence over those that hold sway in the macro-world. Quantum effects such as tunneling and atomistic disorder dominate the characteristics of these nanoscale devices

The first transistors built in 1947 were over 1 centimeter in size; the smallest working transistor today is 7 nanometers long – over 1.4 million times smaller (1 cm equals 10 million nanometers). The result of these efforts are billion-transistor processors where, once industry embraces 7nm manufacturing techniques, 20 billion transistor-based circuits are integrated into a single chip.

Nanoelectronic Devices

Spintronics

Besides transistors, nanoelectronic devices play a role in data storage (memory). Here, *spintronics* – the study and exploitation in solid-state devices of electron spin and its associated magnetic moment, along with electric charge – is already an established technology.

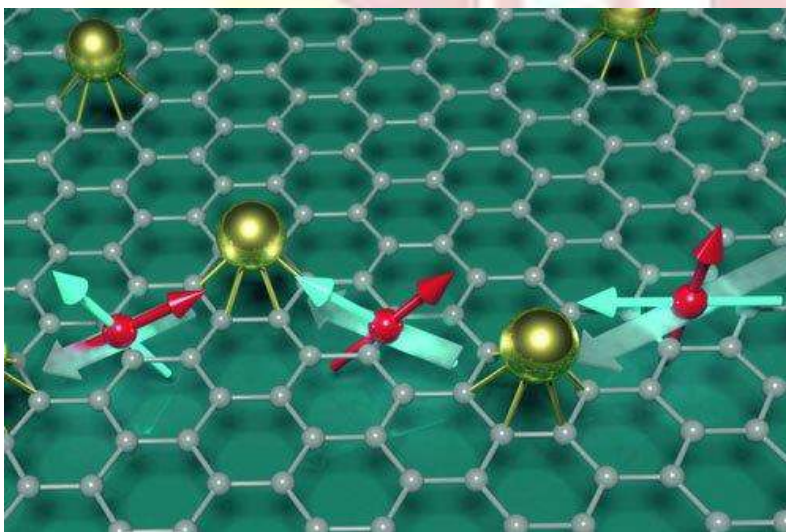


Illustration of electron spin in a graphene lattice.

Spintronics also plays a role in new technologies that exploit quantum behavior for computing

Optoelectronics

Electronic devices that source, detect and control light – i.e. optoelectronic devices – come in many shapes and forms. Highly energy-efficient (less heat generation and power consumption) optical communications are increasingly important because they have the potential to solve one of the biggest problems of our information age: energy consumption.

In the field of nanotechnology, materials like nanofibers (see for instance: "[Light-emitting nanofibers shine the way for optoelectronic textiles](#)") and carbon nanotubes have been used and especially graphene has shown [exciting potential for optoelectronic devices](#).

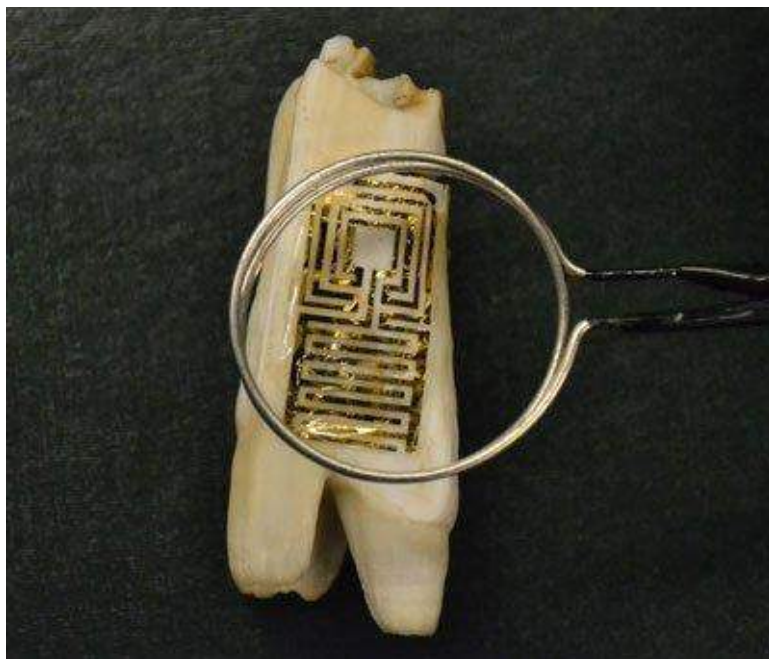
Displays

Display technologies can be grouped into three broad technology areas; Organic LEDs, electronic paper and other devices intended to show still images, and Field Emission Displays.

Wearable, flexible electronics

The age of wearable electronics is upon us as witnessed by the fast growing array of smart watches, fitness bands and other advanced, next-generation health monitoring devices such as electronic stick-on tattoos.

If current research is an indicator, wearable electronics will go far beyond just very small electronic devices or wearable, flexible computers. Not only will these devices be embedded in textile substrates but an electronics device or system could ultimately become the fabric itself. Electronic textiles (e-textiles) will allow the design and production of a new generation of garments with distributed sensors and electronic functions. Such e-textiles will have the revolutionary ability to sense, act, store, emit, and move – think biomedical monitoring functions or new man-machine interfaces – while ideally leveraging an existing low-cost textile manufacturing infrastructure (see for instance "[wearing single-walled carbon nanotube electronics on your skin](#)", a "[temporary tattoo to monitor glucose levels](#)" or "[graphene nanosensor tattoo on teeth monitors bacteria in your mouth](#)").



Optical image of the graphene wireless sensor biotransferred onto the surface of a tooth.

Nanoelectronics in Energy

Solar cells and supercapacitors are examples of areas where nanoelectronics is playing a major role in energy generation and storage.

Molecular Electronics

Distinct from nanoelectronics, where devices are scaled down to nanoscale levels, molecular electronics deals with electronic processes that occur in molecular structures such as those found in nature, from photosynthesis to signal transduction. Molecular electronics aims at the fundamental understanding of charge transport through molecules and is motivated by the vision of molecular circuits to enable miniscule, powerful and energy efficient computers (see for instance: "[Adding an optoelectronic component to molecular electronics](#)").

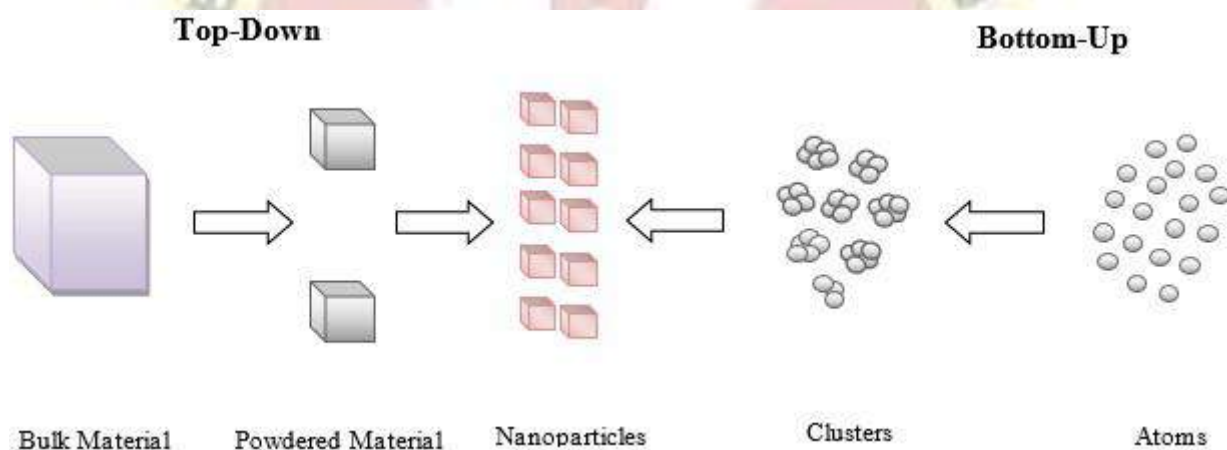
Nanotechnology approaches for nanoelectronics

There are mainly two types of approaches for the synthesis of nanomaterials used in nanoelectronics:

1. Top-down approach
2. Bottom-up approach

Top-down approach discusses about the slicing or successive cutting of a bulk material in order to get nano-dimensional particles. Bottom-up approach refers to the stockpile of a

material from the bottom: atom by atom, molecule by molecule, or cluster by cluster. Attrition or milling is a characteristic top-down method in the production of nanoparticles, while the colloidal dispersion is a good illustration of bottom-up approach in the synthesis of nanoparticles. The major difficulty with top-down approach is the defectiveness of surface structure and significant crystallographic impairment of the processed patterns. These deficiencies lead to extra challenges in the device design and construction. But this approach leads to the bulk fabrication of nanomaterial. Regardless of the flaws produced by top-down approach, they will continue to play an imperative role in the production of nanostructures. When structures plunge into a nanometer scale, there is a minute chance for top-down approach. All the tools we have possessed are too large to deal with such miniature subjects. Bottom-up approach also assures a better chance to attain nanostructures with less defects and more consistent chemical composition. On the contrary, top-down approach presumably introduces internal stress, additionally to surface defects and contaminations.



Approaches for the synthesis of nanomaterials.

The performance of Very Large Scale Integration circuits which are basically based on silicon has been progressively enhanced over the past few decades by scaling down the dimensions of the device, plus a virtually exponential development of microelectronics proficiencies is attained. Yet, maintaining this top-down trend for miniaturization is becoming very hard due to the basic technological and physical restrictions as well as the financial limitation. By contrast, using organic molecules as a building block for nanoscale devices has engrossed much consideration because the specifically controlled nanostructures may be formed economically by utilizing self-assembly of molecules. This bottom-up

technology can possibly overcome the integral problem of the present silicon top-down technology .

Integrated circuit (IC) technology also utilizes the top-down methodology in which the interconnects and devices are prepared by procedures such as thin-film deposition, etching, photolithography, and metallization. Although the fabrication tool competencies keep refining with each technology generation, the complications rise histrionically as the dimensions of the components approach nanometer scale in which various physical effects would stop the tools from operating properly. These restrictions set the ultimate scaling barrier of silicon CMOS, irrespective of the great technological impetus built up over the last three decades. Bottom-up methodology employs chemistry which is not so expensive, to stimulate self-assembly of multifarious mesoscopic structures. There are some fundamental advantages related to bottom-up approach in nanotechnology, like extremely low-power dissipation, rich functionality, and high component packing density, which would fall perfectly on the trend of technological demand but unattainable by the top-down approach [1].

The fundamental differences between the traditional top-down semiconductor nanoscale technology and futuristic bottom-up molecular nanotechnology are listed in [Table 1](#).

Top-down approach for semiconductor nanoscale technology	Bottom-up approach for molecular nanotechnology
---	--

Approach is from larger (bulk wafer) to smaller (chip)	Approach is from small (self-assembled structure) to large (chip)
--	---

Methods employed are pattern and etch

Methods employed are synthesis and self-assembly

Production cost is high

Production cost is low

Accessibility for material/device is less

Accessibility is more

Selection of material is stubborn

Selection of material is malleable

Design tool/infrastructure is developed

Design tool/infrastructure is open

Overall, considering the advantages of bottom-up approach over the top-down approach, it can be said that bottom-up technology is better than the top-down technology for the fabrication of various materials used in nanoelectronics.

What are Nanomaterials – Classification and Its Properties

It was observed that the quantum properties of the material can differ at the nanoscale. Material behaving as the insulator at the molecular level can express the properties of the

conductor when looked at its nanoscale level. Nanotechnology has emerged as the research methodology that deals with the study of the change in the properties of the material at the nanoscale. It involves the combinational study of various sciences such as quantum physics, semiconductor physics, material [fabrication](#), etc. at the nanoscale level. Materials formed by using the principles and methods of nanotechnology, whose properties lie between that of macroscopic solids and atomic systems, are known as Nanomaterials.

Nanomaterials

The term nanoscale refers to the dimension of 10^{-9} meters. It is the one billionth part of a meter. So, the particles whose any of the external dimensions or internal structure dimension or surface structure dimension lies in the range of 1nm to 100nm are considered as Nanomaterials. These materials are invisible to the naked eye. The material science-based approach of nanotechnology is considered for nanomaterials. At this scale, these materials have unique optical, electronic, mechanical and quantum properties compared to their molecular-scale behavior.

A nanomaterial can be a nano object or a nanostructured material. Nano objects are the discrete pieces of material, on the other hand, Nanostructured materials have their internal or surface structure in the nanoscale dimension.

Nanomaterials can be of natural existence, artificially manufactured or incidentally formed. With the advance in the research, nanomaterials are being commercialized and are being used as commodities.

Properties of Nanomaterials

A drastic change in the **properties of nanomaterials** can be observed when they are breakdown to the nanoscale level. As we go towards the nanoscale level from the molecular level, the electronic properties of materials get modified due to the quantum size effect. Change in the mechanical, thermal and catalytic properties of the materials can be seen with the increase in surface area to volume ratio at the nanoscale level.

Many of the insulator materials start behaving as conductors at their nanoscale dimensions. Similarly, as we reach the nanoscale dimensions many interesting quantum and surface phenomena can be observed.

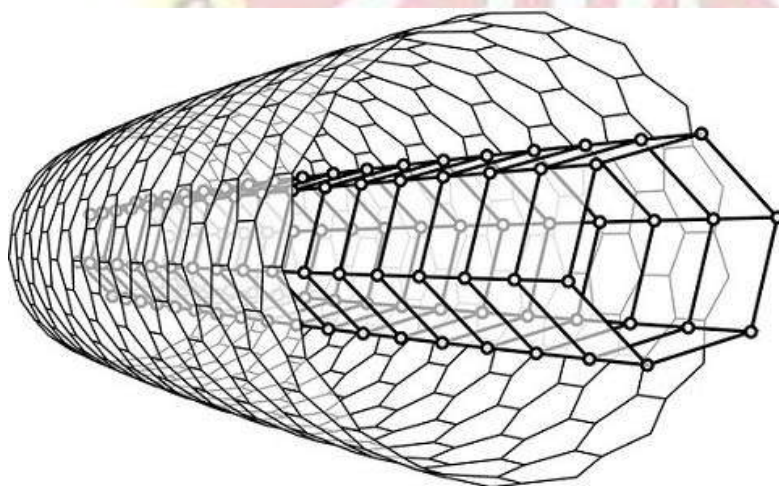
Particle size, shape, chemical composition, crystal structure, physicochemical stability, surface area, and surface energy, etc...attributes to the physicochemical properties of the nanomaterials. As the surface area to volume ratio of the nanomaterials increases, their surface becomes more reactive on itself and other systems. The size of the nanomaterials

plays a significant role in their pharmacological behavior. When nanomaterials interact with water or other dispersion media they can rearrange their crystal structure. The size, composition and surface charge of the nanomaterials affect their aggregation states. The magnetic, physicochemical and psychokinetic properties of these materials get affected by surface coating. These materials produce ROS when their surface reacts with oxygen, ozone, and transition materials.

At the nanoscale level, the interaction between particles is either due to the van der Waal forces or strong polar or covalent bonds. The surface properties of the nanomaterials and their interactions with other elements and environments can be modified with the use of polyelectrolytes.

Examples

Nanomaterials can be found as either engineered nanomaterials, incidental or of natural existence. Engineered nanomaterials are manufactured by humans with some desired properties. They include carbon black and titanium dioxide nanomaterials. The nanoparticles are also produced due to mechanical or industrial processes incidentally like during vehicle exhausts, welding fumes, cooking, and fuel heating. Incidentally produced atmospheric nanomaterials are also known as ultrafine particles. Fullerenes are the nanomaterial produced due to the burning of biomass, candle.



Nanotube

Natural existing nanomaterials are formed due to many of the natural processes such as forest fires, volcanic ash, ocean spray, weathering of metals, etc... Some of the **examples of nanomaterials** present in biological systems are the structure of wax crystals covering lotus, structure of viruses, spider-mite silk, blue hue of tarantula spiders, butterfly wing scales. Particles like milk, blood, horn, teeth, skin, paper, corals, beaks, feathers, bone

matrix, cotton, nail, etc.. are all-natural occurring organic nanomaterials. Clays are the example of naturally occurring inorganic nanomaterial, as they are formed due to crystal growths in diverse chemical conditions on the earth's crust.

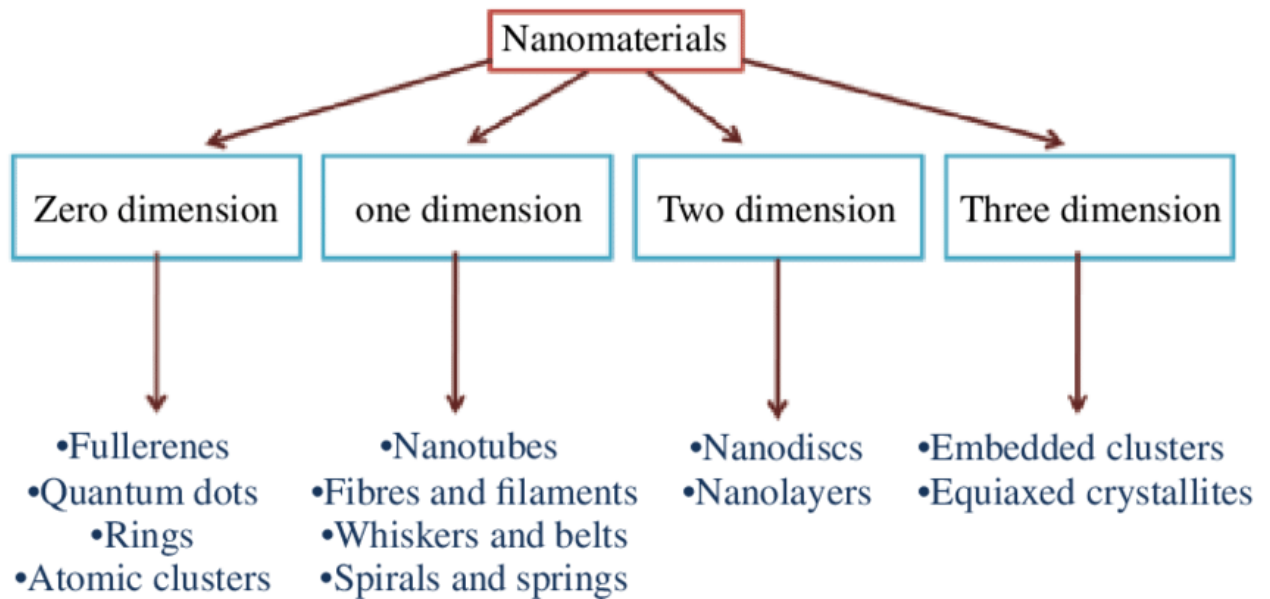
Classification

The classification of nanomaterials mainly depends on the morphology and their structure, they are classified into two major groups as Consolidated materials and Nanodispersions. Consolidated nanomaterials are further classified into several groups. The one dimensional Nano dispersive systems are termed as Nanopowders and Nanoparticles. Here the nanoparticles are further classified as Nanocrystals, Nanoclusters, Nanotubes, supermolecules, etc..

For the nanomaterials, the size is an important physical attribute. Nanomaterials are often classified depending upon the number of their dimensions falls under nanoscale. The nanomaterial whose all the three dimensions are of nanoscale and the is significantly no difference between the longest and shortest axes, are called Nanoparticles. Materials with their two dimensions in the nanoscale are called Nanofibres. Hollow nanofibres are known as Nanotubes and the solid ones are known as Nanorods. Materials with one dimension in the nanoscale are known as Nanoplates. Nanoplates with two different longer dimensions are known as Nanoribbons.


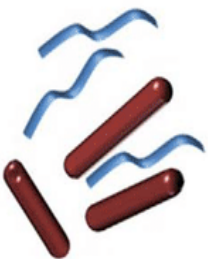
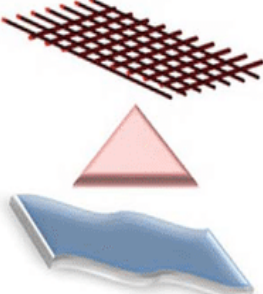
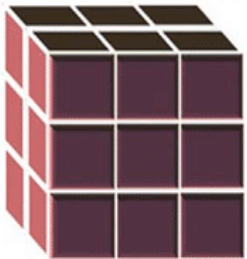
Based on the phases of matter contained by the nanostructured materials they are classified as nanocomposite, nanofoam, nanoporous and nanocrystalline materials. Solid materials containing at least one physically or chemically distinct region with at least one region with dimensions in the nanoscale are called Nano Composites. Nanofoams contain a liquid or solid matrix, filled with a gaseous phase and one of the two phases has dimensions in the nanoscale.

Solid materials with nanopores, cavities with dimensions on the nanoscale are considered as Nanoporous materials. Nanocrystalline materials have crystal grains in the nanoscale.



Dimensions of nanomaterials

This classification is based on the number of dimensions of a material, which are outside the nanoscale (<100 nm) range.

Isotropic nanomaterials	Anisotropic nanomaterials		
			
0D	1D	2D	3D
Spheres, Clusters	Nanorods, wires	Nanofilms, plates	Nanoparticles

Accordingly, in *zero-dimensional* (0D) nanomaterials all the dimensions are measured within the nanoscale (no dimensions are larger than 100 nm). Most commonly, 0D nanomaterials are nanoparticles.

In *one-dimensional* nanomaterials (1D), one dimension is outside the nanoscale. This class includes nanotubes, nanorods, and nanowires.

In *two-dimensional* nanomaterials (2D), two dimensions are outside the nanoscale. This class exhibits plate-like shapes and includes graphene, nanofilms, nanolayers, and nanocoatings.

Three-dimensional nanomaterials (3D) are materials that are not confined to the nanoscale in any dimension. This class can contain bulk powders, dispersions of nanoparticles, bundles of nanowires, and nanotubes as well as multi-nanolayers.

Applications of Nanomaterials

Today nanomaterials are being highly commercialized. Some of the commercial nanomaterials available in the market are cosmetics, strain resistant textiles, electronics, sunscreens, paints, etc...Nanocoatings and nanocomposites are being used in various consumer products such as sports equipment, windows, automobiles, etc..To protect the damage caused to beverages from sunlight, glass bottles are being coated with nanocoating which blocks the UV rays. Using nano-clay composites longer-lasting tennis balls are being manufactured. Nanoscale silica is used as a filler in dental fillings.

The optical properties of the nanomaterials are used to form optical detectors, sensors, lasers, displays, solar cells. This property is also used in biomedicine and photoelectrochemistry. In microbial fuel cells, the electrodes are made up of carbon nanotubes. Nanocrystalline zinc selenide is used in the display screens to increase the resolution of the pixels forming High Definition TV sets and personal computers. In the microelectronic industry, miniaturizing of circuits such as transistors, diodes, resistors, and capacitors is emphasized.

Nanowires are being used in forming junctionless [transistors](#). Nanomaterials are also used as catalysts in automobile catalytic converters and power generation systems, to react with toxic gases such as carbon monoxide and nitrogen oxide, thereby preventing the environmental pollution caused by them. To increase the sun protection factor(SPF) in the sunscreens nano-TiO₂ is used. To provide a highly active surface to the sensors, engineered nanolayers are used.

Fullerenes are used in cancer to treat cancer cells such as melanoma. These have also found use as light-activated antimicrobial agents. Due to their optical and electrical properties, quantum dots, nanowires, and nanorods have highly opted for Optoelectronics. Nanomaterials are being tested for applications in tissue engineering, drug delivery, and

biosensors. Nanozymes are the artificial enzymes used for biosensing, bioimaging, tumor detection.

Advantages and Disadvantages of Nanomaterials

The electrical, magnetic, optical and mechanical properties of the nanomaterials have provided many fascinating applications. Research is still in progress to know about these properties. Properties of the nanomaterials differ from that of their bulk size model. Some of the advantages of the nanomaterials are as follows-

- Nanomaterial [semiconductor](#) q-particles show quantum confinement effects, thereby giving them the luminescence property.
- Compared to coarse-grained ceramics, nanophase ceramics are more ductile at elevated temperatures.
- Cold welding property of the nanosized metallic powders along with their ductility is highly useful for metal-metal bonding.
- Single nanosized magnetic particles provide super paramagnetism property.
- Nanostructured metal clusters of monometallic composition act as precursors for heterogeneous catalysts.
- For solar cells, Nanocrystalline silicon films form a highly transparent contact.
- Nanostructured titanium oxide porous films provide high transmission and high surface area enhancement.
- Challenges faced by the microelectronic industry in the miniaturization of the circuits such as poor dissipation of heat generated by high-speed [microprocessors](#), poor reliability can be overcome with the help of nanocrystalline materials. These provide high thermal conductivity, high durability, and durable long-lasting interconnections.

There are also some technological disadvantages found in the use of nanomaterials. Some of those disadvantages are as follows –

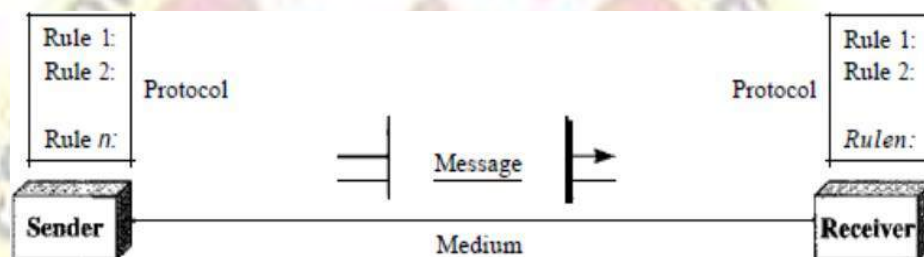
- Instability of the nanomaterials.
- Poor corrosion resistance.
- High solubility.
- When the nanomaterials with the high surface area come in direct contact with oxygen exothermic combustion takes place leading to an explosion.
- Impurity

- Nanomaterials are considered to be biologically harmful. These have high toxicity which can lead to irritations.
- Carcinogenic
- Difficult to synthesize
- No safe disposal available
- Hard to recycle

UNIT V

DATA & VOICE COMMUNICATION

Components of data communication system



A communication system has following components:

Message: It is the information or data to be communicated. It can consist of text, numbers, pictures, sound or video or any combination of these.

Sender

: The sender is the device that sends the data message. It can be a computer, workstation, telephone handset, video, camera & soon.

Receiver: The receiver is the device that receives the message. It can be computer, workstation, telephone and soon.

Medium: The transmission medium is the physical path by which a message travels from sender to receiver.

Protocol

: A computer network is a group of two or more interconnected computer systems. You can establish a network connection using either cable or wireless media.

++rotocols

In computer networks, communication occurs between entities in different systems. An entity is anything capable of sending or receiving information.

For communication to occur, the entities must agree on a protocol.

A protocol is a set of rules that govern data communications. A protocol defines what is communicated, how it is communicated, and when it is communicated. The key elements of a protocol are syntax, semantics, and timing.

Syntax : The term *syntax* refers to the structure or format of the data, meaning the order in which they are presented. For example, a simple protocol might expect

the first 8 bits of data to be the address of the sender, the second 8 bits to be the address of the receiver, and the rest of the stream to be the message itself.

Semantics: The word *semantics* refers to the meaning of each section of bits.

Timing : The term *timing* refers to two characteristics: when data should be sent and how fast they can be sent. For example, if a sender produces data at 100 Mbps but the receiver can process data at only 1 Mbps, the transmission will overload the receiver and some data will be lost.

Standards

Standards are essential in creating and maintaining an open and competitive market for equipment manufacturers and in guaranteeing national and international interoperability of data and telecommunications technology and processes. Standards provide guidelines to manufacturers, vendors, government agencies, and other service providers to ensure the kind of interconnectivity necessary in today's marketplace and in international communications.

Data communication standards fall into two categories: *de facto* (meaning "by fact" or "by convention") and *de jure* (meaning "by law" or "by regulation").

o De facto : Standards that have not been approved by an organized body but have been adopted as standards through widespread use are de facto standards. De facto standards are often established originally by manufacturers who seek to define the functionality of a new product or technology.

o De jure: Those standards that have been legislated by an officially recognized body are de jure standards.

TCP/IP model

The TCP/IP model was developed prior to the OSI model.

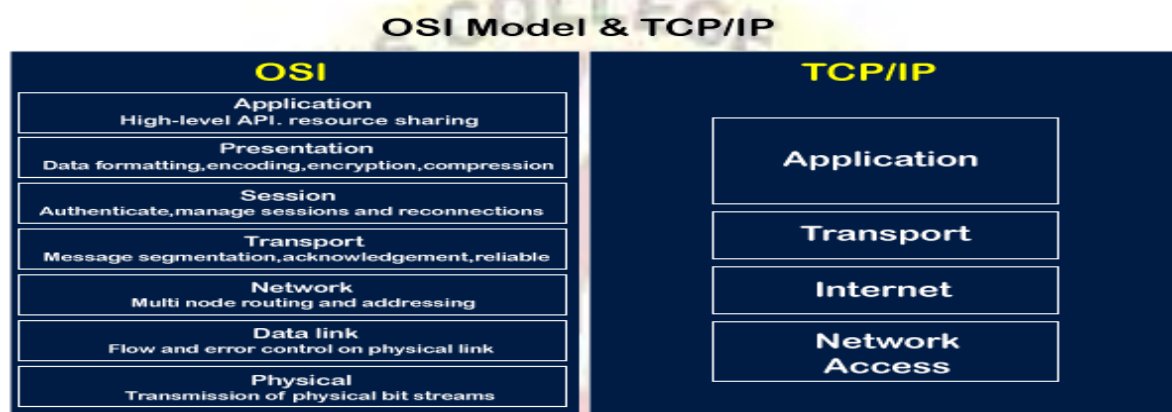
The TCP/IP model is not exactly similar to the OSI model.

The TCP/IP model consists of five layers: the application layer, transport layer, network layer, data link layer and physical layer.

The first four layers provide physical standards, network interface, internetworking, and transport functions that correspond to the first four layers of the OSI model and these four layers are represented in TCP/IP model by a single layer called the application layer.

TCP/IP is a hierarchical protocol made up of interactive modules, and each of them provides specific functionality.

Here, hierarchical means that each upper-layer protocol is supported by two or more lower-level protocols

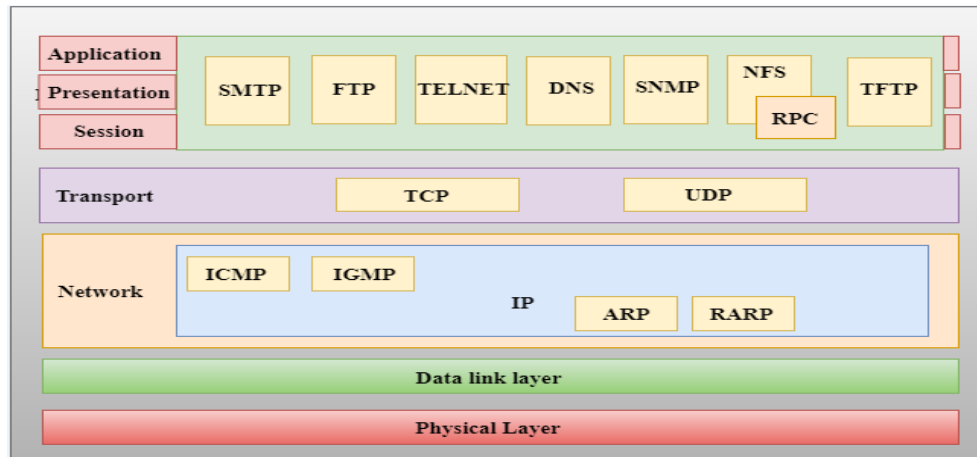


differences between the OSI and TCP/IP model in a tabular form:

OSI Model	TCP/IP Model
It stands for Open System Interconnection.	It stands for Transmission Control Protocol.
OSI model has been developed by ISO (International Standard Organization).	It was developed by ARPANET (Advanced Research Project Agency Network).
It is an independent standard and generic protocol used as a communication gateway between the network and the end user.	It consists of standard protocols that lead to the development of an internet. It is a communication protocol that provides the connection among the hosts.
In the OSI model, the transport layer provides a guarantee for the delivery of the packets.	The transport layer does not provide the surety for the delivery of packets. But still, we can say that it is a reliable model.

This model is based on a vertical approach.	This model is based on a horizontal approach.
In this model, the session and presentation layers are separated, i.e., both the layers are different.	In this model, the session and presentation layer are not different layers. Both layers are included in the application layer.
It is also known as a reference model through which various networks are built. For example, the TCP/IP model is built from the OSI model. It is also referred to as a guidance tool.	It is an implemented model of an OSI model.
In this model, the network layer provides both connection-oriented and connectionless service.	The network layer provides only connectionless service.
Protocols in the OSI model are hidden and can be easily replaced when the technology changes.	In this model, the protocol cannot be easily replaced.
It consists of 7 layers.	It consists of 4 layers.
OSI model defines the services, protocols, and interfaces as well as provides a proper distinction between them. It is protocol independent.	In the TCP/IP model, services, protocols, and interfaces are not properly separated. It is protocol dependent.
The usage of this model is very low.	This model is highly used.
It provides standardization to the devices like router, motherboard, switches, and other hardware devices.	It does not provide the standardization to the devices. It provides a connection between various computers.

Functions of TCP/IP layers:



Network Access Layer

network layer is the lowest layer of the TCP/IP model.

A network layer is the combination of the Physical layer and Data Link layer defined in the OSI reference model.

It defines how the data should be sent physically through the network.

This layer is mainly responsible for the transmission of the data between two devices on the same network.

The functions carried out by this layer are encapsulating the IP datagram into frames transmitted by the network and mapping of IP addresses into physical addresses.

The protocols used by this layer are ethernet, token ring, FDDI, X.25, frame relay.

Internet Layer

An internet layer is the second layer of the TCP/IP model.

An internet layer is also known as the network layer.

The main responsibility of the internet layer is to send the packets from any network, and they arrive at the destination irrespective of the route they take.

Following are the protocols used in this layer are:

IP Protocol: IP protocol is used in this layer, and it is the most significant part of the entire TCP/IP suite.

Following are the responsibilities of this protocol:

IP Addressing: This protocol implements logical host addresses known as IP addresses. The IP addresses are used by the internet and higher layers to identify the device and to provide internetwork routing.

Host-to-host communication: It determines the path through which the data is to be transmitted.

Data Encapsulation and Formatting: An IP protocol accepts the data from the transport layer protocol. An IP protocol ensures that the data is sent and received securely, it encapsulates the data into message known as IP datagram.

Fragmentation and Reassembly: The limit imposed on the size of the IP datagram by data link layer protocol is known as Maximum Transmission unit (MTU). If the size of IP datagram is greater than the MTU unit, then the IP protocol splits the datagram into smaller units so that they can travel over the local network. Fragmentation can be done by the sender or intermediate router. At the receiver side, all the fragments are reassembled to form an original message.

Routing: When IP datagram is sent over the same local network such as LAN, MAN, WAN, it is known as direct delivery. When source and destination are on the distant network, then the IP datagram is sent indirectly. This can be accomplished by routing the IP datagram through various devices such as routers.

ARP Protocol

ARP stands for **Address Resolution Protocol**.

ARP is a network layer protocol which is used to find the physical address from the IP address.

The two terms are mainly associated with the ARP Protocol:

ARP request: When a sender wants to know the physical address of the device, it broadcasts the ARP request to the network.

ARP reply: Every device attached to the network will accept the ARP request and process the request, but only recipient recognize the IP address and sends back its physical address in the form of ARP reply. The recipient adds the physical address both to its cache memory and to the datagram header

ICMP Protocol

ICMP stands for Internet Control Message Protocol.

It is a mechanism used by the hosts or routers to send notifications regarding datagram problems back to the sender.

A datagram travels from router-to-router until it reaches its destination. If a router is unable to route the data because of some unusual conditions such as disabled links, a device is on

fire or network congestion, then the ICMP protocol is used to inform the sender that the datagram is undeliverable.

An ICMP protocol mainly uses two terms:

ICMP Test: ICMP Test is used to test whether the destination is reachable or not.

ICMP Reply: ICMP Reply is used to check whether the destination device is responding or not.

The core responsibility of the ICMP protocol is to report the problems, not correct them. The responsibility of the correction lies with the sender.

ICMP can send the messages only to the source, but not to the intermediate routers because the IP datagram carries the addresses of the source and destination but not of the router that it is passed to.

Transport Layer

The transport layer is responsible for the reliability, flow control, and correction of data which is being sent over the network.

The two protocols used in the transport layer are **User Datagram protocol and Transmission control protocol.**

User Datagram Protocol (UDP)

It provides connectionless service and end-to-end delivery of transmission.

It is an unreliable protocol as it discovers the errors but not specify the error.

User Datagram Protocol discovers the error, and ICMP protocol reports the error to the sender that user datagram has been damaged.

UDP consists of the following fields:

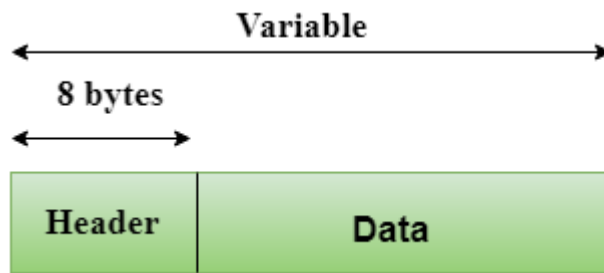
Source port address: The source port address is the address of the application program that has created the message.

Destination port address: The destination port address is the address of the application program that receives the message.

Total length: It defines the total number of bytes of the user datagram in bytes.

Checksum: The checksum is a 16-bit field used in error detection.

UDP does not specify which packet is lost. UDP contains only checksum; it does not contain any ID of a data segment.



Header Format

Source port address 16 bits	Destination port address 16 bits
Total length 16 bits	Checksum 16 bits

Transmission Control Protocol (TCP)

It provides a full transport layer services to applications.

It creates a virtual circuit between the sender and receiver, and it is active for the duration of the transmission.

TCP is a reliable protocol as it detects the error and retransmits the damaged frames. Therefore, it ensures all the segments must be received and acknowledged before the transmission is considered to be completed and a virtual circuit is discarded.

At the sending end, TCP divides the whole message into smaller units known as segment, and each segment contains a sequence number which is required for reordering the frames to form an original message.

At the receiving end, TCP collects all the segments and reorders them based on sequence numbers.

Application Layer

An application layer is the topmost layer in the TCP/IP model.

It is responsible for handling high-level protocols, issues of representation.

This layer allows the user to interact with the application.

When one application layer protocol wants to communicate with another application layer, it forwards its data to the transport layer.

There is an ambiguity occurs in the application layer. Every application cannot be placed inside the application layer except those who interact with the communication system. For example: text editor cannot be considered in application layer while web browser using **HTTP** protocol to interact with the network where **HTTP** protocol is an application layer protocol.

Following are the main protocols used in the application layer:

HTTP: HTTP stands for Hypertext transfer protocol. This protocol allows us to access the data over the world wide web. It transfers the data in the form of plain text, audio, video. It is known as a Hypertext transfer protocol as it has the efficiency to use in a hypertext environment where there are rapid jumps from one document to another.

SNMP: SNMP stands for Simple Network Management Protocol. It is a framework used for managing the devices on the internet by using the TCP/IP protocol suite.

SMTP: SMTP stands for Simple mail transfer protocol. The TCP/IP protocol that supports the e-mail is known as a Simple mail transfer protocol. This protocol is used to send the data to another e-mail address.

DNS: DNS stands for Domain Name System. An IP address is used to identify the connection of a host to the internet uniquely. But, people prefer to use the names instead of addresses. Therefore, the system that maps the name to the address is known as Domain Name System.

TELNET: It is an abbreviation for Terminal Network. It establishes the connection between the local computer and remote computer in such a way that the local terminal appears to be a terminal at the remote system.

FTP: FTP stands for File Transfer Protocol. FTP is a standard internet protocol used for transmitting the files from one computer to another computer.

HTTP

HTTP stands for **HyperText Transfer Protocol**.

It is a protocol used to access the data on the World Wide Web (www).

The HTTP protocol can be used to transfer the data in the form of plain text, hypertext, audio, video, and so on.

This protocol is known as HyperText Transfer Protocol because of its efficiency that allows us to use in a hypertext environment where there are rapid jumps from one document to another document.

HTTP is similar to the FTP as it also transfers the files from one host to another host. But, HTTP is simpler than FTP as HTTP uses only one connection, i.e., no control connection to transfer the files.

HTTP is used to carry the data in the form of MIME-like format.

HTTP is similar to SMTP as the data is transferred between client and server. The HTTP differs from the SMTP in the way the messages are sent from the client to the server and

from server to the client. SMTP messages are stored and forwarded while HTTP messages are delivered immediately.

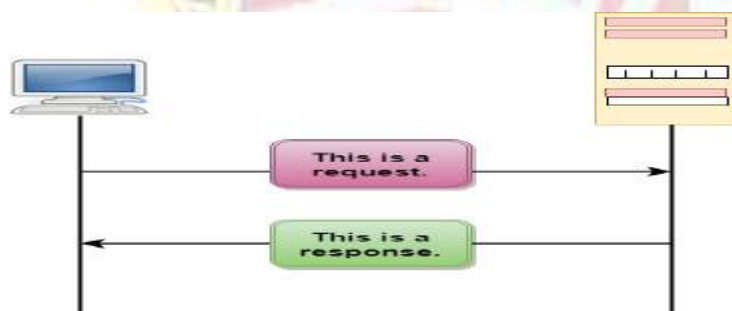
Features of HTTP:

Connectionless protocol: HTTP is a connectionless protocol. HTTP client initiates a request and waits for a response from the server. When the server receives the request, the server processes the request and sends back the response to the HTTP client after which the client disconnects the connection. The connection between client and server exist only during the current request and response time only.

Media independent: HTTP protocol is a media independent as data can be sent as long as both the client and server know how to handle the data content. It is required for both the client and server to specify the content type in MIME-type header.

Stateless: HTTP is a stateless protocol as both the client and server know each other only during the current request. Due to this nature of the protocol, both the client and server do not retain the information between various requests of the web pages.

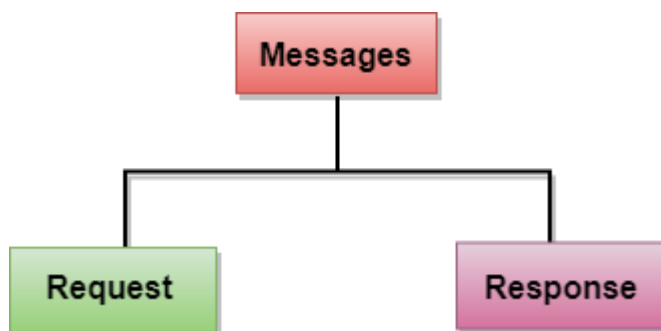
HTTP Transactions



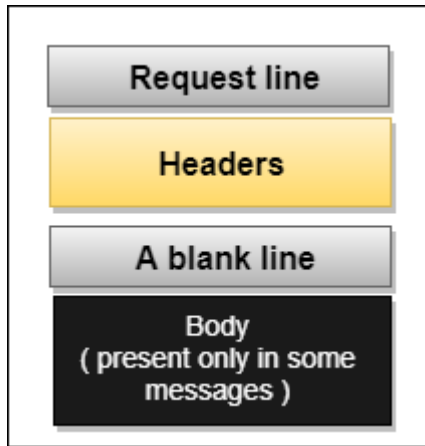
The above figure shows the HTTP transaction between client and server. The client initiates a transaction by sending a request message to the server. The server replies to the request message by sending a response message.

Messages

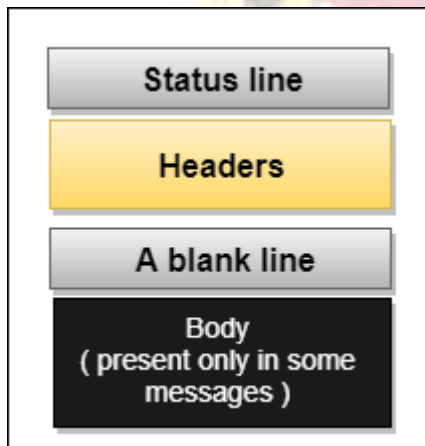
HTTP messages are of two types: request and response. Both the message types follow the same message format.



Request Message: The request message is sent by the client that consists of a request line, headers, and sometimes a body.



Response Message: The response message is sent by the server to the client that consists of a status line, headers, and sometimes a body.



Uniform Resource Locator (URL)

A client that wants to access the document in an internet needs an address and to facilitate the access of documents, the HTTP uses the concept of Uniform Resource Locator (URL).

The Uniform Resource Locator (URL) is a standard way of specifying any kind of information on the internet.

The URL defines four parts: method, host computer, port, and path.



Method: The method is the protocol used to retrieve the document from a server. For example, HTTP.

Host: The host is the computer where the information is stored, and the computer is given an alias name. Web pages are mainly stored in the computers and the computers are given an alias name that begins with the characters "www". This field is not mandatory.

Port: The URL can also contain the port number of the server, but it's an optional field. If the port number is included, then it must come between the host and path and it should be separated from the host by a colon.

Path: Path is the pathname of the file where the information is stored. The path itself contain slashes that separate the directories from the subdirectories and files.

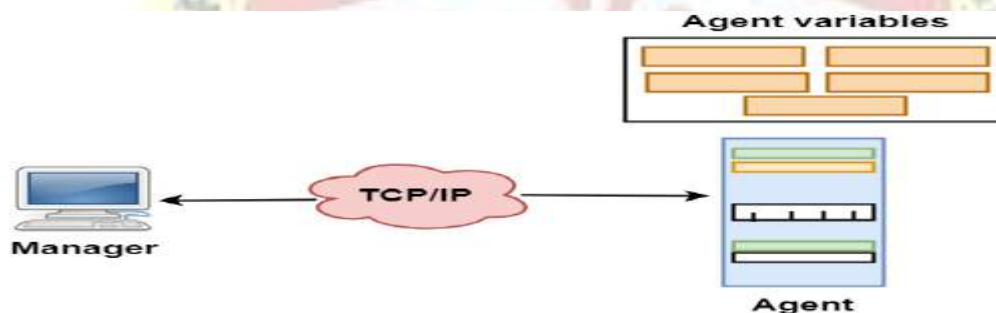
SNMP

SNMP stands for **Simple Network Management Protocol**.

SNMP is a framework used for managing devices on the internet.

It provides a set of operations for monitoring and managing the internet.

SNMP Concept



SNMP has two components Manager and agent.

The manager is a host that controls and monitors a set of agents such as routers.

It is an application layer protocol in which a few manager stations can handle a set of agents.

The protocol designed at the application level can monitor the devices made by different manufacturers and installed on different physical networks.

It is used in a heterogeneous network made of different LANs and WANs connected by routers or gateways.

Managers & Agents

A manager is a host that runs the SNMP client program while the agent is a router that runs the SNMP server program.

Management of the internet is achieved through simple interaction between a manager and agent.

The agent is used to keep the information in a database while the manager is used to access the values in the database. For example, a router can store the appropriate variables such as a number of packets received and forwarded while the manager can compare these variables to determine whether the router is congested or not.

Agents can also contribute to the management process. A server program on the agent checks the environment, if something goes wrong, the agent sends a warning message to the manager.

Management with SNMP has three basic ideas:

A manager checks the agent by requesting the information that reflects the behavior of the agent.

A manager also forces the agent to perform a certain function by resetting values in the agent database.

An agent also contributes to the management process by warning the manager regarding an unusual condition.

Management Components

Management is not achieved only through the SNMP protocol but also the use of other protocols that can cooperate with the SNMP protocol. Management is achieved through the use of the other two protocols: SMI (Structure of management information) and MIB (management information base).

Management is a combination of SMI, MIB, and SNMP. All these three protocols such as abstract syntax notation 1 (ASN.1) and basic encoding rules (BER).



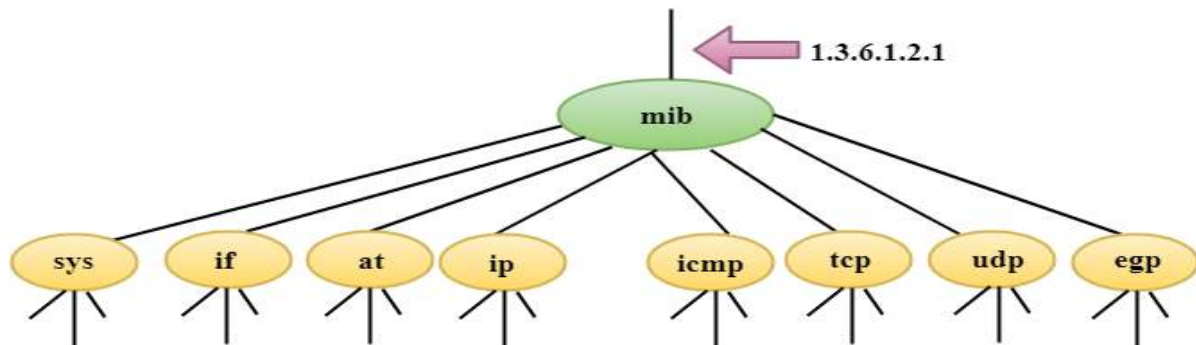
SMI

The SMI (Structure of management information) is a component used in network management. Its main function is to define the type of data that can be stored in an object and to show how to encode the data for the transmission over a network.

MIB

The MIB (Management information base) is a second component for the network management.

Each agent has its own MIB, which is a collection of all the objects that the manager can manage. MIB is categorized into eight groups: system, interface, address translation, ip, icmp, tcp, udp, and egp. These groups are under the mib object.



SNMP

SNMP defines five types of messages: GetRequest, GetNextRequest, SetRequest, GetResponse, and Trap.



GetRequest: The GetRequest message is sent from a manager (client) to the agent (server) to retrieve the value of a variable.

GetNextRequest: The GetNextRequest message is sent from the manager to agent to retrieve the value of a variable. This type of message is used to retrieve the values of the entries in a table. If the manager does not know the indexes of the entries, then it will not be able to retrieve the values. In such situations, GetNextRequest message is used to define an object.

GetResponse: The GetResponse message is sent from an agent to the manager in response to the GetRequest and GetNextRequest message. This message contains the value of a variable requested by the manager.

SetRequest: The SetRequest message is sent from a manager to the agent to set a value in a variable.

Trap: The Trap message is sent from an agent to the manager to report an event. For example, if the agent is rebooted, then it informs the manager as well as sends the time of rebooting.

SMTP

SMTP stands for Simple Mail Transfer Protocol.

SMTP is a set of communication guidelines that allow software to transmit an electronic mail over the internet is called **Simple Mail Transfer Protocol**.

It is a program used for sending messages to other computer users based on e-mail addresses.

It provides a mail exchange between users on the same or different computers, and it also supports:

It can send a single message to one or more recipients.

Sending message can include text, voice, video or graphics.

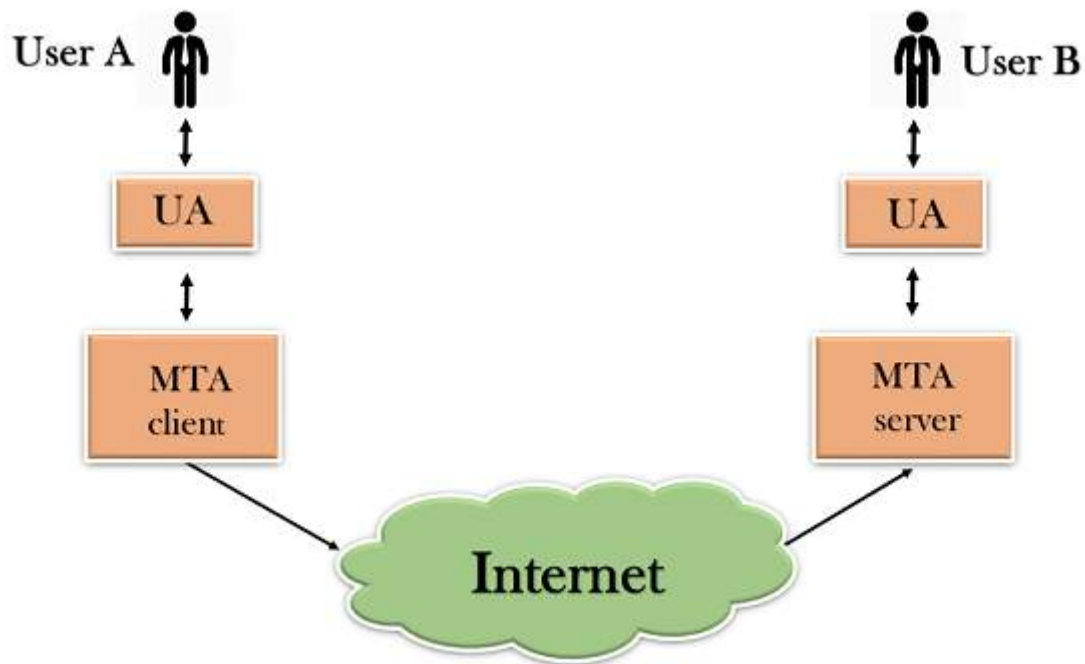
It can also send the messages on networks outside the internet.

The main purpose of SMTP is used to set up communication rules between servers. The servers have a way of identifying themselves and announcing what kind of communication they are trying to perform. They also have a way of handling the errors such as incorrect email address. For example, if the recipient address is wrong, then receiving server reply with an error message of some kind.

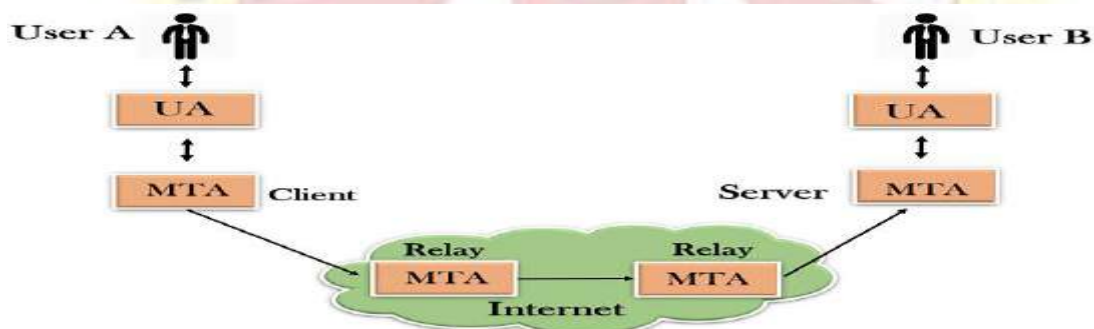
Components of SMTP



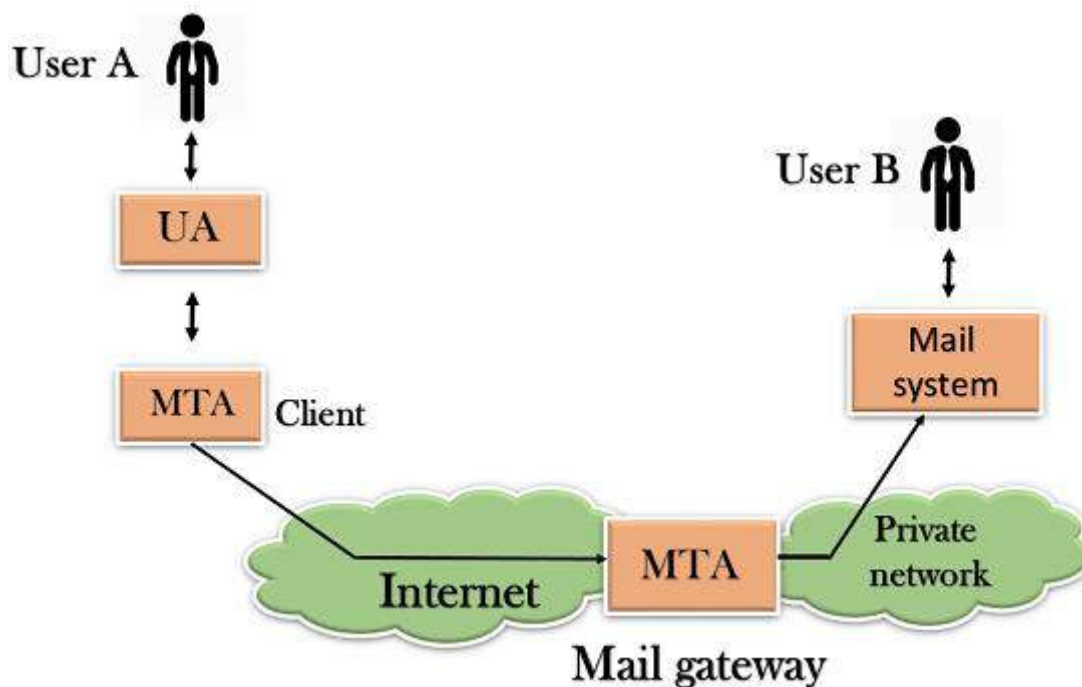
First, we will break the SMTP client and SMTP server into two components such as user agent (UA) and mail transfer agent (MTA). The user agent (UA) prepares the message, creates the envelope and then puts the message in the envelope. The mail transfer agent (MTA) transfers this mail across the internet.



SMTP allows a more complex system by adding a relaying system. Instead of just having one MTA at sending side and one at receiving side, more MTAs can be added, acting either as a client or server to relay the email.



The relaying system without TCP/IP protocol can also be used to send the emails to users, and this is achieved by the use of the mail gateway. The mail gateway is a relay MTA that can be used to receive an email.



Working of SMTP

Composition of Mail: A user sends an e-mail by composing an electronic mail message using a Mail User Agent (MUA). Mail User Agent is a program which is used to send and receive mail. The message contains two parts: body and header. The body is the main part of the message while the header includes information such as the sender and recipient address. The header also includes descriptive information such as the subject of the message. In this case, the message body is like a letter and header is like an envelope that contains the recipient's address.

Submission of Mail: After composing an email, the mail client then submits the completed e-mail to the SMTP server by using SMTP on TCP port 25.

Delivery of Mail: E-mail addresses contain two parts: username of the recipient and domain name. For example, vivek@gmail.com, where "vivek" is the username of the recipient and "gmail.com" is the domain name. If the domain name of the recipient's email address is different from the sender's domain name, then MSA will send the mail to the Mail Transfer Agent (MTA). To relay the email, the MTA will find the target domain. It checks the MX record from Domain Name System to obtain the target domain. The MX record contains the domain name and IP address of the recipient's domain. Once the record is located, MTA connects to the exchange server to relay the message.

Receipt and Processing of Mail: Once the incoming message is received, the exchange server delivers it to the incoming server (Mail Delivery Agent) which stores the e-mail where it waits for the user to retrieve it.

Access and Retrieval of Mail: The stored email in MDA can be retrieved by using MUA (Mail User Agent). MUA can be accessed by using login and password.

DNS

An application layer protocol defines how the application processes running on different systems, pass the messages to each other.

DNS stands for Domain Name System.

DNS is a directory service that provides a mapping between the name of a host on the network and its numerical address.

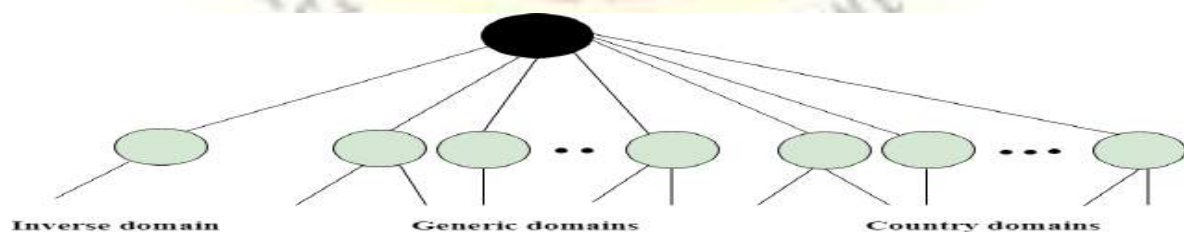
DNS is required for the functioning of the internet.

Each node in a tree has a domain name, and a full domain name is a sequence of symbols specified by dots.

DNS is a service that translates the domain name into IP addresses. This allows the users of networks to utilize user-friendly names when looking for other hosts instead of remembering the IP addresses.

For example, suppose the FTP site at EduSoft had an IP address of 132.147.165.50, most people would reach this site by specifying ftp.EduSoft.com. Therefore, the domain name is more reliable than IP address.

DNS is a TCP/IP protocol used on different platforms. The domain name space is divided into three different sections: generic domains, country domains, and inverse domain.



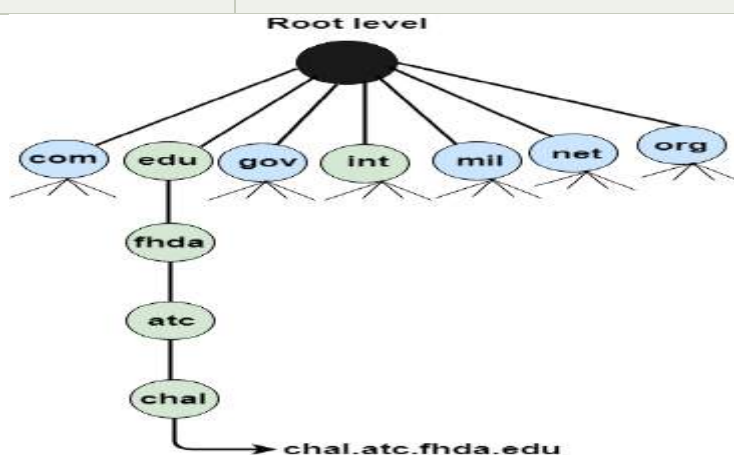
Generic Domains

It defines the registered hosts according to their generic behavior.

Each node in a tree defines the domain name, which is an index to the DNS database.

It uses three-character labels, and these labels describe the organization type.

Label	Description
aero	Airlines and aerospace companies
biz	Businesses or firms
com	Commercial Organizations
coop	Cooperative business Organizations
edu	Educational institutions
gov	Government institutions
info	Information service providers
int	International Organizations
mil	Military groups
museum	Museum & other nonprofit organizations
name	Personal names
net	Network Support centers
org	Nonprofit Organizations
pro	Professional individual Organizations



Country Domain

The format of country domain is same as a generic domain, but it uses two-character country abbreviations (e.g., us for the United States) in place of three character organizational abbreviations.

Inverse Domain

The inverse domain is used for mapping an address to a name. When the server has received a request from the client, and the server contains the files of only authorized clients. To determine whether the client is on the authorized list or not, it sends a query to the DNS server and ask for mapping an address to the name.

Working of DNS

DNS is a client/server network communication protocol. DNS clients send requests to the server while DNS servers send responses to the client.

Client requests contain a name which is converted into an IP address known as a forward DNS lookups while requests containing an IP address which is converted into a name known as reverse DNS lookups.

DNS implements a distributed database to store the name of all the hosts available on the internet.

If a client like a web browser sends a request containing a hostname, then a piece of software such as **DNS resolver** sends a request to the DNS server to obtain the IP address of a hostname. If DNS server does not contain the IP address associated with a hostname, then it forwards the request to another DNS server. If IP address has arrived at the resolver, which in turn completes the request over the internet protocol.

Telnet

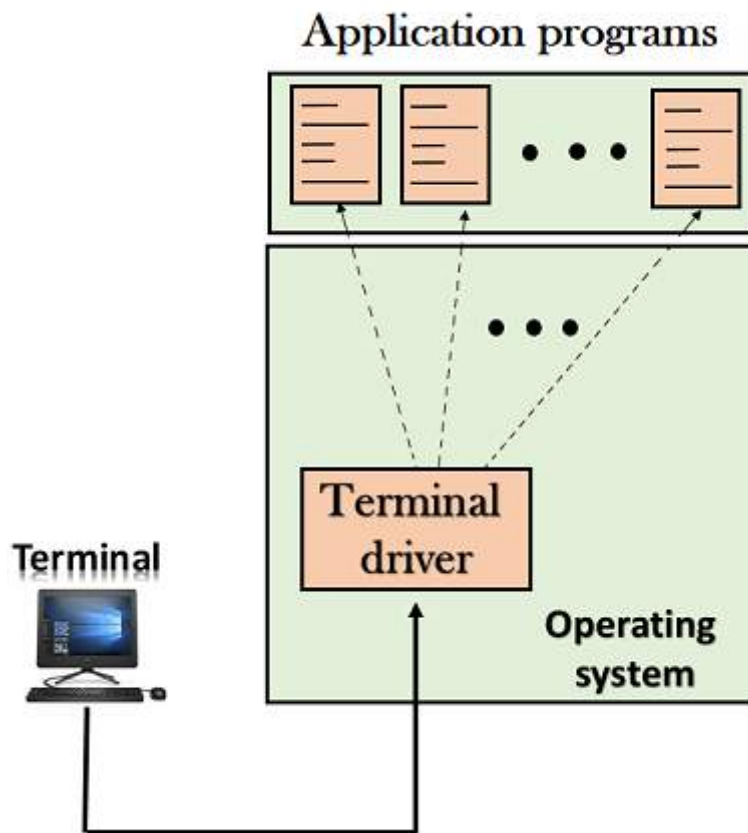
The main task of the internet is to provide services to users. For example, users want to run different application programs at the remote site and transfers a result to the local site. This requires a client-server program such as FTP, SMTP. But this would not allow us to create a specific program for each demand.

The better solution is to provide a general client-server program that lets the user access any application program on a remote computer. Therefore, a program that allows a user to log on to a remote computer. A popular client-server program Telnet is used to meet such demands. Telnet is an abbreviation for **Terminal Network**.

Telnet provides a connection to the remote computer in such a way that a local terminal appears to be at the remote side.

There are two types of login:

Local Login

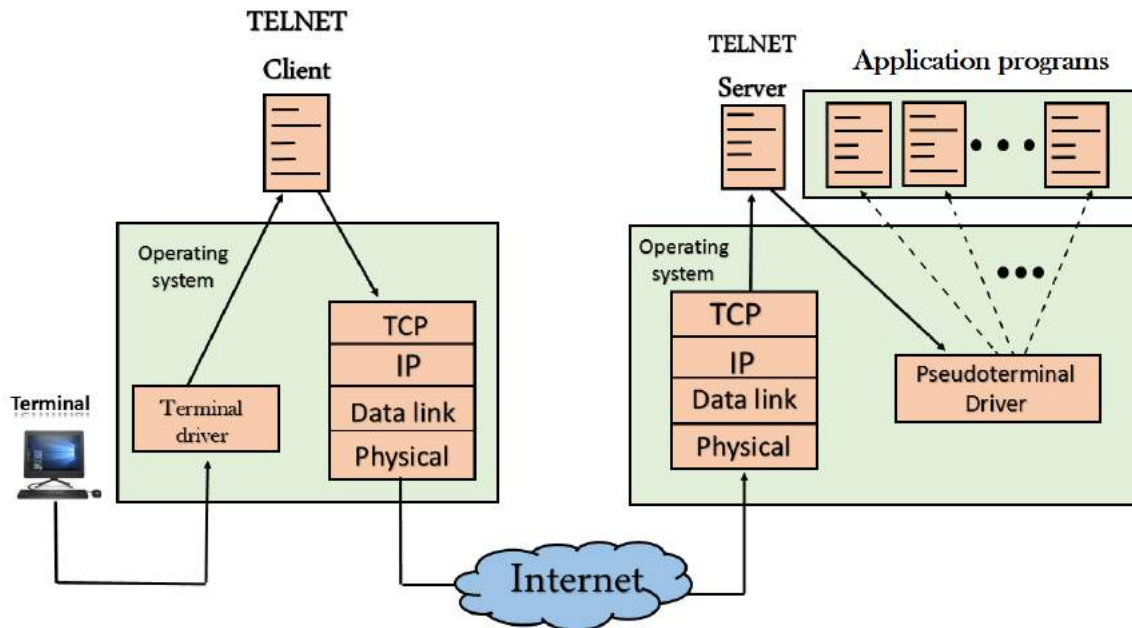


When a user logs into a local computer, then it is known as local login.

When the workstation running terminal emulator, the keystrokes entered by the user are accepted by the terminal driver. The terminal driver then passes these characters to the operating system which in turn, invokes the desired application program.

However, the operating system has special meaning to special characters. For example, in UNIX some combination of characters have special meanings such as control character with "z" means suspend. Such situations do not create any problem as the terminal driver knows the meaning of such characters. But, it can cause the problems in remote login.

Remote login



When the user wants to access an application program on a remote computer, then the user must perform remote login.

How remote login occurs

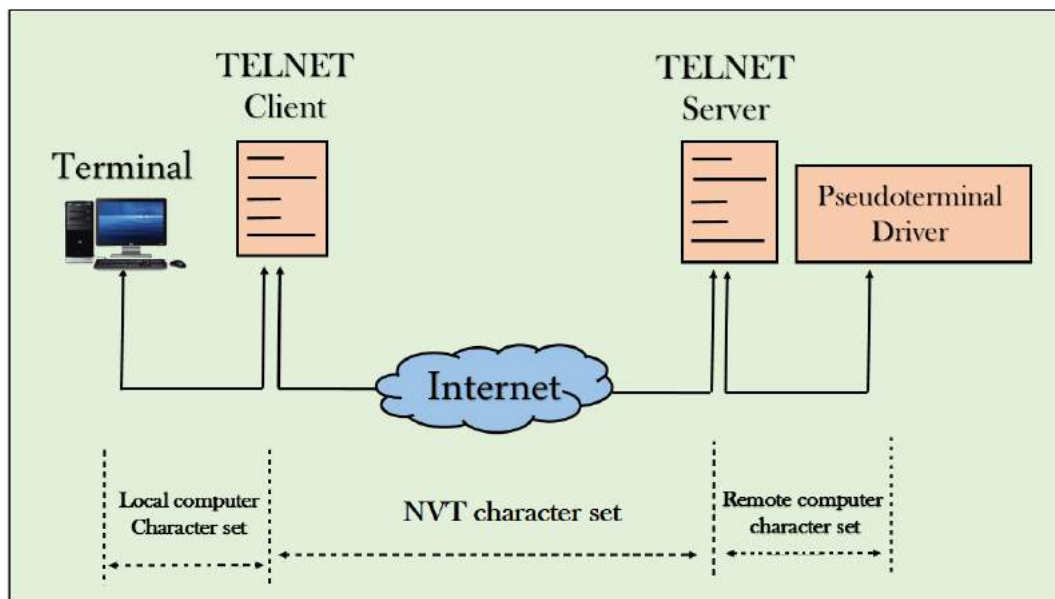
At the local site

The user sends the keystrokes to the terminal driver, the characters are then sent to the TELNET client. The TELNET client which in turn, transforms the characters to a universal character set known as network virtual terminal characters and delivers them to the local TCP/IP stack

At the remote site

The commands in NVT forms are transmitted to the TCP/IP at the remote machine. Here, the characters are delivered to the operating system and then pass to the TELNET server. The TELNET server transforms the characters which can be understandable by a remote computer. However, the characters cannot be directly passed to the operating system as a remote operating system does not receive the characters from the TELNET server. Therefore it requires some piece of software that can accept the characters from the TELNET server. The operating system then passes these characters to the appropriate application program.

Network Virtual Terminal (NVT)



The network virtual terminal is an interface that defines how data and commands are sent across the network.

In today's world, systems are heterogeneous. For example, the operating system accepts a special combination of characters such as end-of-file token running a DOS operating system *ctrl+z* while the token running a UNIX operating system is *ctrl+d*.

TELNET solves this issue by defining a universal interface known as network virtual interface.

The TELNET client translates the characters that come from the local terminal into NVT form and then delivers them to the network. The Telnet server then translates the data from NVT form into a form which can be understandable by a remote computer.

FTP

FTP stands for File transfer protocol.

FTP is a standard internet protocol provided by TCP/IP used for transmitting the files from one host to another.

It is mainly used for transferring the web page files from their creator to the computer that acts as a server for other computers on the internet.

It is also used for downloading the files to computer from other servers.

Objectives of FTP

It provides the sharing of files.

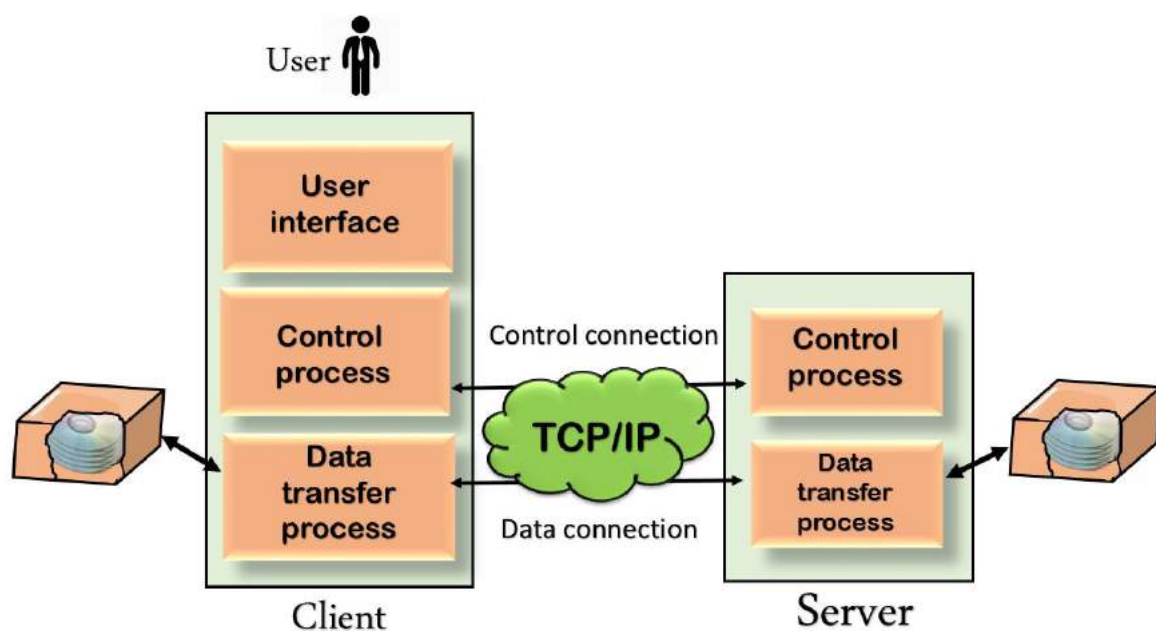
It is used to encourage the use of remote computers.

It transfers the data more reliably and efficiently.

Why FTP?

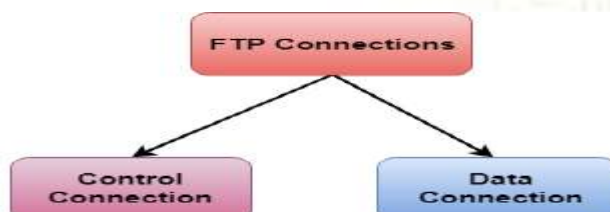
Although transferring files from one system to another is very simple and straightforward, but sometimes it can cause problems. For example, two systems may have different file conventions. Two systems may have different ways to represent text and data. Two systems may have different directory structures. FTP protocol overcomes these problems by establishing two connections between hosts. One connection is used for data transfer, and another connection is used for the control connection.

Mechanism of FTP



The above figure shows the basic model of the FTP. The FTP client has three components: the user interface, control process, and data transfer process. The server has two components: the server control process and the server data transfer process.

There are two types of connections in FTP:



Control Connection: The control connection uses very simple rules for communication. Through control connection, we can transfer a line of command or line of response at a time. The control connection is made between the control processes. The control connection remains connected during the entire interactive FTP session.

Data Connection: The Data Connection uses very complex rules as data types may vary. The data connection is made between data transfer processes. The data connection opens when a command comes for transferring the files and closes when the file is transferred.

FTP Clients

FTP client is a program that implements a file transfer protocol which allows you to transfer files between two hosts on the internet.

It allows a user to connect to a remote host and upload or download the files.

It has a set of commands that we can use to connect to a host, transfer the files between you and your host and close the connection.

The FTP program is also available as a built-in component in a Web browser. This GUI based FTP client makes the file transfer very easy and also does not require to remember the FTP commands.

Advantages of FTP:

Speed: One of the biggest advantages of FTP is speed. The FTP is one of the fastest way to transfer the files from one computer to another computer.

Efficient: It is more efficient as we do not need to complete all the operations to get the entire file.

Security: To access the FTP server, we need to login with the username and password. Therefore, we can say that FTP is more secure.

Back & forth movement: FTP allows us to transfer the files back and forth. Suppose you are a manager of the company, you send some information to all the employees, and they all send information back on the same server.

Disadvantages of FTP:

The standard requirement of the industry is that all the FTP transmissions should be encrypted. However, not all the FTP providers are equal and not all the providers offer encryption. So, we will have to look out for the FTP providers that provides encryption.

FTP serves two operations, i.e., to send and receive large files on a network. However, the size limit of the file is 2GB that can be sent. It also doesn't allow you to run simultaneous transfers to multiple receivers.

Passwords and file contents are sent in clear text that allows unwanted eavesdropping. So, it is quite possible that attackers can carry out the brute force attack by trying to guess the FTP password.

It is not compatible with every system.

Synchronous Optical Network (SONET)

SONET stands for Synchronous Optical Network. SONET is a communication protocol, developed by Bellcore – that is used to transmit a large amount of data over relatively large distances using optical fibre. With SONET, multiple digital data streams are transferred at the same time over the optical fibre.

Key Points:

Developed by Bellcore

Used in North America

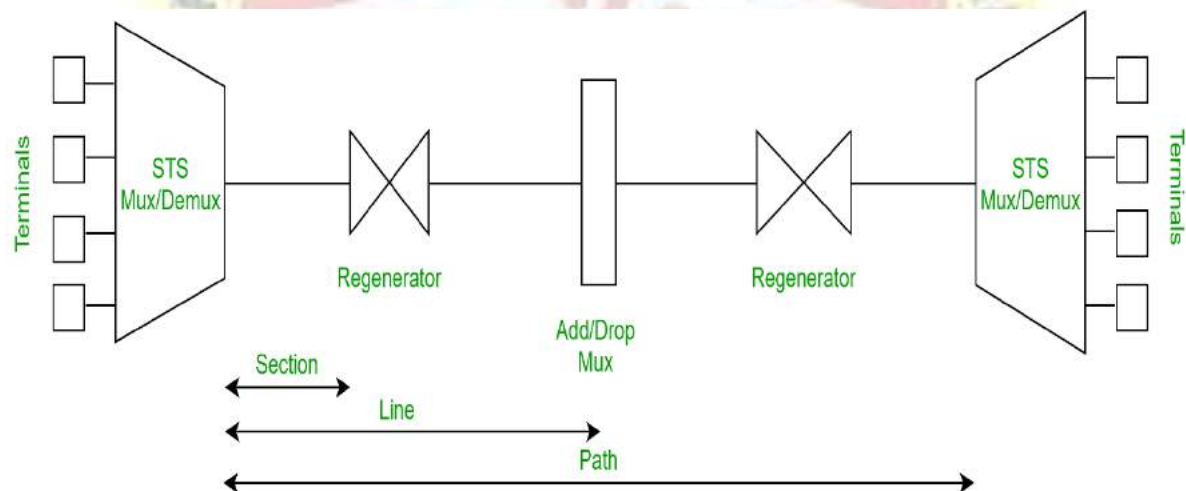
Standardized by ANSI (American National Standards Institute)

Similar to SDH (Synchronous Digital Hierarchy) which is used in Europe and Japan.

Why SONET is called a Synchronous Network?

A single clock (Primary Reference Clock, PRC) handles the timing of transmission of signals & equipments across the entire network.

SONET Network Elements:



STS Multiplexer:

Performs multiplexing of signals

Converts electrical signal to optical signal

STS Demultiplexer:

Performs demultiplexing of signals

Converts optical signal to electrical signal

Regenerator:

It is a repeater, that takes an optical signal and regenerates (increases the strength) it.

Add/Drop Multiplexer:

It allows to add signals coming from different sources into a given path or remove a signal.

Why SONET is used?

SONET is used to convert electrical signal into optical signal so that it can travel longer distances.

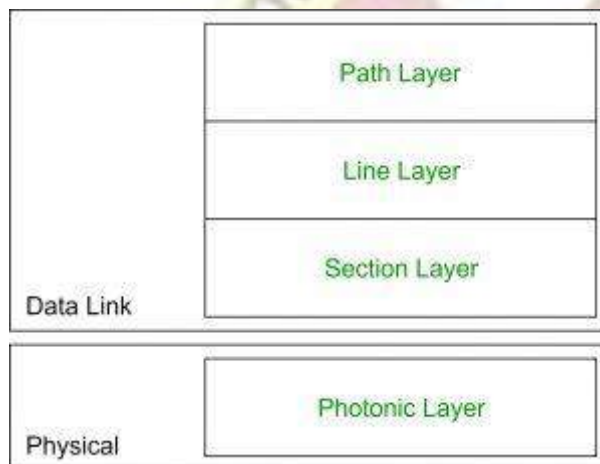
SONET Connections:

Section: Portion of network connecting two neighbouring devices.

Line: Portion of network connecting two neighbouring multiplexers.

Path: End-to-end portion of the network.

SONET Layers:



SONET includes four functional layers:

Path Layer:

It is responsible for the movement of signal from its optical source to its optical destination.

STS Mux/Demux provides path layer functions.

Line Layer:

It is responsible for the movement of signal across a physical line.

STS Mux/Demux and Add/Drop Mux provides Line layer functions.

Section Layer:

It is responsible for the movement of signal across a physical section.

Each device of network provides section layer functions.

Photonic Layer:

It corresponds to the physical layer of the OSI model.

It includes physical specifications for the optical fibre channel (presence of light = 1 and absence of light = 0).

Advantages of SONET:

Transmits data to large distances

Low electromagnetic interference

High data rates

Large Bandwidth

Definition of SDH

SDH expands to **Synchronous Digital Hierarchy** emerged as a standard body for the telecommunication networks founded on optical fibres. However, the SONET and SDH are very similar, and SDH is said to be a variant of SONET. It has facilitated a transmission network which does not rely on vendor and provides a complex signal structure along with substantial characteristics. As an outcome, the new network technologies and equipment are needed to be deployed, and high power is needed for handling the system operations.

The SDH characteristics are founded on high order multiplexing. This is achieved by the hierarchy of progressing data rates at maximum 565 Mbps within Europe. It also brought the concept of digital transmission over coaxial cables. As we have discussed the concept of a plesiochronous system in the above definition, where the multiplexing involves the combination of the lightly nonsynchronous rates and this results in Plesiochronous digital hierarchy (PDH).

Differences Between SONET and SDH

The SONET is a digital hierarchy interface for the optical transmission, formed by Bellcore. On the other hand, SDH is a network node interface, user-network interface and U reference-point interface to assist BISDN.

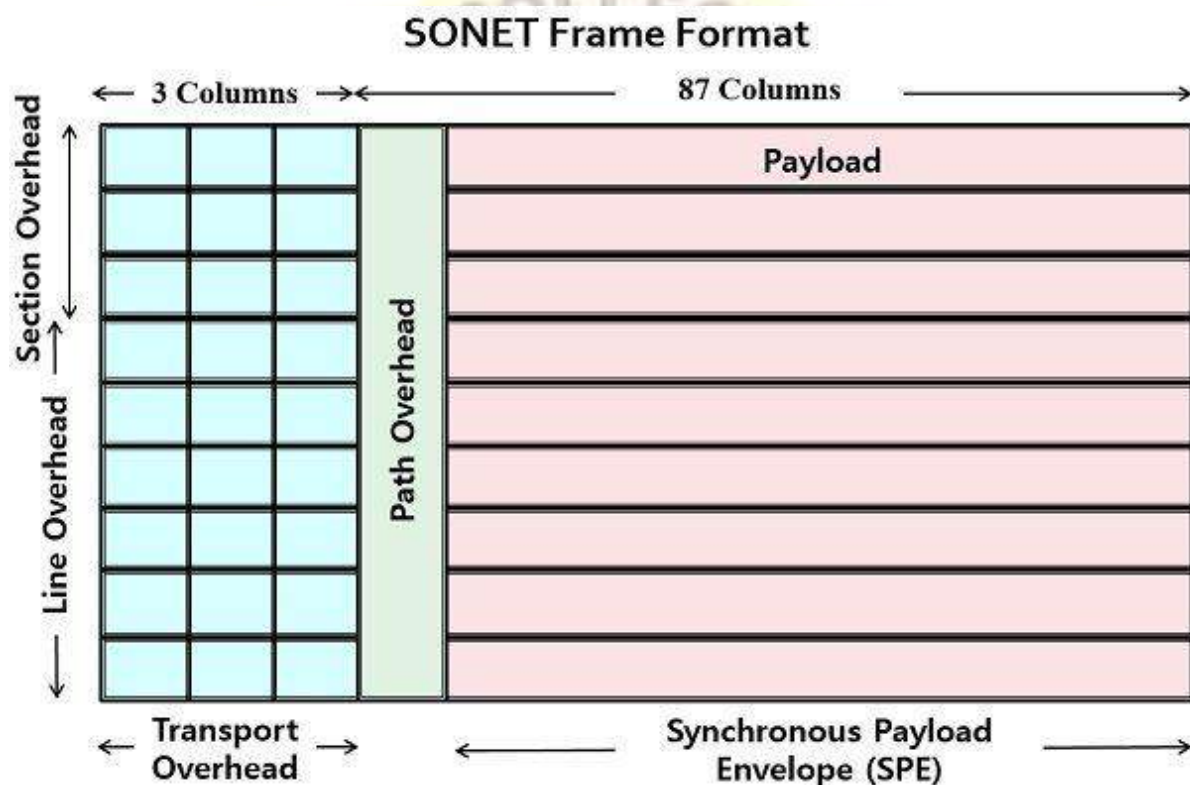
SONET is developed by ANSI (American National Standards Institute) and majorly used in the United States while SDH is formed by ITU-T (International Telecommunication Union – Telecommunication Standardization Sector) and globally used. However, it was initially deployed in Europe as it was initiated by ETSI (European Telecommunications Standards Institute).

SONET can transmit data in only synchronous mode whereas in SDH asynchronous transfer is also possible.

rames in SONET

The fastly moving information of various digital channels is simultaneously multiplexed in SONET, which is needed to be separated from each other. So, to achieve this distinction between the different channels information SONET implies the concept of **Frames**, which can be seen as an address.

In SONET the data is arranged into 9X90 two-dimensional array (9 rows and 90 columns) which makes 810-byte blocks known as frames. These are serially transmitted, from the extreme left to the right, byte by byte. Each row has two 3 bytes of transport overheads (total number of transport overhead of $9 \times 3 = 27$ bytes) and 87 bytes of payload (i.e., $9 \times 87 = 783$).

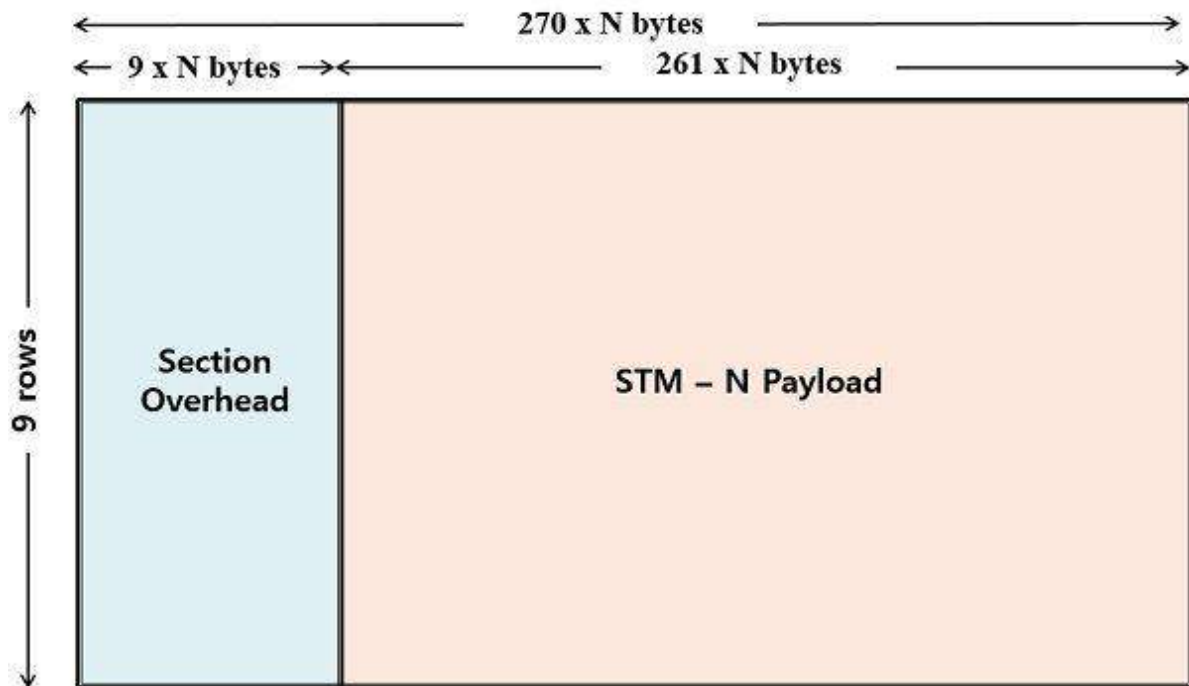


payload is the traffic transmitted by the SONET network and overhead is needed to observe and administer the signal transmission. Among 27 bytes in transport overhead, the 9 bytes are for section overhead, and 18 are for line overhead.

Frames in SDH

The SDH frame format is created on the basis of the synchronous transport module STM-1. The organization of the frame comprised of 2430 bytes and arranged in 9 rows and 270 columns.

SDH Frame Format



Here the total section overhead is of 81 bytes (9×9), and the remaining

SIGNAL HIREACHY

2349 bytes are for pay

ANSI Designation	Optical Signal	CCITT Designation SDH	DataRate (Mbps)	PayloadRate (Mbps)
STS-1	OC-1		51.84	50.112
STS-3	OC-3	STM-1	155.52	150.336
STS-9	OC-9	STM-3	466.56	451.008
STS-12	OC-12	STM-4	622.08	601.344
STS-18	OC-18	STM-6	933.12	902.016
STS-24	OC-24	STM-8	1244.16	1202.688
STS-36	OC-36	STM-12	1866.24	1804.032
STS-48	OC-48	STM-16	2488.32	2405.376
STS-96	OC-96	STM-32	4976.64	4810.176
STS-192	OC-192	STM-64	9953.28	9620.928

ynchronousTransportSignalLeveln=STS-
 n=n´51.84MbpsSTM=SynchronousTransportModule,OC=OpticalCarrierlevel

What is a Router?

The router is a physical or virtual internetworking device that is designed to receive, analyze, and forward data packets between computer networks. A router examines a destination IP address of a given data packet, and it uses the headers and forwarding tables to decide the best way to transfer the packets. There are some popular companies that develop routers; such are **Cisco, 3Com, HP, Juniper, D-Link, Nortel**, etc. Some important points of routers are given below:

A router is used in **LAN** (Local Area Network) and **WAN** (Wide Area Network) environments. For example, it is used in **offices** for connectivity, and you can also establish the connection between distant networks such as from **Bhopal** to

It shares information with other routers in networking.

It uses the routing protocol to transfer the data across a network.

Furthermore, it is more **expensive** than other networking devices like switches and hubs.

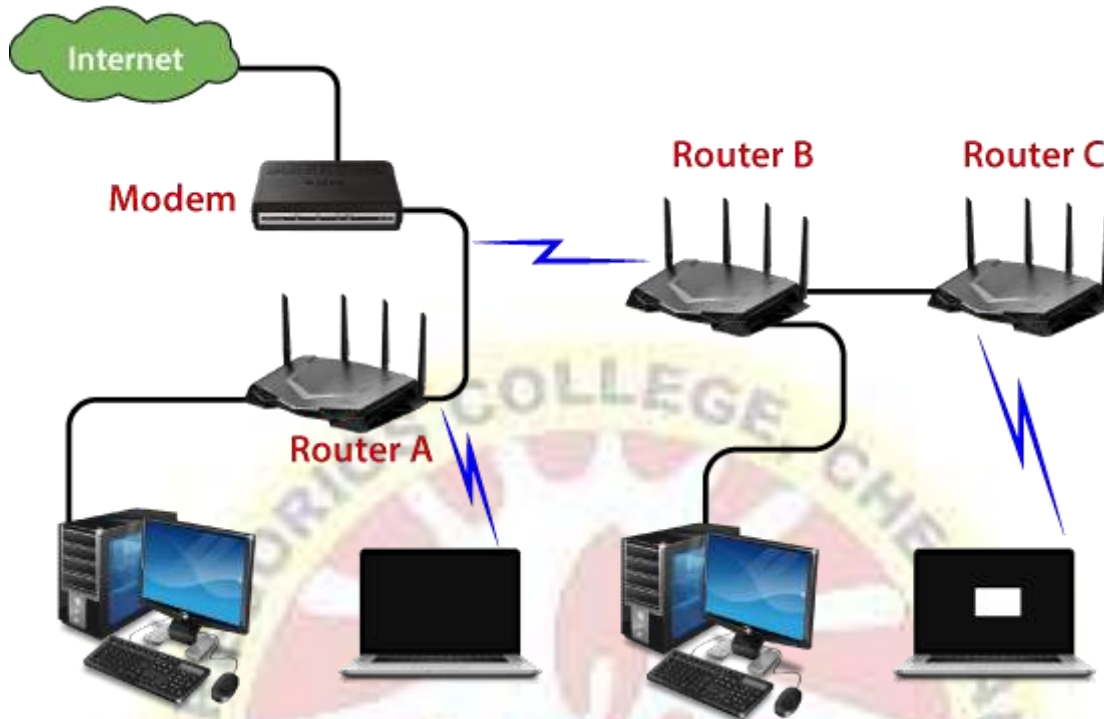
A router works on the **third layer** of the OSI model, and it is based on the IP address of a computer. It uses protocols such as ICMP to communicate between two or more networks. *It is also known as an **intelligent device** as it can calculate the best route to pass the network packets from source to the destination automatically.*

A virtual router is a software function or software-based framework that performs the same functions as a physical router. It may be used to increase the reliability of the network by virtual router redundancy protocol, which is done by configuring a virtual router as a default gateway. A virtual router runs on commodity servers, and it is packaged with alone or other network functions, like load balancing, firewall packet filtering, and wide area network optimization capabilities.

A router analyzes a destination IP address of a given packet header and compares it with the routing table to decide the packet's next path. The list of routing tables provides directions to transfer the data to a particular network destination. They have a set of rules that compute the best path to forward the data to the given IP address.

Routers use a **modem** such as a cable, fiber, or DSL modem to allow communication between other devices and the internet. Most of the routers have several ports to connect

different devices to the internet at the same time. It uses the **routing tables** to determine where to send data and from where the traffic is coming.



A routing table mainly defines the default path used by the router. So, it may fail to find the best way to forward the data for a given packet. For example, the office router along a single default path instructs all networks to its internet services provider.

There are two types of tables in the router that are **static and dynamic**. The static routing tables are configured manually, and the dynamic routing tables are updated automatically by dynamic routers based on network activity.

Features of Router

A router works on the 3rd layer (Network Layer) of the OSI model, and it is able to communicate with its adjacent devices with the help of IP addresses and subnet.

A router provides high-speed internet connectivity with the different types of ports like gigabit, fast-Ethernet, and STM link port.

It allows the users to configure the port as per their requirements in the network.

Routers' main components are central processing unit (CPU), flash memory, RAM, Non-Volatile RAM, console, network, and interface card.

Routers are capable of routing the traffic in a large networking system by considering the sub-network as an intact network.

Routers filter out the unwanted interference, as well as carry out the data encapsulation and decapsulation process.

Routers provide the redundancy as it always works in master and slave mode.

It allows the users to connect several LAN and WAN.

Furthermore, a router creates various paths to forward the data.

Applications of Routers

There are various areas where a router is used:

Routers are used to connect hardware equipment with remote location networks like **BSC, MGW, IN, SGSN**, and other servers.

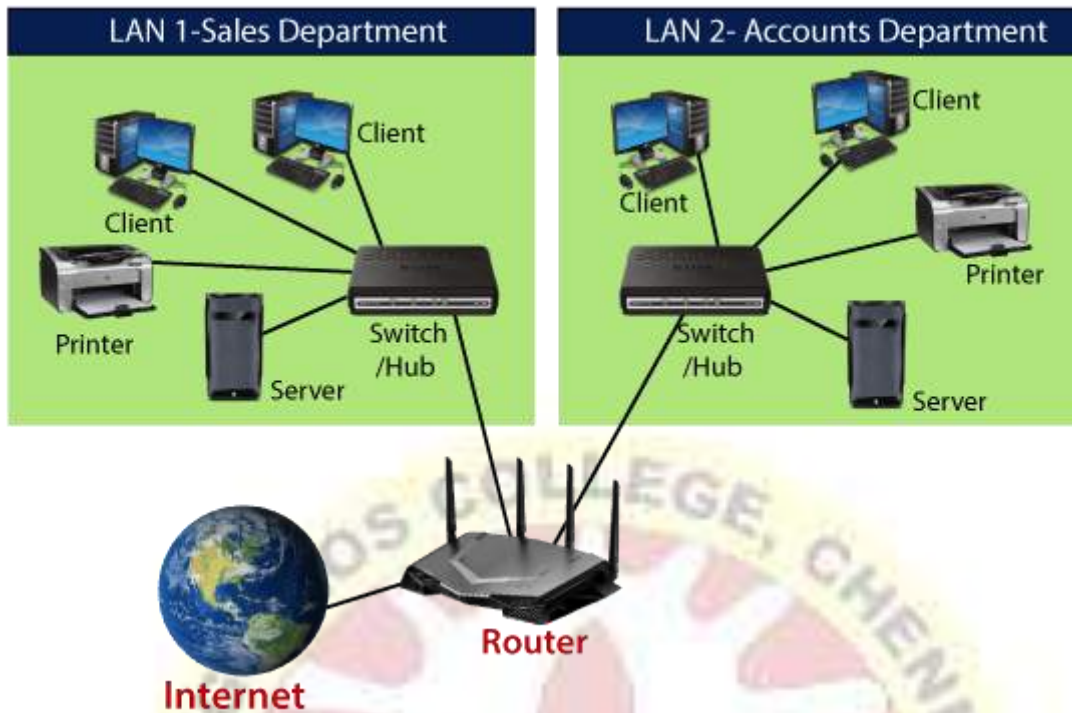
It provides support for a fast rate of data transmission because it uses high STM links for connectivity; that's why it is used in both wired or wireless communication.

Internet service providers widely use routers to send the data from source to destination in the form of e-mail, a web page, image, voice, or a video file. Furthermore, it can send data all over the world with the help of an IP address of the destination.

Routers offer access restrictions. It can be configured in a way that allows for few users to access the overall data and allows others to access the few data only, which is defined for them.

Routers are also used by software testers for WAN communications. For example, the software manager of an organization is located in Agra, and its executive is located at a different place like Pune or Bangalore. Then the router provides the executive the method to share his software tools and other applications with the manager with the help of routers by connecting their PCs to the router using WAN architecture.

In wireless networks, by configuring VPN in routers, it can be used in the client-server model, which allows sharing the internet, video, data, voice, and hardware resources. As shown in the below picture:



In modern times, routers have the facility of inbuilt USB ports within the hardware. They have enough internal storage capacity. External storage devices can be used with routers to store and share data.

Routers are used to set up the operation and maintenance center of an organization, which is known as the NOC center. All equipment at a distant location are connected by routers on optical cable at a central location, which also offer redundancy through the main link and protection link topology.
