EXPERIMENT 1

NAME:Vaidehi Vatsaraj

UID: 2018130060

CLASS: TE COMPS

BATCH: D

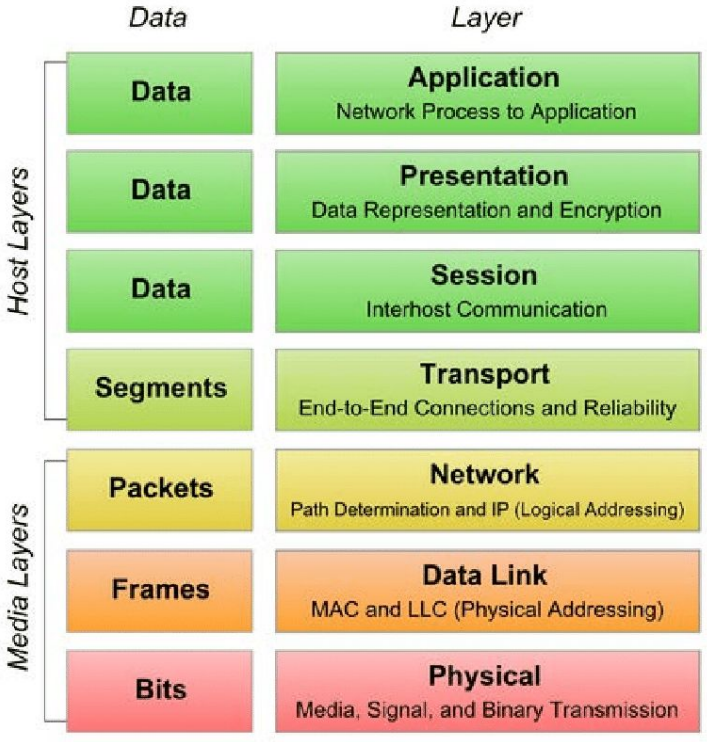
Aim: Study the different types of physical layer wired and wireless connections.

Theory:

What is the OSI model? (Ref no.1)

The Open Systems Interconnection (OSI) model is a conceptual model created by the International Organization for Standardization which enables diverse communication systems to communicate using standard protocols. In plain English, the OSI provides a standard for different computer systems to be able to communicate with each other.

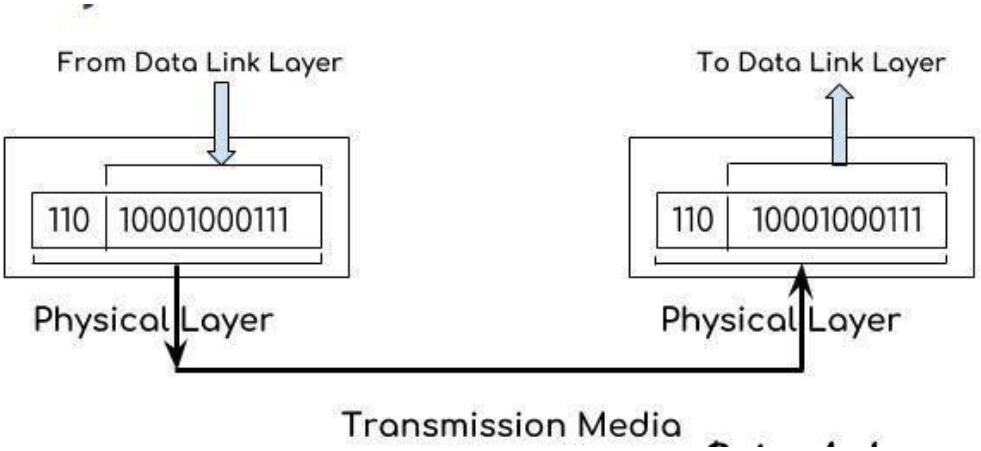
The OSI model can be seen as a universal language for computer networking. It's based on the concept of splitting up a communication system into seven abstract layers, each one stacked upon the last.



Each layer of the OSI model handles a specific job and communicates with the layers above and below itself.

Physical Layer (Ref no.2 and 3)

The lowest layer of the Open Systems Interconnection (OSI) reference model is the physical layer. It is responsible for the actual physical connection between the devices. The physical layer contains information in the form of bits.



It is responsible for sending bits from one computer to another. This layer is not concerned with the meaning of the bits and deals with the setup of physical connection to the network and with transmission and reception of signals.This layer defines the rate of transmission which is the number of bits per second.
This layer connects devices with the medium: Point to Point configuration and Multipoint configuration. Devices must be connected using the following topologies: Mesh, Star, Ring and Bus. Physical Layer defines the direction of transmission between two devices: Simplex, Half Duplex, Full Duplex.Deals with baseband and broadband transmission.

Wired Connections (Ref no.4)

Signals being transmitted are directed and confined in a narrow pathway by using physical links. Wired connections are by far the most common. The main media in use are coaxial cable, twisted pairs and fibre optics It must also support two-way or multiway communications.
Features:

- High Speed
- Secure
- Used for comparatively shorter distances

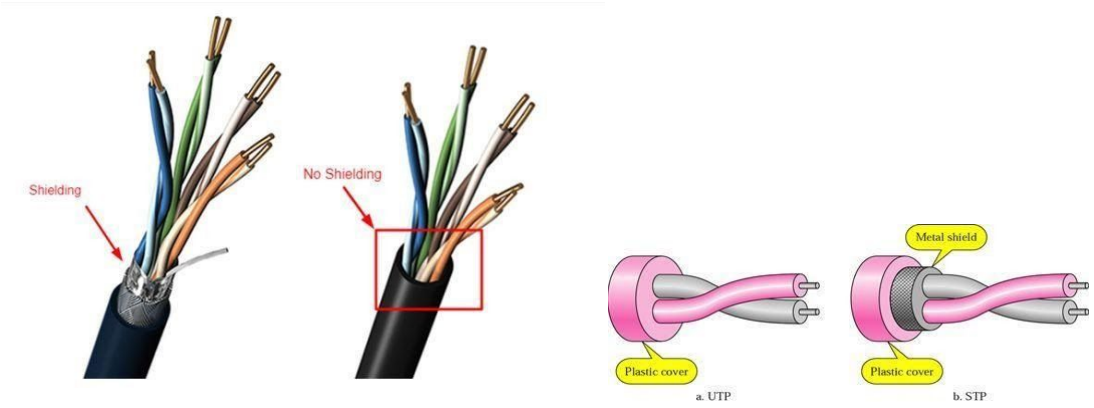
There are 3 major types of Wired Media:

- **Twisted Pair Cable**
- **Coaxial Cable**
- **Optical Fibre Cable**

1) Twisted Pair Cable (Ref no.5)

Twisted pair cables are widely used in the transferring information, especially over long a distances. The twist in the cable cancels out any magnetic interference that may develop in the wiring.

It consists of 2 separately insulated conductor wires wound about each other. Generally, several such pairs are bundled together in a protective sheath. They are the most widely used Transmission Media.
There are two common types of twisted pair cabling, STP and UTP. The S represents Shielded, the U represents Unshielded, and the TP represents the twisted pair for both.



1.1)Unshielded Twisted Pair (UTP):
This type of cable has the ability to block interference and does not depend on a physical shield for this purpose. It is used for telephonic applications.
Advantages:

- Least expensive
- Easy to install
- High speed capacity
- Susceptible to external interference
- Lower capacity and performance in comparison to STP
- Short distance transmission due to attenuation

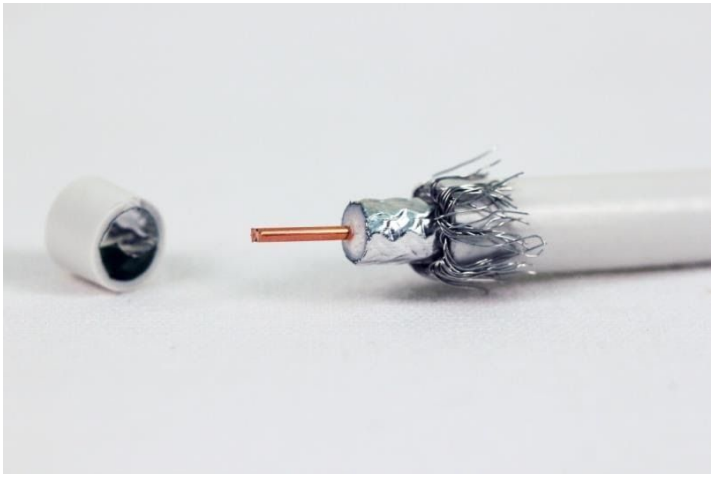
1.2)Shielded Twisted Pair (STP):
This type of cable consists of a special jacket to block external interference. It is used in fast-data- rate Ethernet and in voice and data channels of telephone lines.
Advantages:

- Better performance at a higher data rate in comparison to UTP
- Eliminates crosstalk

- Comparitively faster
- Comparitively difficult to install and manufacture
- More expensive
- Bulky

2) Coaxial Cable (Ref no.6)

It has an outer plastic covering containing 2 parallel conductors each having a separate insulated protection cover. Coaxial cable transmits information in two modes: Baseband mode(dedicated cable bandwidth) and Broadband mode(cable bandwidth is split into separate ranges).



Coaxial cable is commonly used by cable operators, telephone companies, and internet providers around the world to convey data, video, and voice communications to customers. It has also been used extensively within homes.

It has been around for a long time as a technology (since the early 20th century) and has many singular advantages for reliable, accurate transmission.

Advantages:

- High Bandwidth
- Better noise Immunity
- Easy to install and expand
- Inexpensive

It also has limitations that will cause it to be replaced in some cases by fiber optic cable, category cable or, sometimes, by wireless signals.

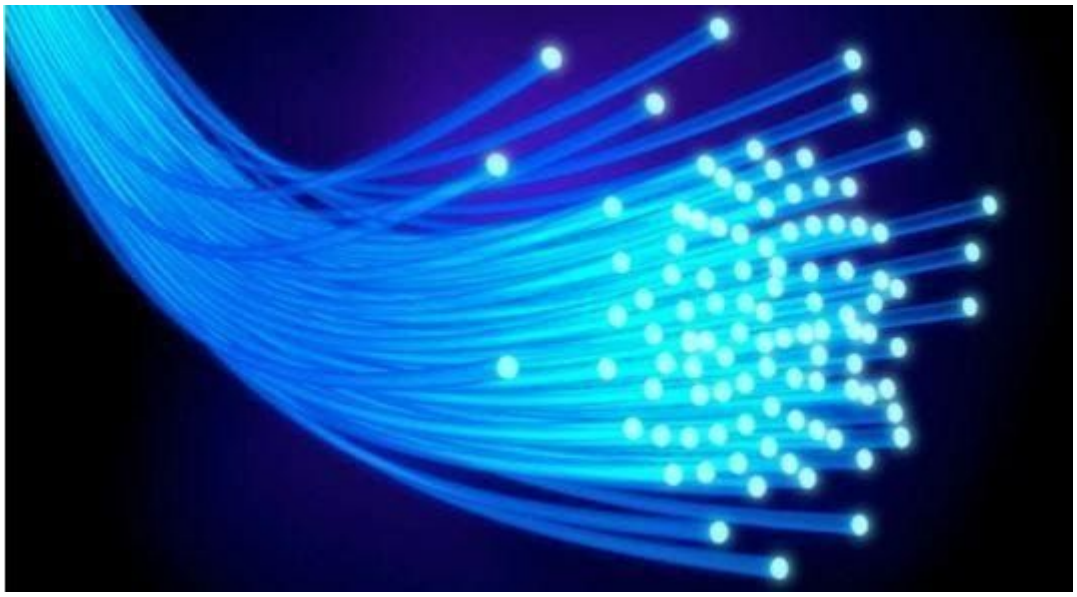
Disadvantages:

- Single cable failure can disrupt the entire network.

3) Optical Fibre Cable (Ref no.7)

It uses the concept of reflection of light through a core made up of glass or plastic. The core is surrounded by a less dense glass or plastic covering called the cladding. It is used for transmission of large volumes of data.

The cable can be unidirectional or bidirectional. The WDM (Wavelength Division Multiplexer) supports two modes, namely unidirectional and bidirectional mode.



It uses a principle known as total internal reflection. Fiber optic cable is actually composed of two layers of glass: The core, which carries the actual light signal, and the cladding, which is a layer of glass surrounding the core. The cladding has a lower refractive index than the core. This causes Total Internal Reflection within the core. Most fibers operate in duplex pairs: one fiber is used to transmit and the other is used to receive. But it is possible to send both signals over a single strand. Each type of fiber has different properties with its own advantages and disadvantages.

Advantages:

- Increased capacity and bandwidth
- Light weight
- Less signal attenuation
- Immunity to electromagnetic interference
- Resistance to corrosive materials

Disadvantages:

- Difficult to install and maintain
- High cost
- Fragile

Some Technologies used in wired media:

1) Universal Serial Bus (Ref no.8)

Universal Serial Bus (**USB**) is an industry standard that establishes specifications for cables and connectors and protocols for connection, communication and power supply (interfacing) between computers, peripherals and other computers. A broad variety of USB hardware exists, including several different connectors, of which USB-C is the most recent.

Released in 1996, the USB standard is currently maintained by the USB Implementers Forum (USB- IF). There have been four generations of USB specifications: USB 1.x, USB 2.0, USB 3.x and USB4.

Specifications:

● Range:

- The USB 1.1 standard specifies that a standard cable can have a maximum length of 5 meters (16 ft 5 in) with devices operating at full speed (12 Mbit/s), and a maximum length of 3 meters (9 ft 10 in) with devices operating at low speed (1.5 Mbit/s).
- USB 2.0 provides for a maximum cable length of 5 meters (16 ft 5 in) for devices running at high speed (480 Mbit/s).
- The USB 3.0 standard does not directly specify a maximum cable length, requiring only that all cables meet an electrical specification: for copper cabling with AWG 26 wires, the maximum practical length is 3 meters (9 ft 10 in).

● **Modulation :**

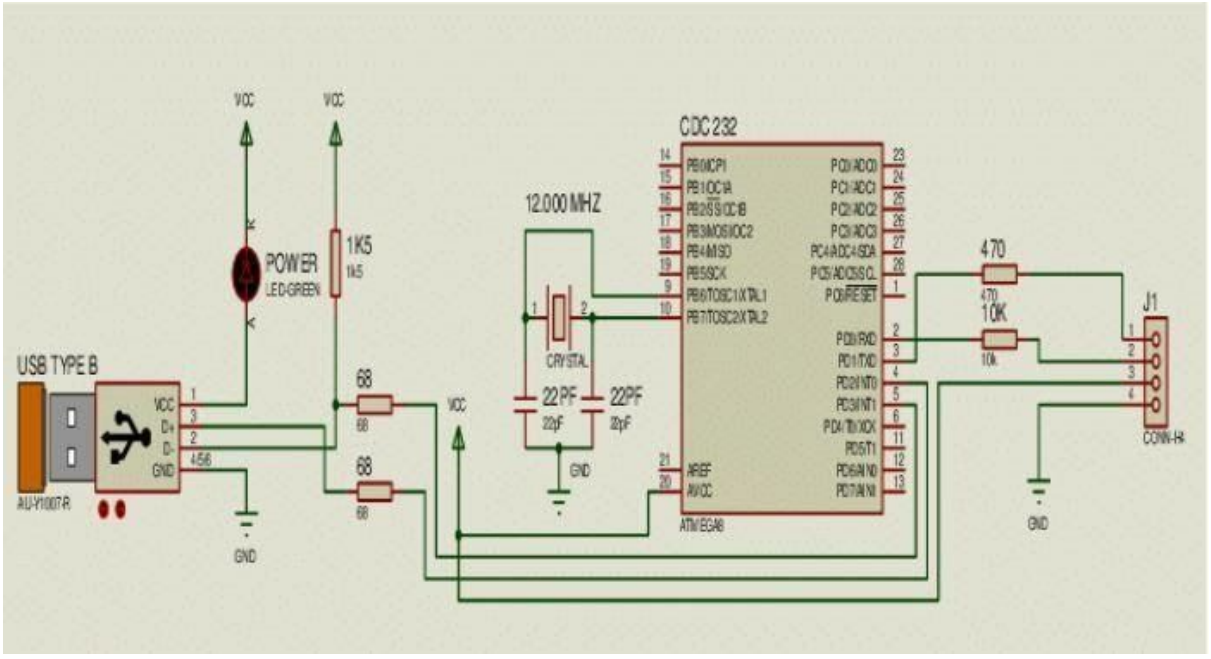
At the input, the device communicates via MIDI and USB protocols. At the output is tension. Its value is managing by pulse-width modulation.

Pulse-width modulation (PWM) is used for controlling the amplitude of digital signals in order to control devices and applications requiring power or electricity. It essentially controls the amount of power, from the perspective of the voltage component, that is given to a device by cycling the on-and-off phases of a digital signal quickly and varying the width of the "on" phase or duty cycle.

Maximum transfer rates for each USB version: (Ref no.9)

USB VERSION	RELEASE DATE	NAME	TRANSFER RATES
USB 1.0	January 1996	Full speed	12 Mbps
USB 1.1	August 1998	Full speed	12 Mbps
USB 2.0	April 2000	High Speed	480 Mbps
USB 3.0	November 2008	SuperSpeed	5 Gbps
USB 3.1	July 2013	SuperSpeed+	10 Gbps
USB 3.2	September 2017	SuperSpeed+	20 Gbps

Schematic View:



2) Ethernet (Ref no.10)

Ethernet is the traditional technology for connecting devices in a wired local area network (LAN) or wide area network (WAN), enabling them to communicate with each other via a protocol -- a set of rules or common network language. Ethernet describes how network devices can format and transmit data so other devices on the same local or campus area network segment can recognize, receive and process the information. An Ethernet cable is the physical, encased wiring over which the data travels.

Connected devices accessing a geographically localized network with a cable -- that is, with a wired rather than wireless connection -- likely use Ethernet. From businesses to gamers, diverse end users depend on the benefits of Ethernet connectivity, which include reliability and security.

Specifications:

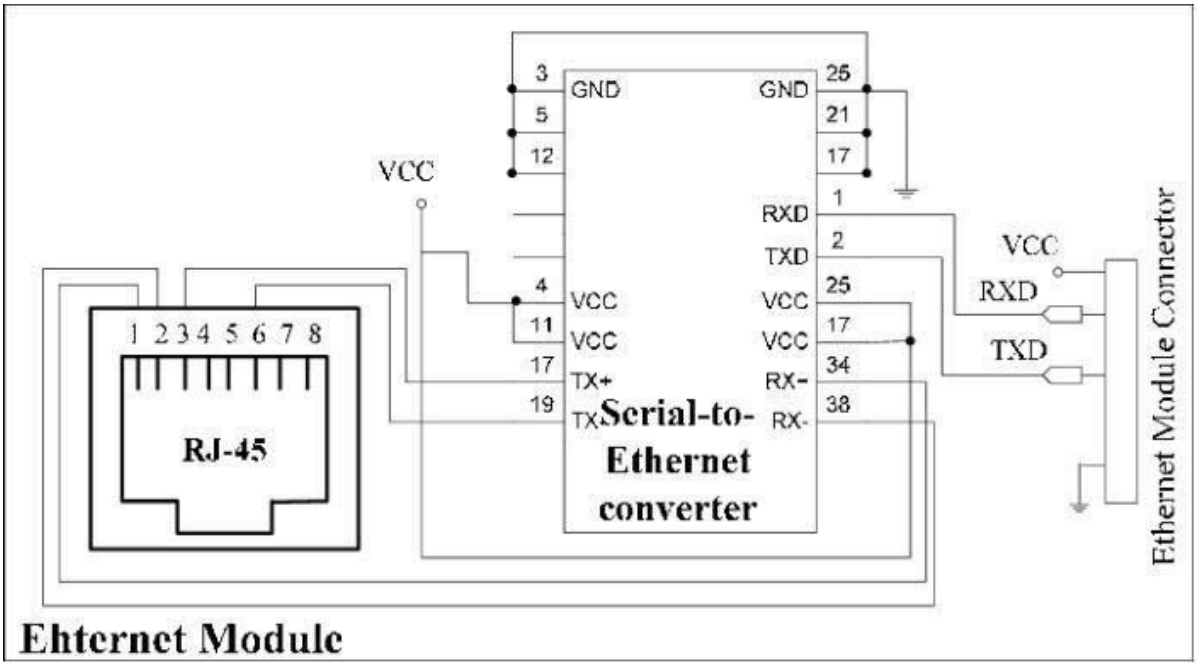
● Range

Over deployed multi-mode cabling ethernet supports ranges of between 240 m and 300 m with 400/500 MHz·km modal bandwidth. It also supports 10 km over single-mode fiber.

● Modulation

Ethernet uses biphase modulation to transmit data bits, this is accomplished by using a Manchester encoded bit-stream. Ethernet does not use IQ modulation because it is not bandwidth limited by the FCC.

Schematic View:



Wireless Connections:

Computer networks that are not connected by cables are called wireless networks. They generally use radio waves for communication between the network nodes. They allow devices to be connected to the network while roaming around within the network coverage.

1) Bluetooth (Ref no.11)

Bluetooth is a wireless technology standard used for exchanging data between fixed and mobile devices over short distances using short-wavelength UHF radio waves in the industrial, scientific and medical radio bands, from 2.402 GHz to 2.480 GHz, and building personal area networks (PANs). It was originally conceived as a wireless alternative to RS-232 data cables.

The IEEE standardized Bluetooth as IEEE 802.15.1, but no longer maintains the standard. The Bluetooth SIG oversees development of the specification, manages the qualification program, and protects the trademarks. A manufacturer must meet Bluetooth SIG standards to market it as a Bluetooth device. A network of patents apply to the technology, which are licensed to individual qualifying devices

Specifications:

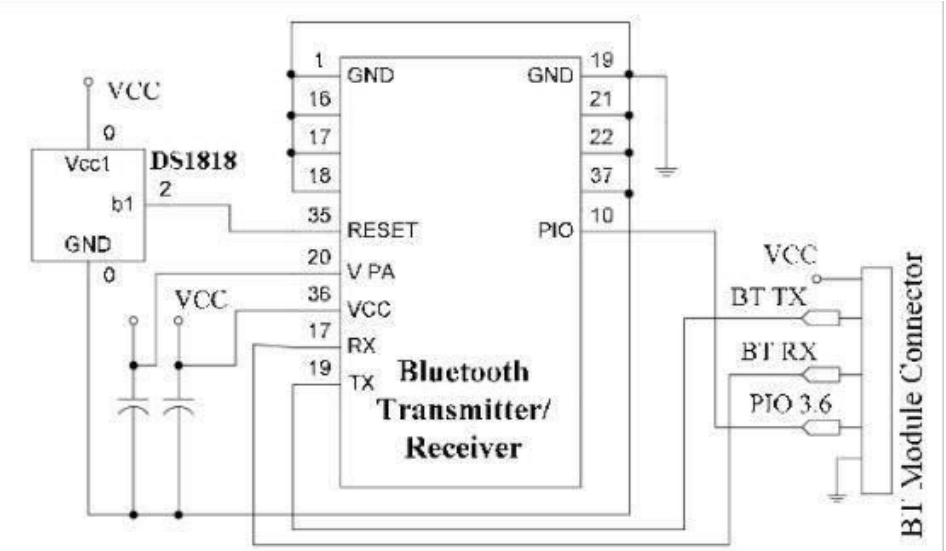
Bluetooth operates at frequencies between 2.402 and 2.480 **GHz**, or 2.400 and 2.4835 **GHz** including guard bands 2 MHz wide at the bottom end and 3.5 MHz wide at the top. This is in the globally unlicensed (but not unregulated) industrial, scientific and medical (ISM) 2.4 **GHz** short-**range** radio frequency band.

Physical range: Typically less than 10 m (33 ft)

- **Modulation (Ref no.12)**

  The format originally chosen for Bluetooth in version 1 was Gaussian frequency shift keying, GFSK, however with the requirement for higher data rates two forms of phase shift keying were introduced for Bluetooth 2 to provide the Enhanced Data Rate, EDR capability.
  The enhanced data rate capability for Bluetooth modulation is implemented as an additional capability so that the system remains backwards compatible.
  The Bluetooth modulation schemes and the general format do not lend themselves to carrying higher data rates. For Bluetooth 3, the higher data rates are not achieved by changing the format of the Bluetooth modulation, but by working cooperatively with an IEEE 802.11g physical layer. In this way data rates of up to around 25 Mbps can be achieved.

Schematic View:



Bluetooth Module

The Bluetooth Module is a low-power embedded Bluetooth v2.0+EDR module with a built-in high- output antenna. The module is a fully Bluetooth compliant device for data communication with a transmission power of up to +8dBm and receiver sensibility of down to -83dBm combined with low power consumption. The Bluetooth Module delivers opportunities for rapid ad-hoc connections and the possibility of automatic, unconscious, connections between WPCOMs. The complete circuit diagram of the Bluetooth Module is given in the figure.

2) Near Field Communication(NFC) (Ref no.13)

Near-field communication (NFC) is a short-range wireless technology that makes your smartphone, tablet, wearables, payment cards, and other devices even smarter. Near-field communication is the ultimate in connectivity. With NFC, you can transfer information between devices quickly and easily with a single touch—whether paying bills, exchanging business cards, downloading coupons, or sharing a research paper.

Near-field communication transmits data through electromagnetic radio fields to enable two devices to communicate with each other. To work, both devices must contain NFC chips, as transactions take place within a very short distance. NFC-enabled devices must be either physically touching or within a few centimeters of each other for data transfer to occur.Because the receiving device reads your data the instant you send it, near-field communications (NFCs) greatly reduce the chance of human error. Rest assured, for example, that you cannot purchase something unknowingly because of a

pocket-dial or by walking past a location that's embedded with an NFC chip (called a "smart poster"). With near-field communication, you must perform an action intentionally.

Specifications:

● **Range**

NFC is a set of short-range wireless technologies, typically requiring a separation of 10 cm or less. **NFC** operates at 13.56 MHz on ISO/IEC 18000-3 air interface and at rates ranging from 106 kbit/s to 424 kbit/s. They can be custom-encoded by their manufacturers or
use **NFC** Forum **specifications**.

● **Modulation**

NFC employs two different coding systems on the RF signal to transfer data. In most cases a level of 10% **modulation** is used, with a Manchester coding format. However for an active device transmitting data at 106 kbps, a modified Miller coding scheme is used with 100% **modulation**.

3) Wireless Fidelity(WiFi) (Ref no.14)

Wi-Fi is a family of wireless network protocols, based on the IEEE 802.11 family of standards, which are commonly used for local area networking of devices and Internet access. Wi-Fi uses multiple parts of the IEEE 802 protocol family and is designed to interwork seamlessly with its wired sibling Ethernet. Compatible devices can network through wireless access points to each other as well as to wired devices and the Internet.

Wi-Fi stations communicate by sending each other data packets: blocks of data individually sent and delivered over radio. As with all radio, this is done by the modulating and demodulation of carrier waves. Different versions of Wi-Fi use different techniques, 802.11b uses DSSS on a single carrier, whereas 802.11a, Wi-Fi 4, 5 and 6 use multiple carriers on slightly different frequencies within the channel (OFDM).

Specifications:

● **Range**

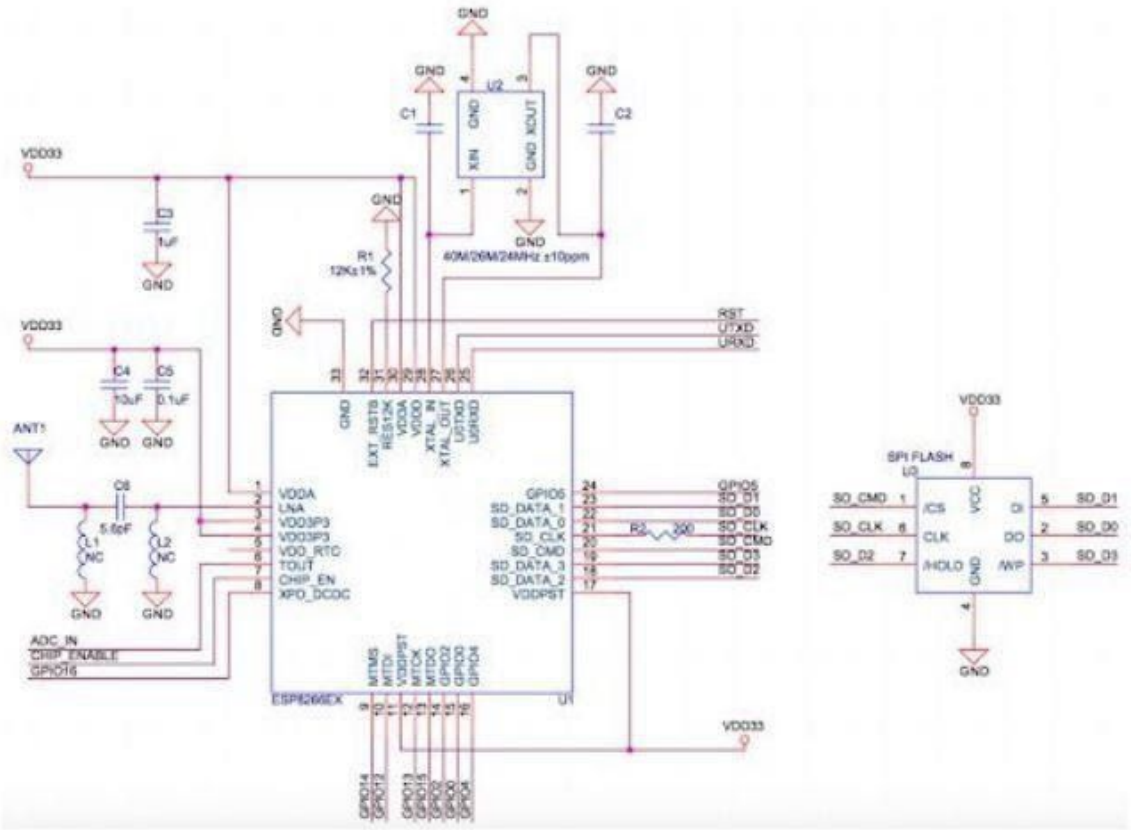
A wireless network's range can vary wildly depending on the type of network. A standard home network using one wireless router can serve a single-family dwelling, but often not much more.
Business networks with grids of access points can serve large office buildings, and wireless hotspots spanning several square miles have been built in some cities.

Wi-Fi can be used on several types of devices like personal computers, video game console, smart phones, digital camera, tablet computers etc. You can use Wi-Fi to create a hotspot within the **range** of 20 meters (66 feet).

● **Modulation**

WiFi systems use two primary radio transmission techniques.
The bit stream is processed with a special coding and then **modulated** using Quadrature Phase Shift Keying (QPSK). 802.11a and g (<=54 Mbps) − The 802.11a and g systems use
64-channel orthogonal frequency division multiplexing (OFDM).

Schematic View:

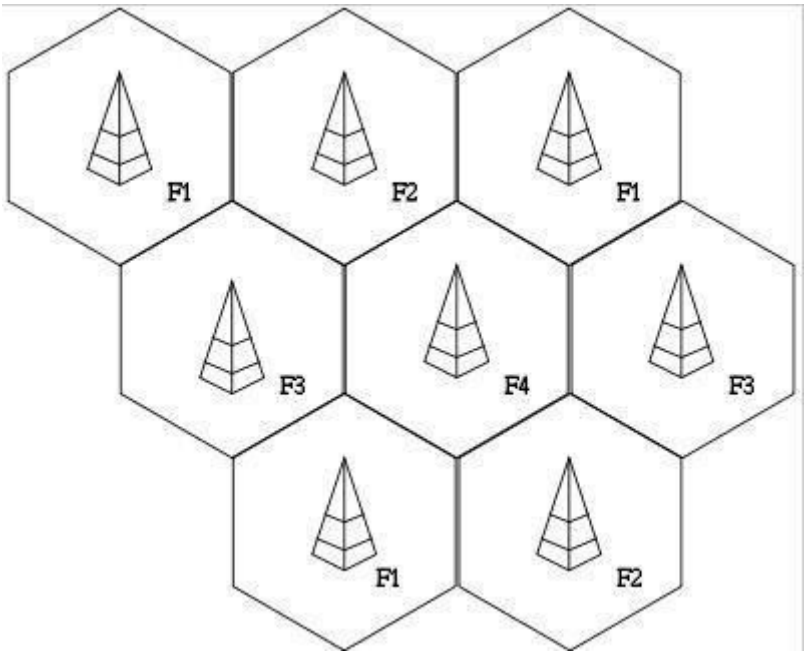


Schematic View ESP8266 - WiFi Module

ESP8266 has powerful on-board processing and storage capabilities that allow it to be integrated with the sensors and other application-specific devices through its GPIOs with minimal development up-front and minimal loading during runtime. Its high degree of on-chip integration allows for minimal external circuitry, and the entire solution, including the front-end module, is designed to occupy minimal PCB area. ESP8266 Serial Wifi Wireless Transceiver Module is suitable for Uno, Mega 2560, and Nano.

4) Cellular Network(Ref no.15)

A **cellular network** or **mobile network** is a communication network where the last link is wireless. The network is distributed over land areas called "cells", each served by at least one fixed- location transceiver, but more normally, three cell sites or base transceiver stations.



Cellular networks offer a number of desirable features:

- More capacity than a single large transmitter, since the same frequency can be used for multiple links as long as they are in different cells
- Mobile devices use less power than with a single transmitter or satellite since the cell towers are closer
- Larger coverage area than a single terrestrial transmitter, since additional cell towers can be added indefinitely and are not limited by the horizon

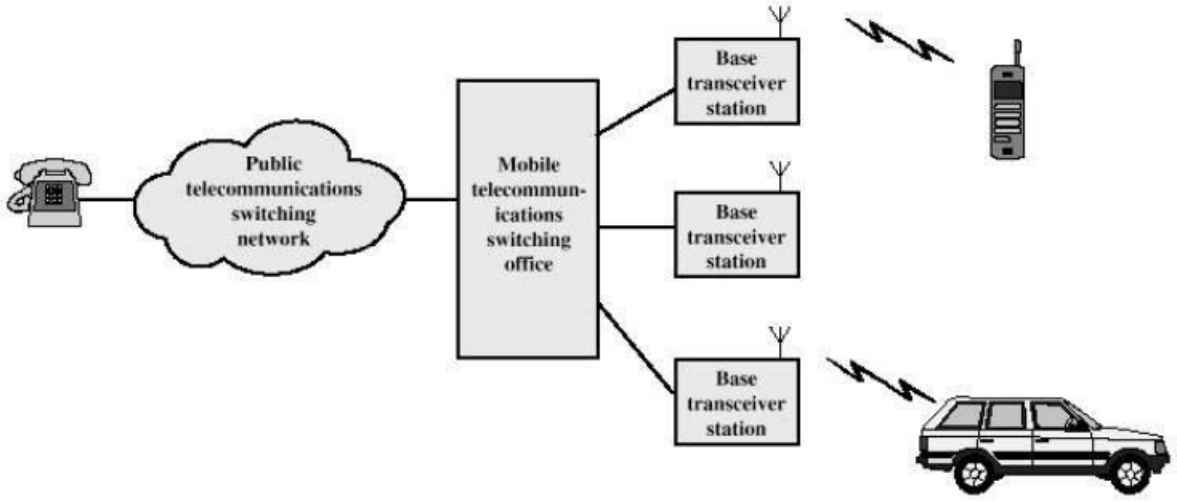
Specifications:

● Range

A cellular network is used by the mobile phone operator to achieve both coverage and capacity for their subscribers. Large geographic areas are split into smaller cells to avoid line- of-sight signal loss and to support a large number of active phones in that area

In cities, each cell site may have a range of up to approximately ½mile (0.80 km), while in rural areas, the range could be as much as 5 miles (8.0 km). It is possible that in clear open areas, a user may receive signals from a cell site 25 miles (40 km) away.

Cellular System Overview: (Ref no.16)



Base Station (BS) – includes an antenna, a controller, and a number of receivers

Mobile telecommunications switching office(MTSO) – connects calls between mobile units

Two types of channels available between mobile unit and BS

- Control channels – used to exchange information having to do with setting up and maintaining calls
- Traffic channels – carry voice or data connection between users

References:

1) https://www.cloudflare.com/learning/ddos/glossary/open-systems-interconnection-model-osi/
2) https://www.studytonight.com/computer-networks/osi-model-physical-layer
3) https://beginnersbook.com/2019/04/osi-model-in-computer-network/
4) https://www.geeksforgeeks.org/types-transmission-media/
5) http://westcoastcomm.com/difference-utp-stp-cable/
6) https://www.ppc-online.com/blog/what-is-coaxial-cable-and-how-is-it-used
7) https://www.firefold.com/blogs/news/what-is-fiber-optic-cable
8) https://en.wikipedia.org/wiki/USB
9) https://www.cmd-ltd.com/advice-centre/usb-chargers-and-power-modules/usb-and-power-module-product-help/usb-data-transfer-guide/
10) https://searchnetworking.techtarget.com/definition/Ethernet
11) https://en.wikipedia.org/wiki/Bluetooth
12) https://www.electronics-notes.com/articles/connectivity/bluetooth/radio-interface-modulation-channels.php
13) https://www.investopedia.com/terms/n/near-field-communication-nfc.asp
14) https://en.wikipedia.org/wiki/Wi-Fi
15) https://en.wikipedia.org/wiki/Cellular_network#:~:text=A%20cellular%20network%20or%20mobile,sites%20or%20base%20transceiver%20stations.
16) http://www.ccs.neu.edu/home/rraj/Courses/6710/S10/Lectures/CellularNetworks.pdf

Conclusion:

1) I learned about the Physical layer , the types of Wired and wireless connections.
2) Also the technologies,specifications and schematic view of connections.