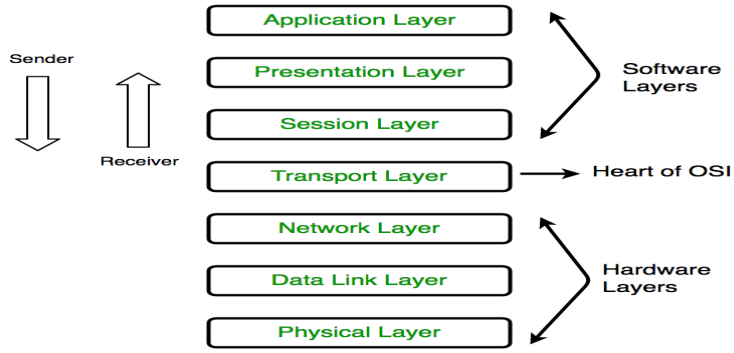
Name : Trusha Talati
UID : 2018130054
Batch : D

Experiment No : 1 Study of different types of physical layer wired/wireless connections .

- **The Open Systems Interconnection (OSI) model** :



The Open Systems Interconnection model (OSI model) is a conceptual model that characterises and standardizes the communication functions of a telecommunication or computing system without regard to its underlying internal structure and technology. Its goal is the interoperability of diverse communication systems with standard communication protocols. The model partitions a communication system into abstraction layers.

A layer serves the layer above it and is served by the layer below it. For example, a layer that provides error-free communications across a network provides the path needed by applications above it, while it calls the next lower layer to send and receive packets that constitute the contents of that path.

The model is a product of the Open Systems Interconnection project at the International Organization for Standardization (ISO).

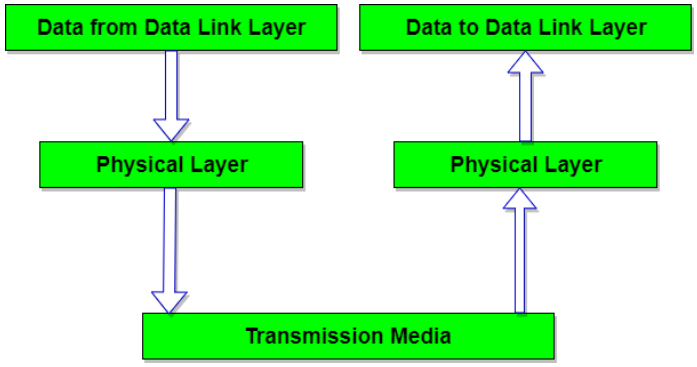
- **Physical Layer** :

Physical layer is the lowest layer of the OSI reference model. 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.
Functions of Physical Layer -

Following are the various functions performed by the Physical layer of the OSI model.

1. Representation of Bits: Data in this layer consists of a stream of bits. The bits must be encoded into signals for transmission. It defines the type of encoding i.e. how 0's and 1's are changed to signal.
2. Data Rate: This layer defines the rate of transmission which is the number of bits per second.
3. Synchronization: It deals with the synchronization of the transmitter and receiver. The sender and receiver are synchronized at bit level.
4. Interface: The physical layer defines the transmission interface between devices and transmission medium.

5. Line Configuration: This layer connects devices with the medium: Point to Point configuration and Multipoint configuration.
6. Topologies: Devices must be connected using the following topologies: Mesh, Star, Ring and Bus.
7. Transmission Modes: Physical Layer defines the direction of transmission between two devices: Simplex, Half Duplex, Full Duplex.
8. Deals with baseband and broadband transmission.



Since it is a hardware component , it is important to know about hardware used to build various networks .

Components used to build networks :

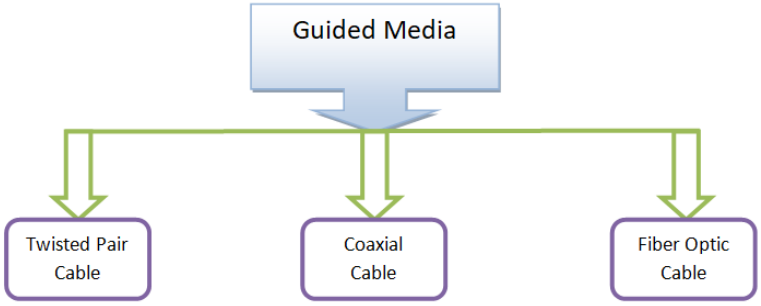
1. **Network Interface Cards** : Before one can begin to set up a network they must first be sure they have a network interface card, commonly referred to as a NIC. NIC is a device that connects a computer or other device to a network. For computers, the NIC is usually installed in an expansion slot and has a chip that handles the physical and data-link layers of network communications . It is an Ethernet Adapter .
2. **Modems** : To establish your network you will need a few key components. If you plan to access the internet you will start your network off with a cable modem. This type of modem is designed to operate using your existing cable lines. Cable internet has a high bandwidth and can support most, if not, all applications you will be using
3. **Routers** :The second component is a router. A router is a device that routes data from one network to another network. A router is connected to at least two networks, commonly two networks or a network and its ISP's network. A router allows for everyone on the network to access the internet.
4. **Hubs** :The next component that you will need to setup a network is a hub or sometimes a switch. A hub is a device that connects the cables from computers and other devices such as printers in a network. Traditionally, hubs are used for star topology networks, but they are often used with other configurations to make it easy to add and remove computers without bringing down the network. (Webopedia.com) A hub can be either active or passive; simply forwarding messages or amplifying or refreshing the data
5. **Switches** : A switch is a device similar to a hub that enables the connection of multiple computers, access points, and other network enabled devices. The difference between a hub and a switch is that a switch filters the data that passes through it and a hub does not.

6. **Access points** :These components have all been modified and are capable of establishing wireless networks. A router can be purchased with wireless capability but a more efficient way of adding wireless to your network is to simply add wired access points. An access point will bride a wired network with a wireless network and can be hard wired in to your existing system. This option allows for the mobility of a wireless network.

7. **Print serve**r :. A print server is used to connect printers to a network to allow for network printing. The server will act as a buffer; storing the messaging and printing them in order of the queue. This device can drastically reduce the cost of networking because now everyone can use the same printer without having a printer attached to every computer.

Wired Transmission Media :

Guided media is a wired transmission media, in which data signals are guided along a physical path i.e. within a wire. Guided transmission media is also known as Bounded or wired. Some well-known Guided Transmission media includes Twisted Pair Cable, Coaxial cable, fiber optic cable, etc. In the previous lesson, we learned what is Transmission Media and its types, Guided and Unguided media



1. **<u>Twisted Pair Cable</u>** -

In Twisted Pair Cable, the wires are twisted to reduce cross talk and electrical interference. It was invented by Alexander Graham Bell in 1881.

Advantages of Twisted Pair Cable -

- Easier to install
- The wire pairs are quite useful, and inexpensive.
- The wire can be used for analog or digital transmission.
- Crosstalk is less, since the wires are twisted.

Disadvantages of Twisted Pair Cable -

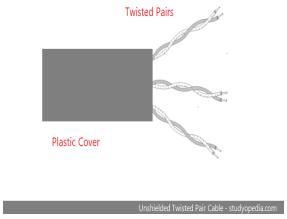
These wires easily pick noise signal. This can be annoying, since it leads to high error rate, on line length extending 100 metres.

Here are the two types of Twisted Pair Cable,

Unshielded Twisted Pair Cable

The unshielded twisted pair cable is a Guided Transmission Media, which is used for transmitting both data and voice. UTP is also useful for LAN technologies, such as Ethernet, security cameras, telephony system etc.

The cable has two insulating copper wires. The size of these wires is 1mm thick. Each of these has its own colored plastic insulation. Colors are different to identify it from particular conductors. They are twisted in a helical form, so that it helps in reducing electrical interference or crosstalk. Also, these cables are cheap, and easy to deploy.

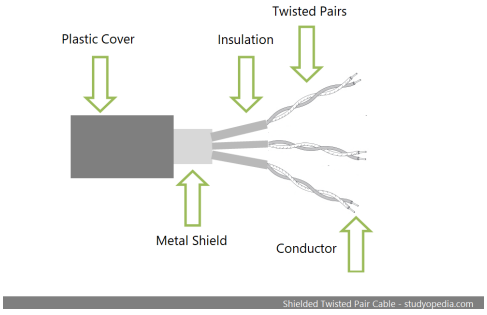


Shielded Twisted Pair Cable

The shielded twisted pair cable is a Guided Transmission Media , which is quite expensive than unshielded twisted pair cable. Shielded cable is less prone to noise.

STP encases each pair of insulated conductors with a metal foil. To prevent the electromagnetic noise, and eliminate cross talk, the casing is useful. Crosstalk occurs when one line catches some other signal travelling down another line. You may have experienced the Crosstalk effect during conversations on telephone.

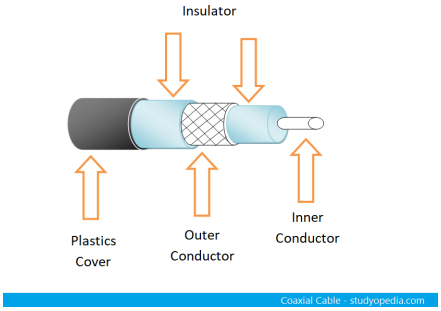
Shielding these twisted pair cables succeed in eliminating majority of Crosstalk.



2 ***Coaxial Cable*** :

Coaxial cable is a group of wrapped and insulated wire line. They transmit data at higher rates. Coax has a central core conductor. The conductor is made of copper wire surrounded by PVC insulation. This insulation is encased in an outer conductor of metal foil, which is enclosed in a PVC insulation sheath. Also, it is completely covered by a plastic cover.

The outer conductor acts as a shield against noise.



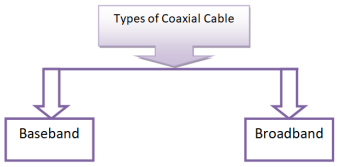
Here are some of the advantages of Coaxial cable,

Advantages of Coaxial Cable

Here are the advantages of Coaxial cable,

- Coaxial cable is used in cable television.
- It offers much higher bandwidth.
- It is preferred for long distance telephone lines as well.
- Provides better shield when compared with Twisted Pair cable.
- It offers data transmission without any distortion.
- Expect quite higher noise immunity from coaxial cable.
-

Here are the two types of Coaxial cable,



Baseband Coaxial Cable

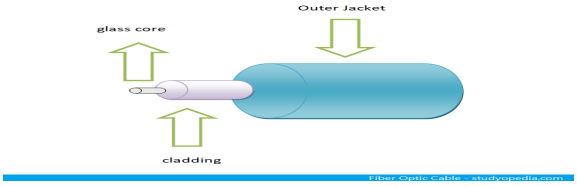
LAN generally uses Baseband Coaxial cable. It is the 50 ohm coaxial cable used for digital transmission. The cable comes with a power of transmitting a single signal at quite high speed. It transmits a single signal at a time.

Broadband Coaxial Cable

This cable transmits many simultaneous signals and that too using different frequency. It covers more area than the Baseband coaxial cable and can run nearly 100km, but requires analog amplifiers. Amplifiers are used to strengthen the signal periodically.

3. **Fiber-optic cable :**

Fiber-optic cable, also known as Optical Fibre provides high quality transmission of signals at high speed.The fiber optic cable has a glass core in the center. Through the glass core, light propagates. The glass core is then surrounded by a glass cladding. This has lower index of refraction as compared to core, so that the light remains in the core itself. To protect the gladding, a thin plastic jacket is used.



How Fiber-optic cable works

In optical fiber, information is transmitted by semiconductor lasers in the form of light. The source has a converter, which converts electrical signals into light waves. The light waves get transmitted over the fiber. The destination also has a converter, which converts the light waves back to electric signals. The signal is sent to the receiver after amplification

Wired technologies :

Universal Serial Bus (USB) :

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.[3] A broad variety of USB hardware exists, including several different connectors, of which USB-C is the most recent.

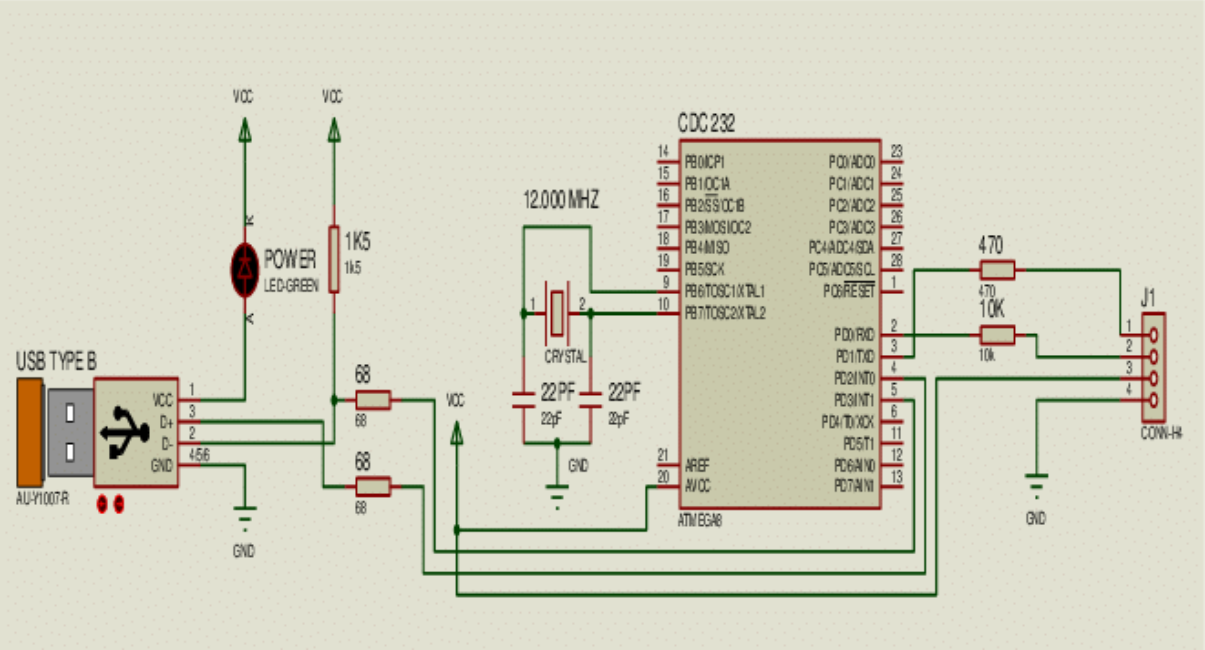
Released in 1996, the USB standard is currently maintained by the USB Implementers Forum (USB-IF). There have been four generations of USB specifications: USB 1.*x*, USB 2.0, USB 3.*x* and USB4.

USB 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).

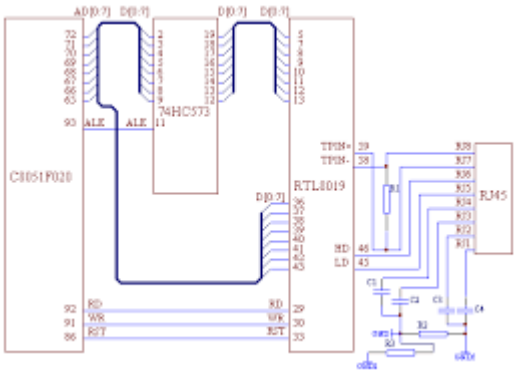
● Modulation : ○ At the input, the device communicates via MIDI and USB protocols. At the output is tension. Its value is managing by pulse-width modulation. ○ Pulse-width modulation (PWM) is used for controlling the amplitude of digital signals in order to control devices and applications requiring 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.

● Other specifications : ○ Two important aspects of USB are its support capability and total bandwidth. It is capable of supporting 127 devices and has a total bandwidth of 12 Mbit per second which is equal to 1.5 MB per second. Working of a 12 Mbit (full speed device) or a 1.5 Mbit (low-speed device) depends on the total bandwidth of the USB. ○ USB 2.0 has a maximum signaling rate of 480 Mbit/s and USB 3.0 has a usable data rate of up to 4 Gbit/s (500 MB/s).



Ethernet :

Schematic view :



Ethernet 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.

Ethernet Scalability :

Ethernet is a family of computer networking technologies commonly used in local area networks (LAN), metropolitan area networks (MAN), and wide area networks(WAN). Ethernet is currently the most widely used technology in enterprise networking. Unfortunately, it is widely acknowledged that Ethernet does not have the scalability to meet the emerging networking needs of large enterprises. Ethernet does not scale well to large networks. The flat MAC address space, whilst having obvious benefits for the user and administrator, is the primary cause of this poor scalability. Ethernet exhibits scalability issues on networks of more than a few thousand devices, such as costly and energy-dense address table logic and storms of broadcast traffic. Ethernet's inability to handle networks containing loops also presents a scalability problem.

- Ethernet cables traditionally used in domestic and business systems are based on four sets of twisted pair cables bunched in an outer sheath. There is a new type automotive Ethernet that only uses a single twisted pair cable rather than the four pairs in current systems.The following information details the types of cables that are likely to be encountered, the classes of Ethernet they can carry, and the modules that Pickering can provide to switch them.

- We have three modules available that are designed for Ethernet switching: 40-201 PXI fault insertion, 50-201 PCI fault insertion, and the 40-736 PXI multiplexer. All of these can switch Ethernet up to 1Gbps (1Gbit per second) but with cautions that are detailed as follows:

Ethernet types : -

10BaseT
The early Ethernet over twisted pair was 10BaseT, which used the standard RJ45 plugs and network cable that would be Cat3 or Cat4. The cable has four twisted pairs, but 10BaseT uses only two of these twisted pairs for 10Mbps communication. The other two twisted pairs can be used for power over Ethernet and things such as phone systems.

100BaseT
For many years the 100BaseT Ethernet communication has been the standard, this also uses the standard RJ45 plugs and network cables, but in this case, higher grade Cat5 is required for distance. The cable has four twisted pairs, but 100BaseT also only uses two of these twisted pairs for 100Mbps communication.

1000BaseT (Gigabit Ethernet)
1000BaseT is the Ethernet standard that many data systems now use, it can utilize the standard RJ45 network cables but over a minimal distance and requires better quality cables such as Cat-5e and Cat-6 to function to full 100m distance. This uses all four twisted pairs for 1Gbps communication.

10000BaseT (10Gigabit Ethernet)
10000BaseT is the next-generation Ethernet that is on some new systems; it again uses four twisted pairs but needs top quality cables i.e., Cat-6a or Cat-7 for 10Gbps communication over distance.

Wireless Transmission Medium -

A wireless network is a computer network that uses wireless data connections between network nodes.[1]

Wireless networking is a method by which homes, telecommunications networks and business installations avoid the costly process of introducing cables into a building, or as a connection .

between various equipment locations.[2] admin telecommunications networks are generally implemented and administered using radio communication. This implementation takes place at the physical level (layer) of the OSI model network structure.[3]

Examples of wireless networks include cell phone networks, wireless local area networks (WLANs), wireless sensor networks, satellite communication networks, and terrestrial microwave networks .

Wireless Technologies : -

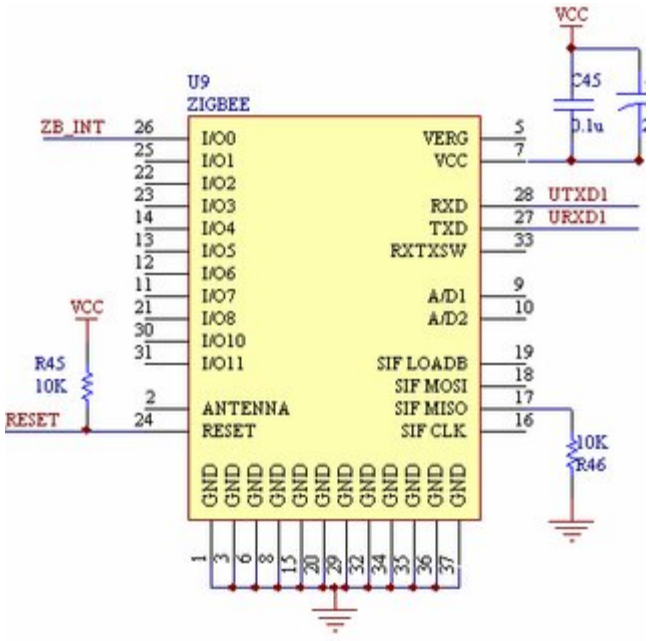
IEEE 802.15.4:ZigBee

A wireless technology currently gaining traction in the LPWAN group, ZigBee is an open global standard and is designed specifically to be used in M2M networks. The technology is inexpensive to run and doesn't require a lot of power, making it an ideal solution for many industrial applications. The technology has a low latency, and a low duty cycle, allowing products to maximize battery life.

The ZigBee protocol offers 128-bit AES encryption. The technology is also used in

Mesh networks, which allow nodes to be connected together through multiple pathways. The wireless technology is hoped to ultimately be implemented in things like smart home devices. The technology's ability to connect multiple devices together simultaneously makes it ideal for a connected home environment where users may want things like smart locks, lights, robots and thermostats to talk to one another. The ZigBee Alliance recently standardized the technology in the hope to make that connectivity possible. Currently all ZigBee devices are not capable of talking to all other ZigBee devices. The hope is that standardization will correct that issue and that the devices will offer a uniform experience for the end user.

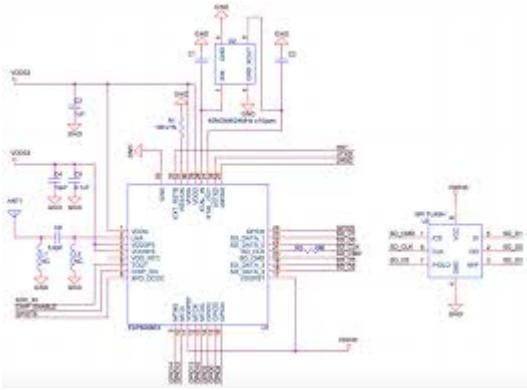
At Link Labs, many of our customers are former ZigBee users, but found that range and performance limited their applications.



IEEE 802.11: WiFi

WiFi uses radio waves (RF) to allow two devices to communicate with one another. The technology is most commonly used to connect Internet routers to devices like computers, tablets and phones; however, it can be used to connect together any two hardware components. WiFi is a local wireless network that runs of the 802.11 standards set forth by the Institute of Electrical and Electronics Engineers (IEEE).

WiFi can utilize both the global 2.4GHz UHF and 5GHz SHF ISM radio bands. The WiFi Alliance certifies some products, allowing them to be labeled as “Wi-Fi Certified.” In order to receive that designation, and product must go through the Alliance’s interoperability certification testing.



Specification:

- 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. ○ A general rule of thumb in home networking says that Wi-Fi routers operating on the 2.4 GHz band can reach up to 150 feet indoors and 300 feet outdoors. Older 802.11a routers that ran on 5 GHz bands reached approximately one-third of these distances. ○ Newer 802.11n and 802.11ac routers that operate on both 2.4 GHz and 5 GHz bands reach greater distances.

● Modulation WiFi systems use two primary radio transmission techniques: ○ 802.11b (<=11 Mbps) – The 802.11b radio link uses a direct sequence spread spectrum technique called complementary code keying (CCK).The bitstream 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). In an OFDM modulation system, the available radio band is divided into a number of subchannels and some of the bits are sent on each. ○ The transmitter encodes the bitstreams on the 64 subcarriers using Binary Phase Shift Keying (BPSK), Quadrature Phase Shift Keying (QPSK), or one of two levels of Quadrature Amplitude Modulation (16, or 64-QAM). Some of the transmitted information is redundant, so the receiver does not have to receive all of the sub-carriers to reconstruct the information.

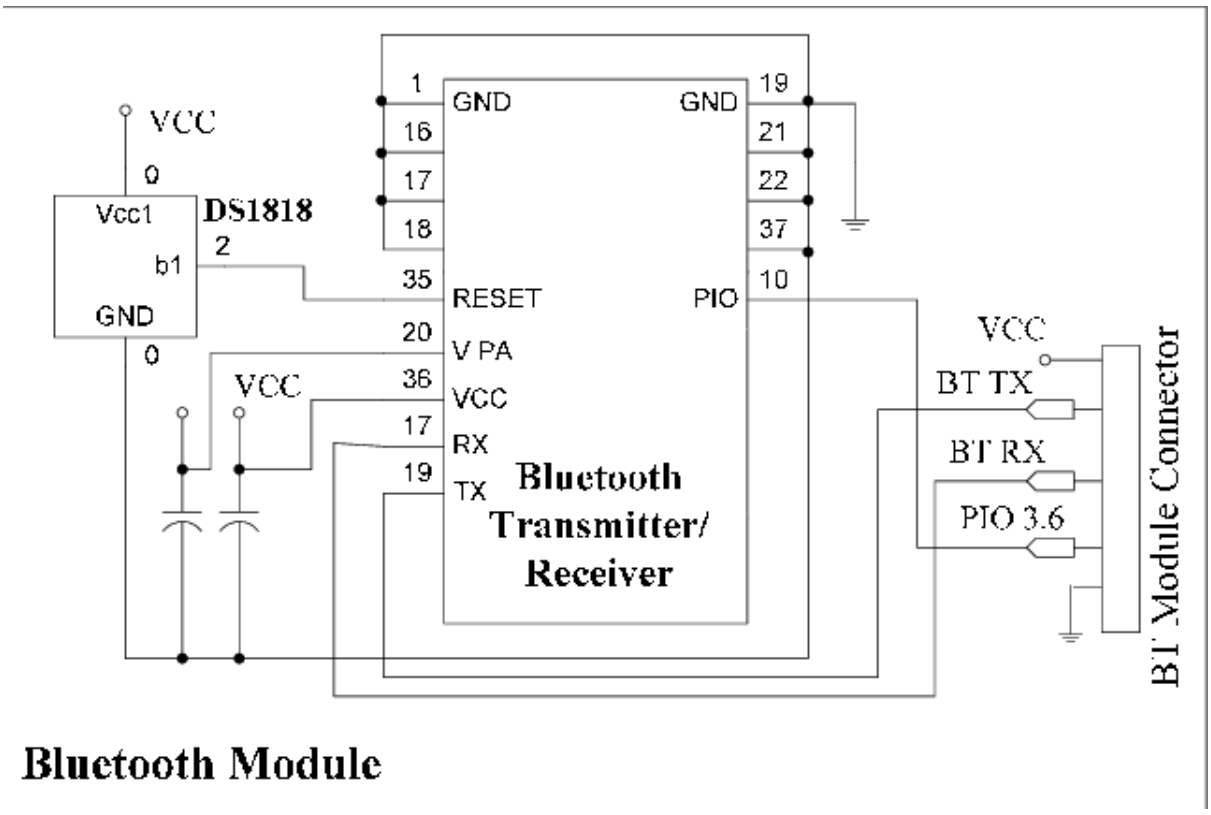
Wi-Fi Scalability :

● Compared to cell phones and similar technology, Wi-Fi transmitters are low power devices. In general, the maximum amount of power that a Wi-Fi device can transmit is limited by local regulations, such as FCC Part 15 in the US. Equivalent isotropically radiated power (EIRP) in the European Union is limited to 20 dBm (100 mW).

● To reach requirements for wireless LAN applications, Wi-Fi has higher power consumption compared to some other standards designed to support wireless personal area network (PAN) applications. For example, Bluetooth provides a much shorter propagation range between 1 and 100m[74] and so in general have a lower power consumption. Other

low-power technologies such as ZigBee have fairly long range, but much lower data rate. The high power consumption of Wi-Fi makes battery life in some mobile devices a concern.

IEEE 802.15.1: Bluetooth and BLE



Bluetooth Module

Bluetooth and Bluetooth Low Energy (BLE) are wireless technologies used to transfer data over short distances. The technology is frequently used in small consider devices that connect to users phones and tablets. For instance, the technology is used in many speaker systems. Bluetooth Low Energy uses less power than standard Bluetooth and is used in hardware such as fitness trackers, smart watches and other connected devices in order to wirelessly transmit data without heavily compromising the battery power in a user's phone.

BLE has only recently started to pick up steam. The technology was initially introduced by smartphone maker Nokia in 2006, but didn't become part of Bluetooth standard until 2010. Today, BLE, which is also referred to as Bluetooth Smart, is supported by the majority of smartphone and computer makers as well as most major operating systems including Windows 8, OS X, Linux, Windows Phone, Android and iOS.

Bluetooth uses UHF radio waves for data transfer. The technology was originally standardized as IEEE 802.15.1, but the IEEE no longer maintains that specific standard. Companies that work with Bluetooth are often affiliated with the Bluetooth Special Interest group (SIG). The group currently has over 20,000 members, and must certify a product before it can be marketed as a Bluetooth device to the consumer or business market. That

certification helps ensure that all Bluetooth devices work in a standardized way and provide a similar experience for consumers.

Bluetooth Specifications :

● Range The Bluetooth Core Specification mandates a range of not less than 10 meters (33 ft), but there is no upper limit on the actual range.

● Modulation

Originally, Gaussian frequency-shift keying (GFSK) modulation was the only modulation scheme available. ○ Since the introduction of Bluetooth 2.0+EDR, π/4-DQPSK (differential quadrature phase-shift keying) and 8-DPSK modulation may also be used between compatible devices. ○ Devices functioning with GFSK are said to be operating in basic rate (BR) mode where an instantaneous bit rate of 1 Mbit/s is possible. The term Enhanced Data Rate (EDR) is used to describe π/4-DPSK and 8-DPSK schemes, each giving 2 and 3 Mbit/s respectively.

Bluetooth Scalability :

● The primary constraining factor in the scalability of a system that uses any wireless communications technology concerns the fact that radio is a shared resource with a finite capacity.

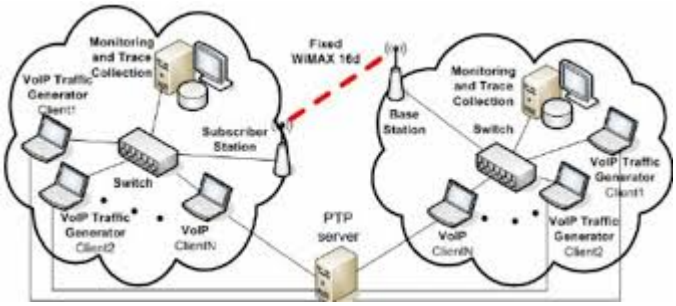
● Bluetooth has been developed to facilitate wireless local area networks (LANs), in which the networks of different handheld computing terminals and mobile terminals can communicate and exchange data - even on the move or when there is no line-of-sight between the terminals.

IEEE 802.16: WiMax

WiMax stands for Worldwide Interoperability for Microwave Access. This wireless technology allows data to be transferred at a rate of 30-40 megabits per second. The term refers specifically to interoperable implementations of the IEEE 802.16 wireless family. The technology was once used by several mobile carriers, notably Sprint, to deliver wireless data to its customers. Sprint, along with many of the other carriers who used the technology, has since switched over to using faster LTE 4G networks for data.

The WiMax Forum certifies devices before they can be sold to consumer or businesses. The technology can be used both indoors and outdoors, however, WiMax devices typically produce a better signal when used outside or by a window.

Link Labs builds a new type of wireless technology, called Symphony Link. Symphony Link solves many of the range and performance issues of the technologies listed above.



<u>Types of network architecture using wired/wireless networks :</u>

- **Personal Area Networks (PAN)** -

To enable data exchange, modern devices such as smartphones, tablets, laptops, and desktop computers can be integrated into a network. This can be wired in the form of a Personal Area Network (PAN). Common transfer techniques include **USB or FireWire**. The wireless variety is known as Wireless Personal Area Network (WPAN) and is based on technologies such as **Bluetooth, Wireless USB, Insteon, IrDA, ZigBee, and Z-Wave**. A wireless Personal Area Network, which can be achieved via Bluetooth, is called Piconet. PANs and WPANs usually only stretch over a few meters, and are therefore not suitable for connecting devices in different rooms or even buildings.

In addition to the communication between individual devices, a Personal Area Network also makes it possible to establish a connection to other networks, usually larger ones. This is known as an uplink. Due to the limited range and a comparatively low data transfer rate, PANs are primarily used to connect peripheral devices in the hobby and entertainment sector. Typical examples include wireless headphones, game consoles, and digital cameras. Within the Internet of Things (IoT)'s framework, WPANs are responsible for the communication of control and monitoring applications with low data rates. Protocols such as Insteon, Z-Wave, and ZigBee have been specifically designed for smart homes and home automation.

- **Local Area Networks (LAN**) -

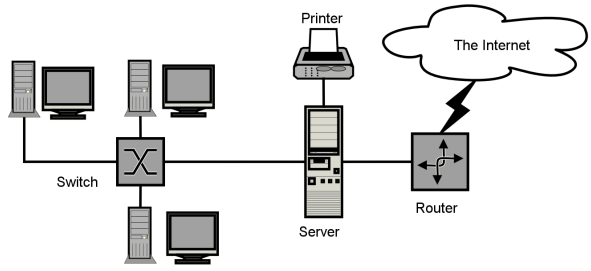
If more than one computer is to be connected to a network, this usually takes the form of a Local Area Network (LAN). Networks like these can include two computers in a private household or several thousand devices in a company. Networks in public institutions such as

those used by public authorities, schools, or universities, are also implemented as LANs. A widely-used standard for wired Local Area Networks is **Ethernet**. Networking technologies such as ARCNET, FDDI, and Token Ring are less common and widely outdated. Data transmission is either electronically based on **copper cables or via fiber optic cables**.

If more than two computers are to be connected in one LAN, additional network components such as hubs, bridges, and switches are needed, which act as coupling elements and distribution nodes. The network type LAN was developed to enable fast transmission of large amounts of data. Depending on the structure of the network and the transmission medium used, a data throughput of 10 to 1,000 Mbit/s is normal. LANs enable convenient information exchange between the various devices connected to the network. In a business context, it's common to share files, network printers, and applications via LAN with several computers.

If a local network is implemented via radio, it is referred to as a Wireless Local Area Network **(WLAN)**. The WLAN standard's technical basis is defined by the **IEEE 802.11** family of standards. Wireless local networks offer the ability to easily integrate devices into home or corporate networks, and are compatible with wired Ethernet LANs. However, the data throughput is lower than for an Ethernet connection.

The range of a LAN depends on the standard and the transmission medium, but can be increased by signal amplifiers, known as repeaters. Regarding gigabit Ethernet via glass fibers, a signal range of several miles is possible. However, Local Area Networks rarely stretch across more than one building complex. Multiple LANs can be connected to a superior Metropolitan Area Network (MAN) or Wide Area Network (WAN).



Campus Area Network(CAN) : -

Campus Area Network (CAN) is a group of interconnected Local Area Networks (LAN) within a limited geographical area like school campus, university campus, military bases, or organizational campuses and corporate buildings etc. A Campus Area Network is larger than Local Area Network but smaller than Metropolitan Area Network (MAN) and Wide Area Network (WAN).

This Campus Area Network also called the Corporate Area Network. Sometimes this network is also referred as Residential Network or ResNet as it is only used by residents of specific campuses only. Campus Area Network is a network of interconnected Local Area Networks where these LANs are connected via Switches and routers and create a single network like CAN. Campus Area Network covers areas of around 1 to 5 km range and it can be both wired or wireless connectivity.

Within a limited geographical area, LANs are interconnected with help of Switches and Routers and connects buildings to buildings of a single campus where all networking resources like wiring, hubs, switches, routers etc are owned by organization itself. In this, they use same kind of technologies like Local Area Network only interconnection between

different buildings is there. Nodes in a campus network are interconnected by means of Optical fiber media, i.e., **Fiber optics** and takes advantage of **10-Gigabit Ethernet technology**. Besides this 10-Gigabit ethernet technology, **Wi-Fi hotspots** and hot zones are different ways of accessing network.

- **Metropolitan Area Networks (MAN)** -

Metropolitan Area Network (MAN) is a broadband telecommunication network that connects several LANs in close proximity. As a rule, these are individual establishments in a company that are connected to a MAN via leased lines. High-performance routers and high-performance fiber-based connections are used, which enable a significantly higher data throughput than the internet. The transfer speed between two remote nodes is comparable to that of communication within a LAN.

The infrastructure for MANs is provided by international network operators. As a Metropolitan Area Network, wired cities can be integrated nationally into Wide Area Networks (WAN) and internationally in Global Area Networks (GAN).

With **Metro Ethernet**, a special transmission technology is available for MANs, which can be used to build powerful Metro Ethernet networks (MEN) based on Carrier Ethernet (CE 1.0) or Carrier Ethernet 2.0 (CE 2.0).

A standard for larger regional radio networks, known as Wireless Metropolitan Area Networks (WMAN), was developed with **IEEE 802.16**. This technology known as **WiMAX** (Worldwide Interoperability for Microwave Access) makes it possible to set up WiFi hotspots. These are several WiFi access points working together in different locations. The current transmission standard DSL is technically only available where copper cables have been laid.

- **Wide Area Networks (WAN)** -

While Metropolitan Area Networks connect areas that are near each other in rural or urban areas, Wide Area Networks (WANs) extend across large geographic areas, such as countries or continents. The number of local networks or individual computers connected in a WAN is unlimited, in principle.

While LANs and MANs can be implemented because of their geographical proximity to the computers and networks based on Ethernet that are to be connected, technologies such as IP/MPLS (Multiprotocol Label Switching), PDH (Plesiochronous Digital Hierarchy), SDH (Synchronous Digital Hierarchy), SONET (Synchronous Optical Network), ATM (Asynchronous Transfer Mode) and sometimes the outdated X.25 are used.

Wide Area Networks are usually owned by an organization or company, and are operated privately or rented. In addition, internet service providers use WANs to connect local company networks and consumers to the internet.

Storage area network (SAN):

A storage area network (SAN) is a dedicated high-speed network or subnetwork that interconnects and presents shared pools of storage devices to multiple servers.

A SAN moves storage resources off the common user network and reorganizes them into an independent, high-performance network. This enables each server to access shared storage as if it were a drive directly attached to the server. When a host wants to access a storage device on the SAN, it sends out a block-based access request for the storage device.

A storage area network is typically assembled using three principle components: cabling, host bus adapters (HBAs), and switches attached to storage arrays and servers. Each switch and storage system on the SAN must be interconnected, and the physical interconnections must support bandwidth levels that can adequately handle peak data activities. IT administrators manage storage area networks centrally.

Storage arrays were initially all **hard disk drive systems**, but are increasingly populated with flash **solid-state drives** (SSDs).

Cellular Network :

A cellular network or mobile network is a radio network distributed over land areas called cells, each served by at least one fixed-location transceiver, known as a cell site or base station. In a cellular network, each cell characteristically uses a different set of radio frequencies from all their immediate neighbouring cells to avoid any interference.

When joined together these cells provide radio coverage over a wide geographic area. This enables a large number of portable transceivers (e.g., mobile phones, pagers, etc.) to communicate with each other and with fixed transceivers and telephones anywhere in the network, via base stations, even if some of the transceivers are moving through more than one cell during transmission.

Although originally intended for cell phones, with the development of smartphones, cellular telephone networks routinely carry data in addition to telephone conversations .

- Global System for Mobile Communications (GSM): The GSM network is divided into three major systems: the switching system, the base station system, and the operation and support system. The cell phone connects to the base system station which then connects to the operation and support station; it then connects to the switching station where the call is transferred to where it needs to go. GSM is the most common standard and is used for a majority of cell phones.[13]
- Personal Communications Service (PCS): PCS is a radio band that can be used by mobile phones in North America and South Asia. Sprint happened to be the first service to set up a PCS.
- D-AMPS: Digital Advanced Mobile Phone Service, an upgraded version of AMPS, is being phased out due to advancement in technology. The newer GSM networks are replacing the older system.

Global Area Networks (GAN) -

A global network, such as the internet, is referred to as the Globe Area Network (GAN). The internet is, however, not the only computer network of its kind. Internationally operating companies also support local networks that comprise several WANs and connect company

computers across the world. GANs use the fiber optic infrastructure from wide area networks and combine these with international undersea cables or satellite transmissions.

Conclusion :

Understood wired and wireless transmission media and technologies used for networking along with various network architecture .

Resources :

1. https://en.wikipedia.org/wiki/OSI_model
2. //:https://www.studytonight.com/computer-networks/osi-model-physical-layer
3. https://www.iup.edu/WorkArea/DownloadAsset.aspx?id=61283
4. //https://studyopedia.com/computer-networks/guided-transmission-media/
5. https://en.wikipedia.org/wiki/USB
6. https://www.link-labs.com/blog/types-of-wireless-technology