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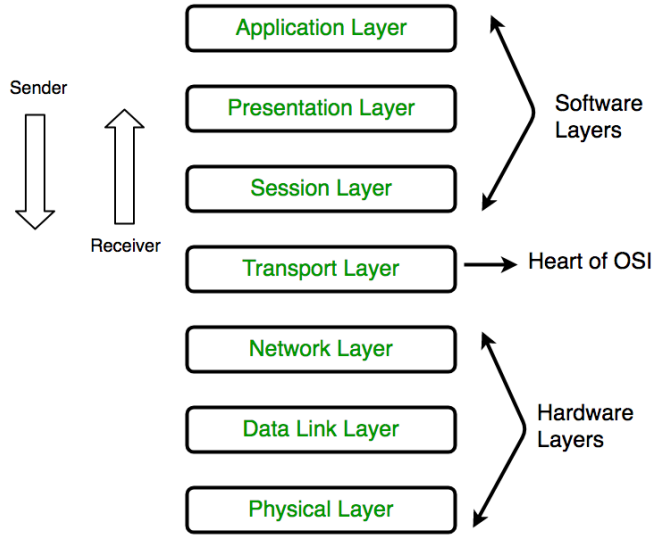
2018130057

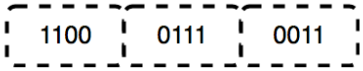
EXPERIMENT 1

AIM: Study of different types of physical layer wired/wireless connections.

THEORY:OSI stands for Open Systems Interconnection. OSI model was developed by the International Organization for Standardization(ISO). It is a reference model for how applications communicate over a network. The OSI model characterizes computing functions into a universal set of rules and requirements in order to support interoperability between different products and software.
The OSI model can be considered as a universal language for computer networking. It is based on the concept of divide and conquers, it splits up the communication system into 7 abstract layers, and the layer is stacked upon the previous layer.
Layers of OSI Model:



Physical Layer (Layer 1) :
The lowest layer of the 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 transmitting individual bits from one node to the next. When receiving data, this layer will get the signal received and convert it into 0s and 1s and send them to the Data Link layer, which will put the frame back together.



The functions of the physical layer are :

1. Bit synchronization: The physical layer provides the synchronization of the bits by providing a clock. This clock controls both sender and receiver thus providing synchronization at bit level.
2. Bit rate control: The Physical layer also defines the transmission rate i.e. the number of bits sent per second.
3. Physical topologies: Physical layer specifies the way in which the different, devices/nodes are arranged in a network i.e. bus, star or mesh topolgy.
4. Transmission mode: Physical layer also defines the way in which the data flows between the two connected devices. The various transmission modes possible are: Simplex, half-duplex and full-duplex.

Hub, Repeater, Modem, Cables are Physical Layer devices.

A **hub** is basically a multiport repeater.A hub connects multiple wires coming from different branches, for example, the connector in star topology which connects different stations. Hubs cannot filter data, so data packets are sent to all connected devices. In other words, collision domain of all hosts connected through Hub remains one. Also, they do not have intelligence to find out best path for data packets which leads to inefficiencies and wastage.

A **repeater** operates at the physical layer. Its job is to regenerate the signal over the same network before the signal becomes too weak or corrupted so as to extend the length to which the signal can be transmitted over the same network. An important point to be noted about repeaters is that they do not amplify the signal. When the signal becomes weak, they copy the signal bit by bit and regenerate it at the original strength. It is a 2 port device.

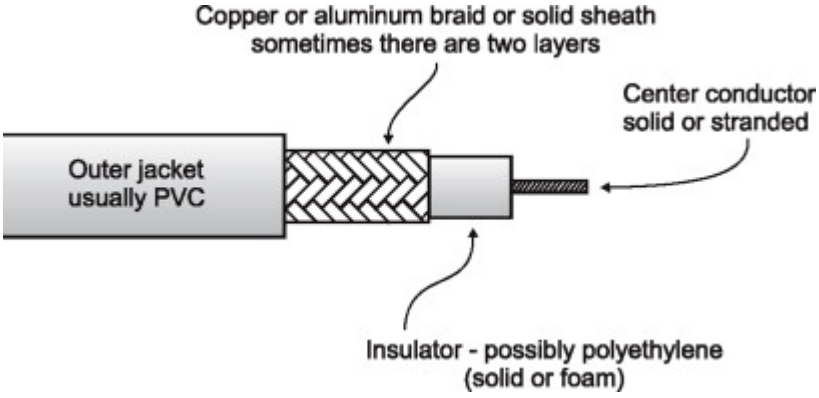
Modem (from modulator-demodulator) is a device that modulates an analog carrier signal to encode digital information, and also demodulates such a carrier signal to decode the transmitted information. The goal is to produce a signal that can be transmitted easily and decoded to reproduce the original digital data.

Network cables are used to connect and transfer data and information between computers, routers, switches and storage area networks . These cables are essentially the carrier or media through which data flows.
There are different types of communications cables, and the appropriate type to use will depend on the structure and topology of the overall architecture of the system.

COAXIAL CABLE
It has a single copper conductor in the middle. A plastic layer provides insulation between the braided metal shield and center conductor. The metal shield blocks outer interference from motors, fluorescent lights, and other computers.
Coaxial cabling is extremely resistant to signal obstruction though it is complex to install. It can handle great cable lengths between network devices than the twisted pair cable. The two types of coaxial cables are thin coaxial and thick coaxial.

Type	Ohms	AWG	Conductor	Description
RG-6	75	18	Solid copper	Used in cable network to provide cable Internet service and

				cable TV over long distances.
RG-8	50	10	Solid copper	Used in the earliest computer networks. This cable was used as the backbone-cable in the bus topology. In Ethernet standards, this cable is documented as the 10base5 Thicknet cable.
RG-58	50	24	Several thin strands of copper	This cable is thinner, easier to handle and install than the RG-8 cable. This cable was used to connect a system with the backbone-cable. In Ethernet standards, this cable is documented as the 10base2 Thinnet cable.
RG-59	75	20 - 22	Solid copper	Used in cable networks to provide short-distance service.



SHIELDED TWISTED PAIR (STP) CABLE

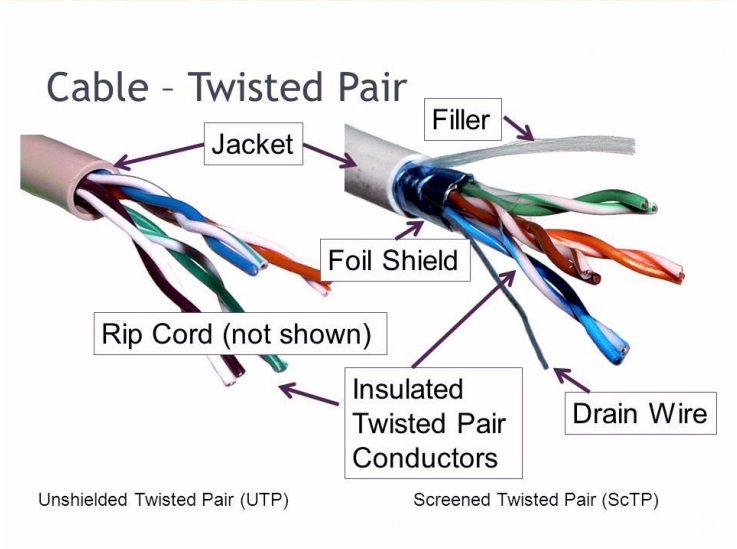
It is a special kind of copper telephone wiring used in business installations. An external shield which functions as a ground is added to the normal twisted pair telephone wires. Shielded twisted pair may be the answer if you want to place the cable in an area with potential interference and risk to the electrical current in the UTP. Shielded cables can also help in expanding the distance between the cables.

UNSHIELDED TWISTED PAIR

It is the most admired type of network cable in the world. UTP cable is used for both conventional telephone and computer networking.

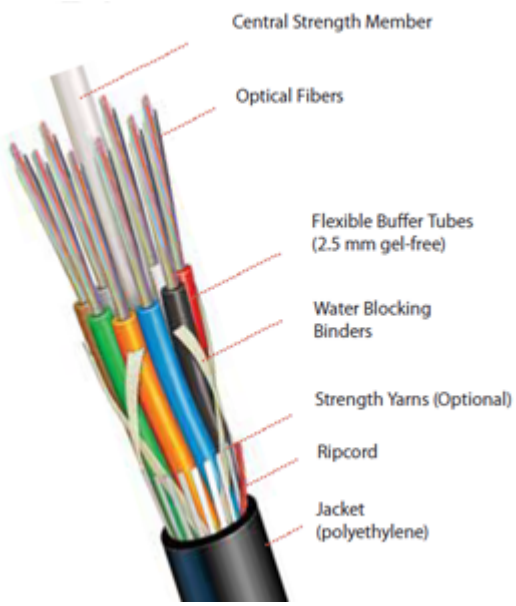
Category / name of the cable	Maximum supported speed	Bandwidth/support signals rate	Ethernet standard	Description
Cat 1	1Mbps	1MHz	Not used for data	This cable contains only two pairs (4 wires). This cable was used in the telephone network for voice transmission.
Cat 2	4Mbps	10MHz	Token Ring	This cable and all further cables have a minimum of 8 wires (4 pairs). This cable was used in the token-ring network.
Cat 3	10Mbps	16MHz	10BASE-T Ethernet	This is the first Ethernet cable that was used in LAN networks.

Cat 4	20Mbps	20MHz	Token Ring	This cable was used in advanced Token-ring networks.
Cat 5	100Mbps	100MHz	100BASE-T Ethernet	This cable was used in advanced (fast) LAN networks.
Cat 5e	1000Mbps	100MHz	1000BASE-T Ethernet	This cable/category is the minimum requirement for all modern LAN networks.
Cat 6	10Gbps	250MHz	10GBASE-T Ethernet	This cable uses a plastic core to prevent cross-talk between twisted-pair. It also uses a fire-resistant plastic sheath.
Cat 6a	10Gbps	500MHz	10GBASE-T Ethernet	This cable reduces attenuation and cross-talk. This cable also potentially removes the length limit. This is the recommended cable for all modern Ethernet LAN networks.
Cat 7	10Gbps	600MHz	Not drafted yet	This cable sets a base for further development. This cable uses multiple twisted-pairs and shields each pair by its own plastic sheath.



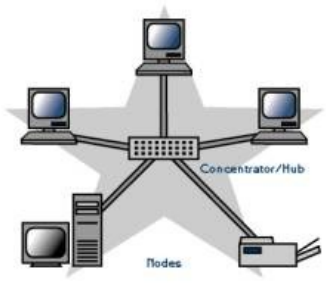
FIBER OPTIC CABLE

Fiber optic cabling consists of a center glass core surrounded by many layers of protective materials. It removes the problem of electrical obstruction by transmitting light rather than electronic signals. This makes them perfect for certain atmospheres which contain huge amount of electrical interference. It has become the standard for connecting networks between buildings because of its resistance to lighting and moisture.



SCALABILITY: Fiber optics are more scalable, as it's simple to install new equipment can over original fiber. Wavelengths can be turned on or off on demand, which allows for the easy provisioning of services and quick scaling for a growing business. Optical fibers are also much smaller and lighter than copper wiring. These fibers can typically be placed in preparation for growth needs up to 15 to 20 years in the future. Alternatively, additional cables can be installed later to make way for network expansion.

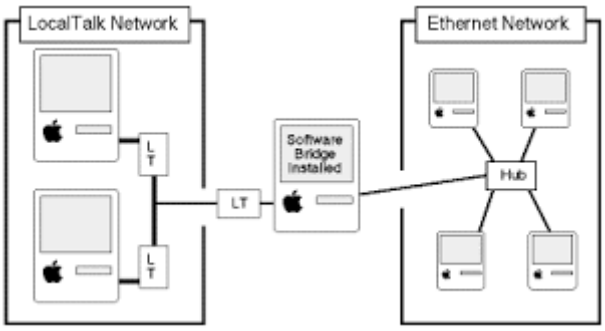
Wired networks, also called Ethernet networks, are the most common type of local area network (LAN) technology. A wired network is simply a collection of two or more computers, printers, and other devices linked by Ethernet cables. Ethernet is the fastest wired network protocol, with connection speeds of 10 megabits per second (Mbps) to 100 Mbps or higher.



Given below is a list of wired networks:

1.LOCAL TALK
Local talk is a protocol developed by Apple Computers, INC for Macintosh computers and different from ethernet, uses CSMA/CA(Carrier Sense Multiple Access with Collision Avoidance) access method . CSMA/CA is an access method where collision is avoided .

CSMA/CA is similar to CSMA/CD except it would signal an intent to transmit before it actually does which would cause collision to be avoided. In Local Talk, a series of computers are connected through a serial port using Local talk adapters and special twisted pair cable . By using twisted pair cable, Local Talk is able to allow linear bus, star, or tree topologies.



Size of the Network

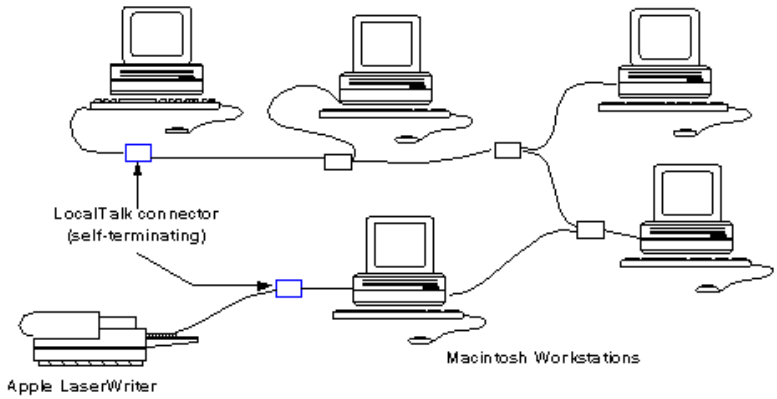
Depending on which type of network you use - LocalTalk, Token-Ring, or Ethernet - there are certain limitations for Apple Computer' s implementation. Some of these limitations, such as the 254 node limit for an EtherTalk Phase 1 network, have already been mentioned. Table below summarizes the maximum nodes for each data link implementation under each phase. When planning your network, keep these numbers in mind.

Data Link Implementation	Phase 1	Phase 2
LocalTalk	32 nodes	32 nodes
EtherTalk	254 nodes	16 million nodes
TokenTalk	Not Supported	16 million nodes

There are also limitations on distance. For example, a LocalTalk LAN segment cannot span more than 300 meters and the maximum speed is 230 Kbps.

A LocalTalk LAN Segment

In a LocalTalk LAN segment, cables are attached to connector boxes. A LocalTalk cable is self-terminating; it begins and ends at the point where a connection box has only one cable connected to it. If a device is not at the terminating end of a LocalTalk LAN segment, one cable will lead from the device to a connection box. Two cables will leave the connection box, each to another device. A LocalTalk LAN segment is defined as the cabling and all its devices between two terminating ends.



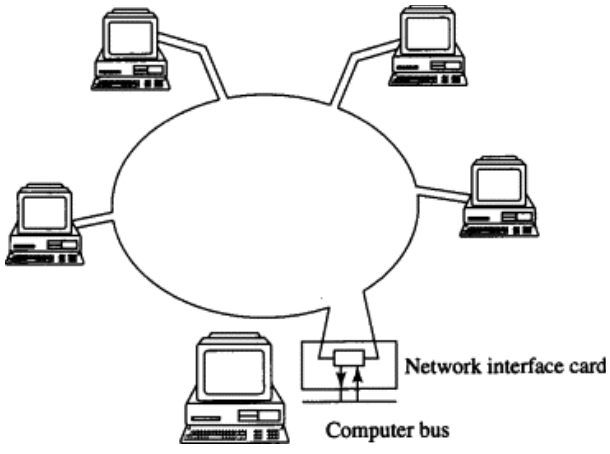
The widespread availability of Ethernet-based networking in the early 1990s led to the swift disappearance of both LocalTalk and PhoneNet. They remained in use for some time in low-cost applications and applications where Ethernet was not available, but as Ethernet became universal on the PC most offices were installing it anyway.For very old Macintosh computers, LocalTalk remains the only option.

2.TOKEN RING(IEEE 802.5)

Token Ring protocol was developed by IBM and uses token-passing as its access method .Token ring is a communication protocol in a local area network (LAN) where all stations are connected in a ring topology and pass one or more tokens for channel acquisition. A token is a special frame of 3 bytes that circulates along the ring of stations. A station can send data frames only if it holds a token. The tokens are released on successful receipt of the data frame. Once there is no more data to send, the token is released; passing to the next station in the Token Ring. Token Ring requires a star-wired ring using twisted pair cable or fiber optic cable .

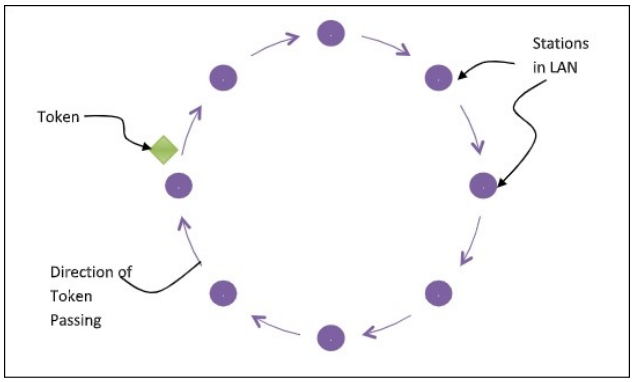
Physical Layer

In a token ring network, the nodes are connected into a ring by point-to-point links. (See Figure 3.19). A network interface has two possible configurations: repeater and open. In the repeater configuration, the interface repeats the incoming signal on the outgoing link with a delay of a few bit transmission times. At the same time, the interface copies the signal for the computer. In the open configuration, the interface transmits on the outgoing link and listens on the incoming link. The transmission rate is 4 Mbps or 16 Mbps, as already mentioned. As with Ethernet, signals may be transmitted over a variety of cabling arrangements, including UTPs.

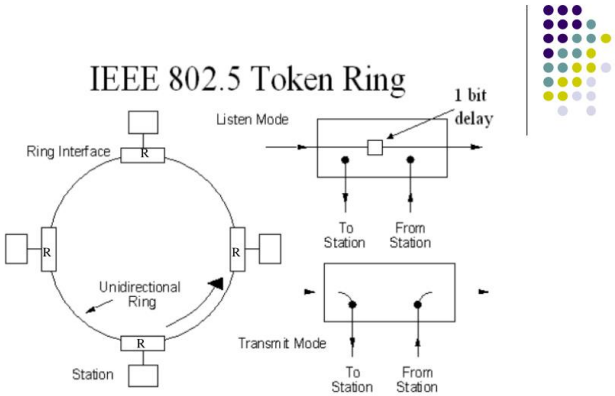


Token Passing Mechanism in Token Ring

If a station has a frame to transmit when it receives a token, it sends the frame and then passes the token to the next station; otherwise it simply passes the token to the next station. Passing the token means receiving the token from the preceding station and transmitting to the successor station. The data flow is unidirectional in the direction of the token passing. In order that tokens are not circulated infinitely, they are removed from the network once their purpose is completed. This is shown in the following diagram −



Schematic View:



Token Ring was introduced by IBM in 1984, and standardized in 1989 as IEEE 802.5. It was a successful technology, particularly in corporate environments, but was gradually eclipsed by the later versions of Ethernet.

3.ETHERNET(IEEE 802.3)
Ethernet is the technology that is commonly used in wired local area networks (LANs). Ethernet is a network protocol that controls how data is transmitted over a LAN and is referred to as the IEEE 802.3 protocol. The protocol has evolved and improved over time to transfer data at the speed of more than a gigabit per second.

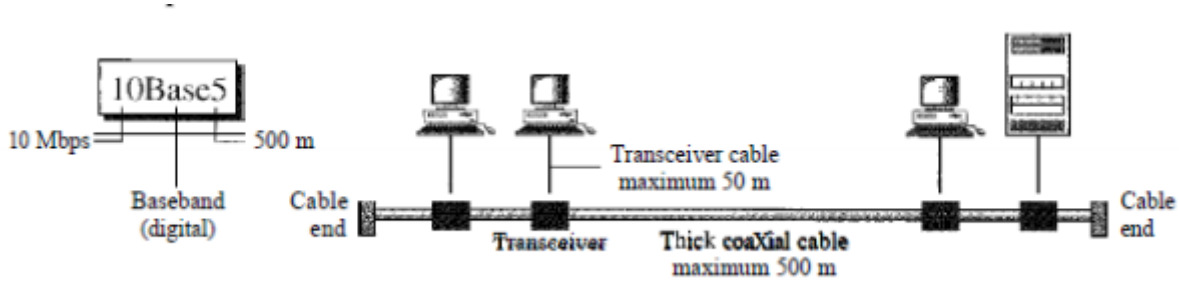
CATEGORIES OF ETHERNET:

Characteristics	10Base5	10Base2	10Base-T	10ase-F
Media	Thick coaxial cable	Thin coaxial cable	UTP	Fibre
Range	500 m	185 m	100 m	2000 m
Topology	Bus	Bus	Star	Star
Line encoding	Manchester	Manchester	Manchester	Manchester
Nodes	100	30	1024	1024
Speed	10Mbps	10Mbps	10Mbps	10Mbps
Scalability	LAN	LAN	LAN	LAN
Modulation	PAM	PAM	PAM	PAM

i) 10Base5: Thick Ethernet

- The first implementation is called 10Base5, thick Ethernet, or Thicknet.
- The nickname derives from the size of the cable, which is roughly the size of a garden hose and too stiff to bend with your hands.
- 105Base5 was the first Ethernet specification to use a bus topology with an external transceiver (transmitter/receiver) connected via a tap to a thick coaxial cable.

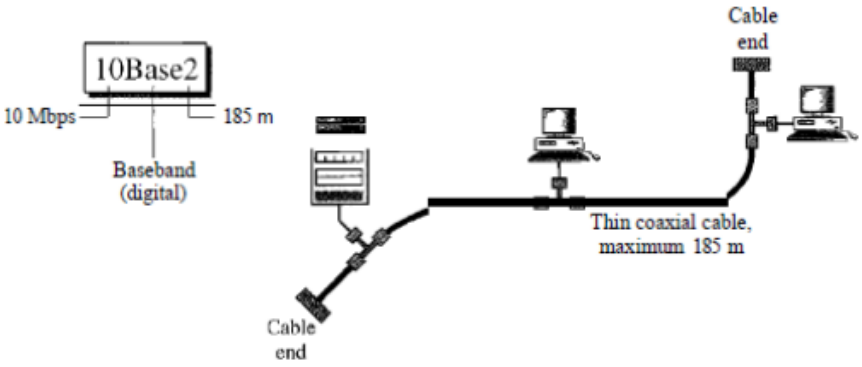
10Base5 Implementation:



ii) 10Base2: Thin Ethernet

- The second implementation is called 10Base2, thin Ethernet, or Cheapernet.
- 1OBase2 also uses a bus topology, but the cable is much thinner and more flexible.
- The cable can be bent to pass very close to the stations. In this case, the transceiver is normally part of the network interface card (NIC), which is installed inside the station.

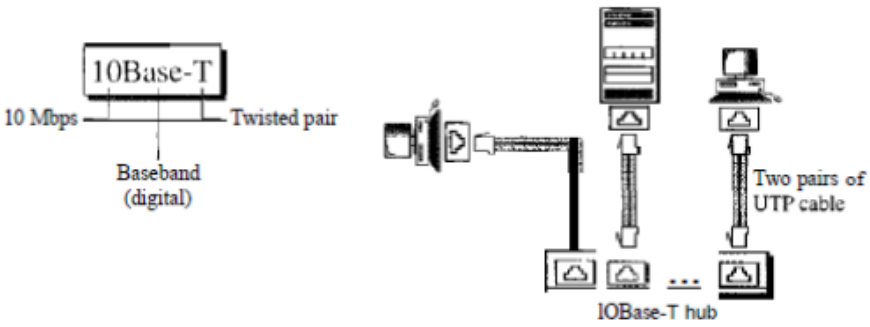
10Base2 Implementation



iii) 10BaseT: Twisted -Pair Ethernet

- The third implementation is called 10Base-T or twisted-pair Ethernet.
- 10Base-T uses a physical star topology. The stations are connected to a hub via two pairs of twisted cable.
- Note that two pairs of twisted cable create two paths (one for sending and one for receiving) between the station and the hub. Any collision here happens in the hub.
- The maximum length of the twisted cable here is defined as 100 m, to minimize the effect of attenuation in the twisted cable.

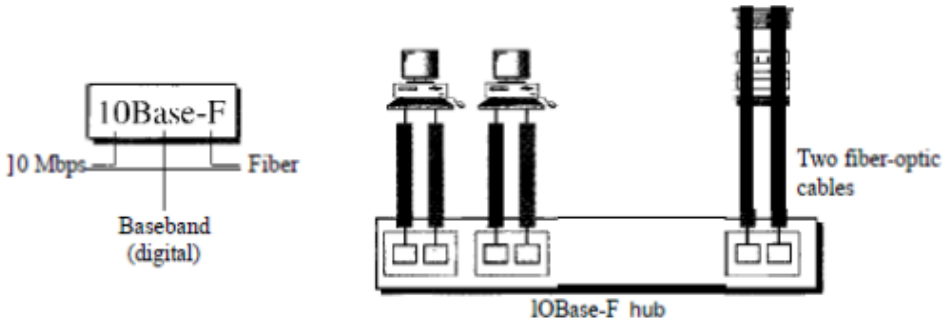
10BaseT Implementation



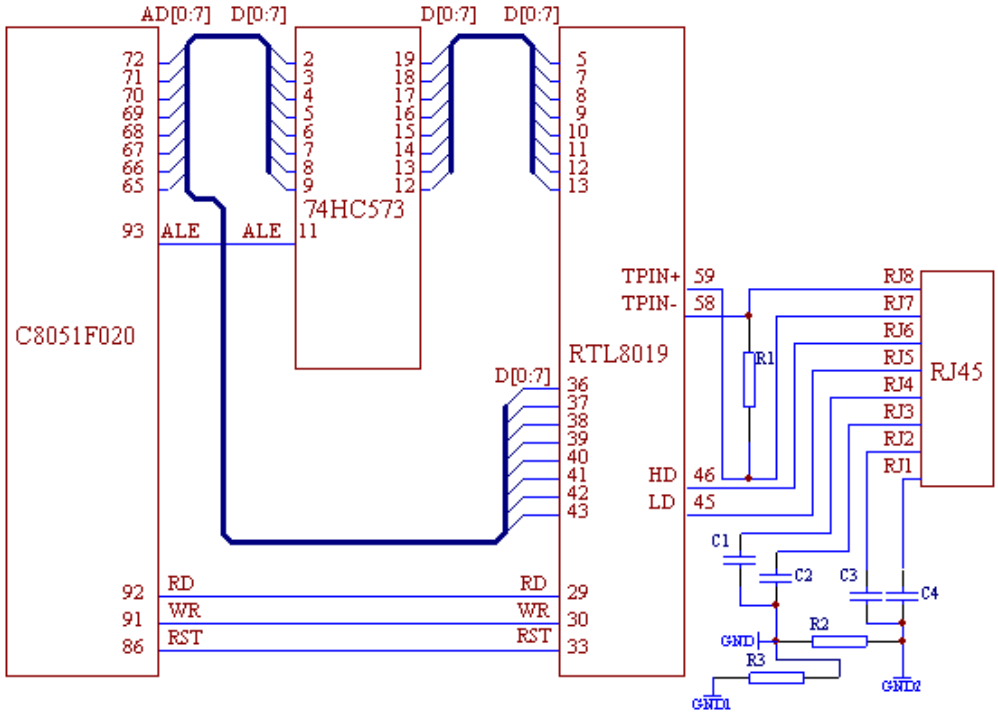
iv) 10Base-F: Fiber Ethernet

- Although there are several types of optical fiber 10-Mbps Ethernet, the most common is called 10Base-F.
- 10Base-F uses a star topology to connect stations to a hub. The stations are connected to the hub using two fiber-optic cables.

10BaseF Implementation

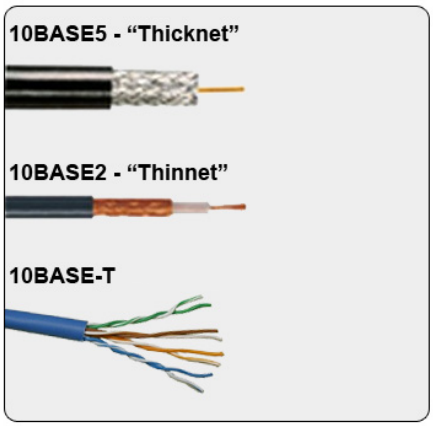


Schematic diagram of Ethernet



4.FAST ETHERNET(IEEE 802.3u)

Fast Ethernet is an extension of the 10 megabit Ethernet standard. It runs on twisted pair or optical fiber cable in a star wired bus topology, similar to the IEEE standard 802.3i called 10BASE-T, itself an evolution of 10BASE5 (802.3) and 10BASE2 (802.3a).



i)100-Base-T4

- This has four pairs of UTP of Category 3, two of which are bi-directional and the other two are unidirectional.
- In each direction, three pairs can be used simultaneously for data transmission.
- Each twisted pair is capable of transmitting a maximum of 25Mbaud data. Thus the three pairs can handle a maximum of 75Mbaud data.
- It uses the encoding scheme 8B/6T (eight binary/six ternary).

ii)100-Base-TX

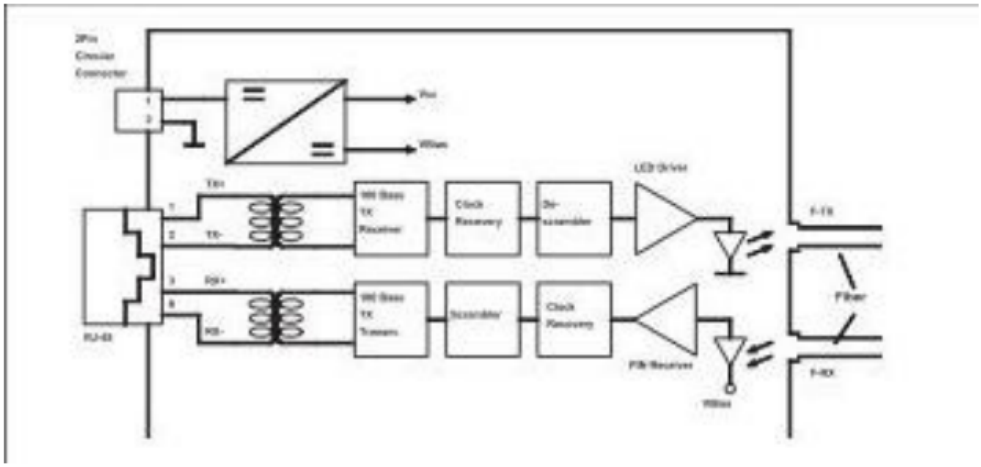
- This has either two pairs of unshielded twisted pairs (UTP) category 5 wires or two shielded twisted pairs (STP) type 1 wires. One pair transmits frames from hub to the device and the other from device to hub.
- Maximum distance between hub and station is 100m.
- It has a data rate of 125 Mbps.
- It uses MLT-3 encoding scheme along with 4B/5B block coding.

iii)100-BASE-FX

- This has two pairs of optical fibers. One pair transmits frames from hub to the device and the other from device to hub.
- Maximum distance between hub and station is 2000m.
- It has a data rate of 125 Mbps.
- It uses NRZ-I encoding scheme along with 4B/5B block coding.

Characteristics	100Base-TX	100Base-FX	100Base-T4
Media	Cat 5 UTP or STP	Fiber	Cat 3 UTP
Range	100 m	100 m	100 m
Topology	Star	Star	Star
Line encoding	MLT-3	NRZ-I	8B/6T
Block encoding	4B/5B	4B/5B	
Number of wires	2	2	4
Speed	100 Mbps	100 Mbps	100 Mbps
Scalability	LAN	LAN	LAN
Modulation	PAM-5	PAM-5	PAM-5

Schematic View:

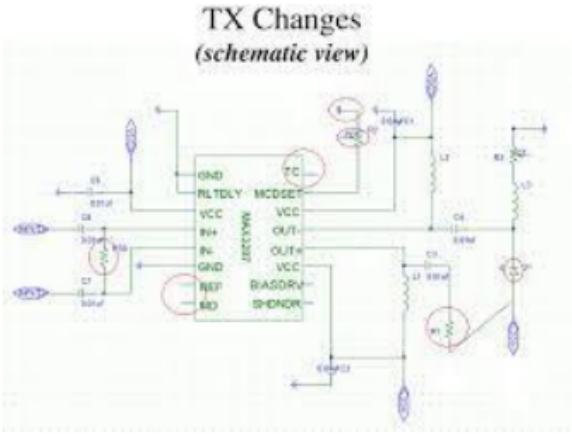


5.GIGABIT ETHERNET(IEEE 802.3z)

Gigabit Ethernet, a transmission technology based on the Ethernet frame format and protocol used in local area networks (LANs), provides a data rate of 1 billion bits per second (one gigabit). Gigabit Ethernet is currently being used as the backbone in many enterprise networks.

Characteristics	1000Base-SX	1000Base-LX	1000Base-CX	1000Base-T
Media	Short wave fiber	Long wave fiber	Copper STP	UTP
Range	550 m	5000 m	25 m	100 m
Topology	Star	Star	Star	Star
Line encoding	NRZ	NRZ	NRZ	4D-PAM5
Block encoding	8B/10B	8B/10B	8B/10B	
Number of wires	2	2	2	4
Speed	1000 Mbps	1000 Mbps	1000 Mbps	1000 Mbps
Scalability	LAN	LAN, MAN, WAN	LAN	LAN
Modulation	PAM-5	PAM-5	PAM-5	PAM-5

Schematic View:



6. Fiber Distributed Data Interface (FDDI)

FDDI uses optical fiber as its physical medium. It provides high data rate of 100 Mbps and can support thousands ofusers.It is used in LANs up to 200 kilometers for long distance voice andmultimedia communication.It uses ring based token passing mechanism and is derived from IEEE 802.4 token bus standard.FDDI technology can also be used as a backbone for a wide area network (WAN).

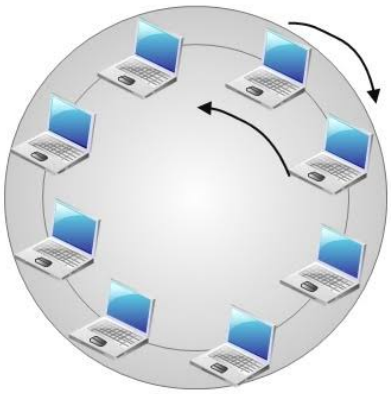


Figure A

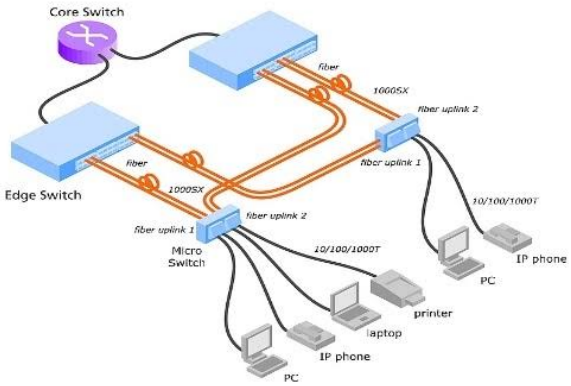


Figure B

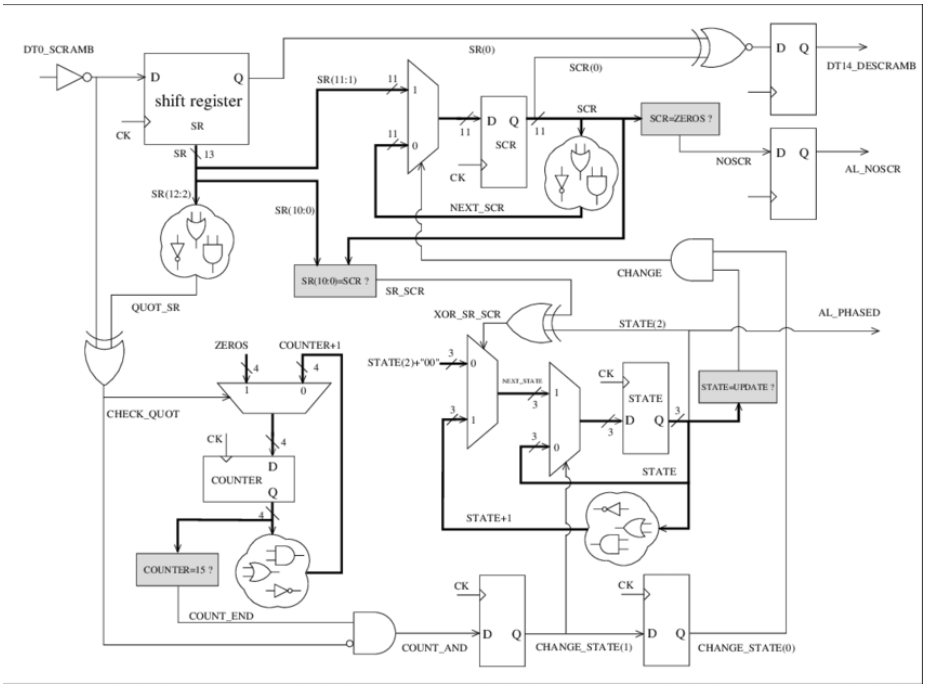
PHY (Physical Layer Protocol)

PMD(Physical Medium Dependent) defines specifications for the physical layer of a network standard, namely, the media and interface connectors used. As FDDI supports both fiber and copper media, two separate specifications are defined. They are the Fiber PMD (for optical fiber media) and TP-PMD (for copper media, specifically for twisted-pair). Other two significant PMDs are SMF-PMD (Single Mode Fiber-PMD), defines the demands on single mode fibers permitting distances of 40 to 60 km (in contrast to multimode fibers permitting distances of maximum 2 km).

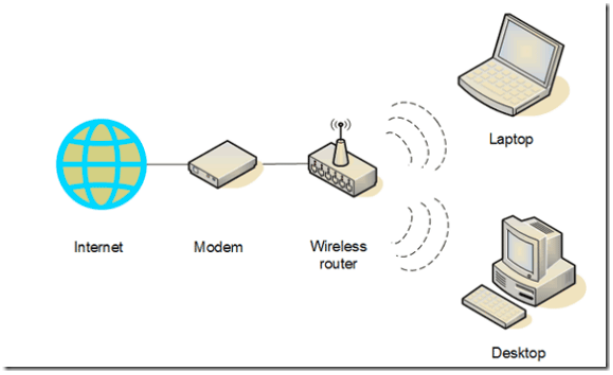
The maximum number of Phys per FDDI ring is 1000. A Dual Attachment Station (OAS) has two PHYs connected directly to the double ring, whereas a SAS (Single Attached Station) has an additional PHY in the concentrator. As each station needs two PHYs, the network can accommodate a maximum of 500 stations.

In all, FDDI supports four different types of cable:
• Multimode fiber optic cable: This type of cable can be used over a maximum of 2000 meters and uses LED as a light source.
• Single mode fiber optic cable: This can be used over a maximum of 10,000metres or more and uses lasers as a light source. Single mode cable is thinner at the core than multimode, but it provides higher bandwidth because of the way the light impulse travels through the cable.
• Unshielded twisted-pair copper wiring: This cable contains eight wires, and as the next category, can be used over distances up to 30 meters.
• Shielded twisted-pair copper wiring: This is a shielded cable that contains two pairs of twisted wires, with each pair also shielded.

Schematic View:



Wireless networks are computer networks that are not connected by cables of any kind. Wireless networks use radio waves to connect devices such as laptops to the Internet, the business network and applications. When laptops are connected to Wi-Fi hot spots in public places, the connection is established to that business's wireless network.



Given below are a few wireless protocols:

1.BLUETOOTH (IEEE 802.15.1)
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).The IEEE standardized Bluetooth as IEEE 802.15.1, but no longer maintains the standard.

Bluetooth is a full protocol stack. The bottom layer of the stack is called the Physical Layer and is normally referred to as PHY. Bluetooth 5 adds two new PHY variants to the PHY specification used in Bluetooth 4. Each PHY variant has its own particular characteristics and was designed with specific aims in mind. The three PHYs have been named to allow them to be easily referenced in specifications. Their names are LE1M, LE 2M, and LE Coded.

	LE 1M	LE Coded S=2	LE Coded S=8	LE 2M
Symbol Rate	1 Ms/s	1 Ms/s	1 Ms/s	2 Ms/s
Data Rate	1 Mbit/s	500 Kbit/s	125 Kbit/s	2 Mbit/s
Error Detection	CRC	CRC	CRC	CRC
Error Correction	NONE	FEC	FEC	NONE
Range Multiplier (approx.)	1	2	4	0.8
Bluetooth 5 Requirement	Mandatory	Optional	Optional	Optional

There are many factors affecting Bluetooth range, typically:

- The output power of the transmitter
- The sensitivity of the receiver
- Physical obstacles in the transmission path
- The antennas

	BLUETOOTH v2.1	**BLUETOOTH 4.0 (LE)**	**BLUETOOTH 5 (LE)**
Range	Up to 100 m	Up to 100 m	Up to 400 m
Max range (free field)	Around 100 m (class 2 outdoors)	Around 100 m (outdoors)	Around 1,000m (outdoors)
Frequency	2.402 – 2.481	2.402 – 2.481 GHz	2.402 - 2.481

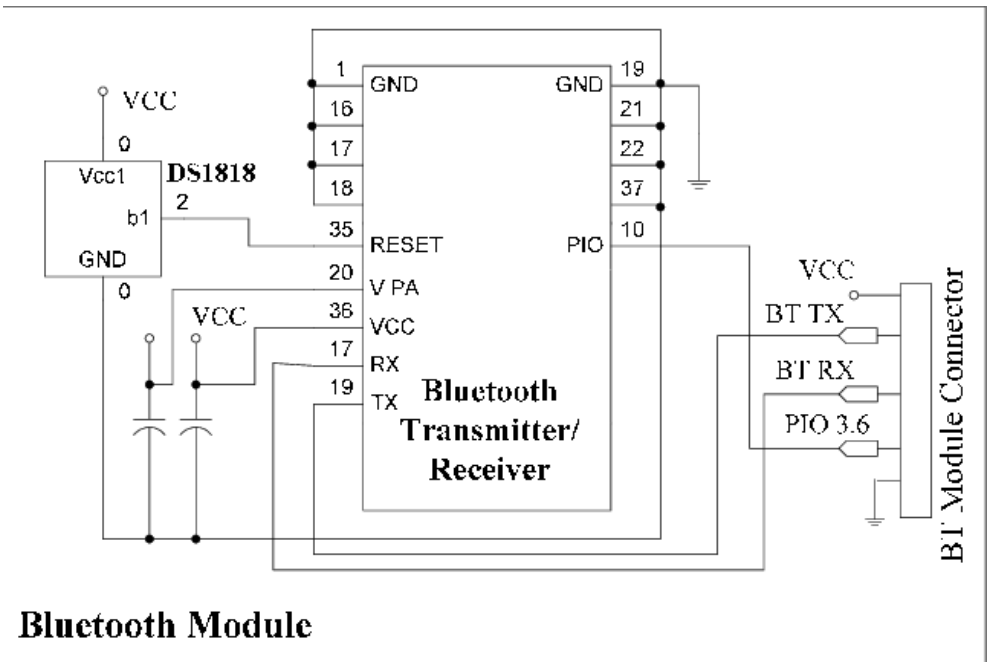
	BLUETOOTH v2.1	BLUETOOTH 4.0 (LE)	BLUETOOTH 5 (LE)
	GHz		GHz
Max data rate	1- 3 Mbit/s	1 Mbit/s	2 Mbit/s
Application Throughput	0.7-2.1 Mbit/s	Up to 305 kbit/s	Up to 1,360 kbit/s
Topologies	Point-to-point, scatternet	Point-to-point, mesh network	Point-to-point, mesh network
Network Standard	IEEE 802.15.1	IEEE 802.15.1	IEEE 802.15.1

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. The combination of these (BR and EDR) modes in Bluetooth radio technology is classified as a *BR/EDR radio*.
In 2019, Apple published an extension called HDR which supports data rates up to 8Mbit/s.

Bluetooth has three generic applications:

- Personal area networks (PAN), where two or more Bluetooth products can communicate directly. This includes synchronising the contacts list between mobile phone, PC and hand-held devices. It can also transfer files to another user's Bluetooth-enabled devices and allows access to printers, facsimiles and copiers
- Local area networks (LAN), where products will communicate to a company's broader network via a Bluetooth LAN access point. The applications for this are the downloading of information, emails and files from Bluetooth-enabled laptops, mobile phone and hand-held devices from a corporate server
- Wide area network (WAN), where a product with Bluetooth-enabled technology can communicate with a wireless WAN device, such as the global system for mobile communications (GSM), to allow connectivity. This application can allow for mobile access to the internet and the retrieval of information or files from desktop computers

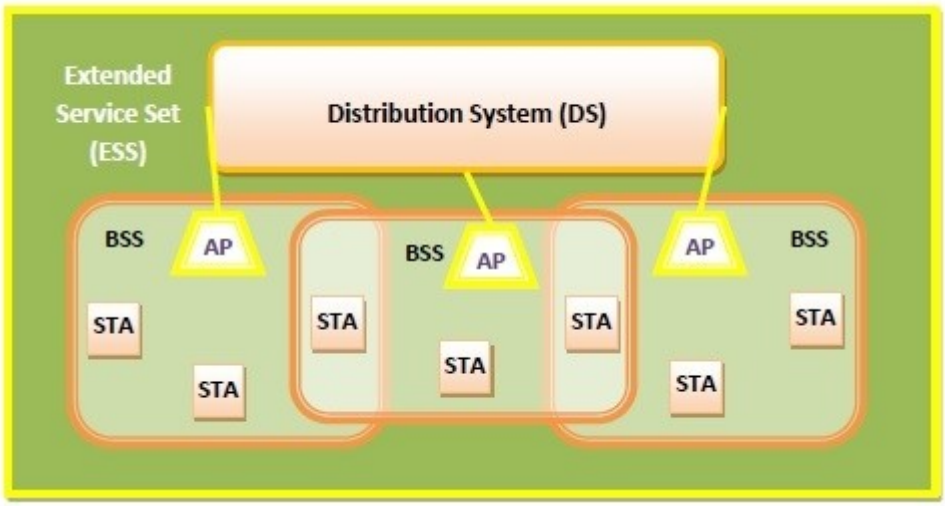
Schematic View:



2.WIFI (IEEE 802.11)
IEEE 802.11 standard, popularly known as WiFi, lays down the architecture and specifications of wireless LANs (WLANs). WiFi or WLAN uses high frequency radio waves instead of cables for connecting the devices in LAN. Users connected by WLANs can move around within the area of network coverage.

The physical layer architecture of IEEE 802.11 has the following components −

- Stations (STA) − Stations comprises of all devices and equipment that are connected to the wireless LAN. A station can be of two types −
    - Wireless Access Point (WAP) − WAPs or simply access points (AP) are generally wireless routers that form the base stations or access.
    - Client. Clients are workstations, computers, laptops, printers, smart phones etc.
- Each station has a wireless network interface controller.
- Basic Service Set (BSS) − A basic service set is a group of stations communicating at physical layer level. BSS can be of two categories depending upon mode of operation −
    - Infrastructure BSS − Here, the devices communicate with other devices through access points.
    - Independent BSS − Here, the devices communicate in peer-to-peer basis in an ad hoc manner.
- Extended Service Set (ESS) − It is a set of all connected BSS.
- Distribution System (DS) − It connects access points in ESS.



WiFi uses adaptive modulation and varying levels of forward error correction to optimize transmission rate and error performance.Adaptive modulation means that the transmitter will automatically shift to a more robust, though less efficient, modulation technique in those adverse conditions.

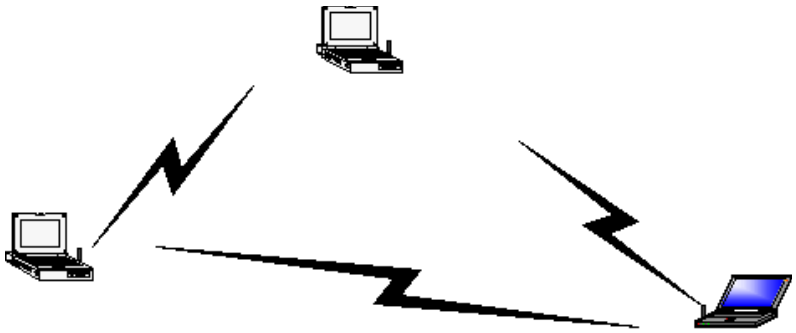
Standard	Frequency Band	Bandwidth	Modulation Scheme	Channel Arch.	Maximum Data Rate	Range
802.11	2.4 GHz	20 MHz	BPSK to 256-QAM	DSSS, FHSS	2 Mbps	20 m
b	2.4 GHz	21 MHz	BPSK to 256-QAM	CCK, DSSS	11 Mbps	35 m
a	5 GHz	22 MHz	BPSK to 256-QAM	OFDM	54 Mbps	35 m
g	2.4 GHz	23 MHz	BPSK to 256-QAM	DSSS, OFDM	54 Mbps	70 m
n	2.4 GHz, 5 GHz	24 MHz and 40 MHz	BPSK to 256-QAM	OFDM	600 Mbps	70 m
ah	900 MHz	1, 2, 4, 8, and 16 MHz	BPSK to 256-QAM	SC, OFDM	40 Mbps	1 km

While a WLAN may look different than a traditional LAN, it functions the same way. New devices are typically added and configured using DHCP. They can communicate with other devices on the network the same way they would on a wired network. The primary difference is how the data is transmitted. In a LAN, data is transmitted over physical cables in a series of Ethernet packets containing. In a WLAN, data is transmitted over the air using one of the IEEE 802.11 protocols.WLAN Stands for "Wireless Local Area Network." A WLAN, or wireless LAN, is a network that allows devices to connect and communicate wirelessly. Unlike a traditional wired LAN, in which devices communicate over Ethernet cables, devices on a WLAN communicate via Wi-Fi.

There are two basic structures for WLANs:
-Ad hoc Networks
-Infrastructure Networks
Both topologies are supported in IEEE 802.11.

Ad hoc Networks

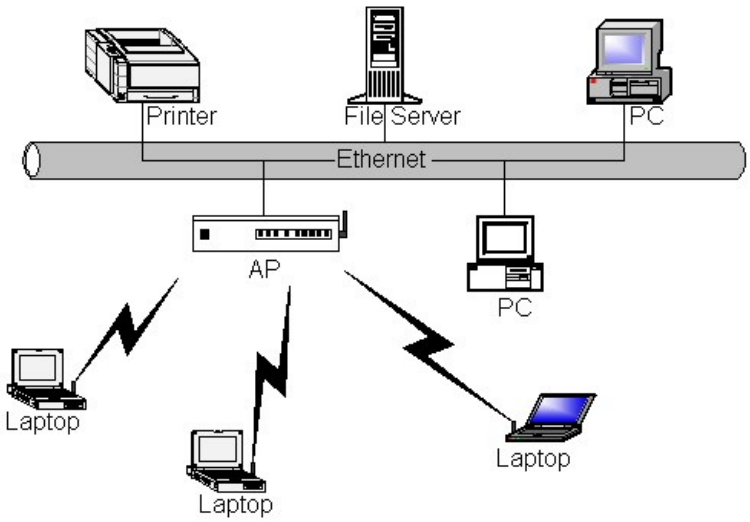
Ad hoc network is also known as IBSS (Independent Basic Service Set) configuration. Logically, this configuration is analogous to a peer-to-peer office network in which no single node is required to function as a server. Ad hoc WLANs include a number of nodes or wireless stations that communicate directly with one another on a peer-to-peer basis, without using an access point (AP) or any connection to a wired network.



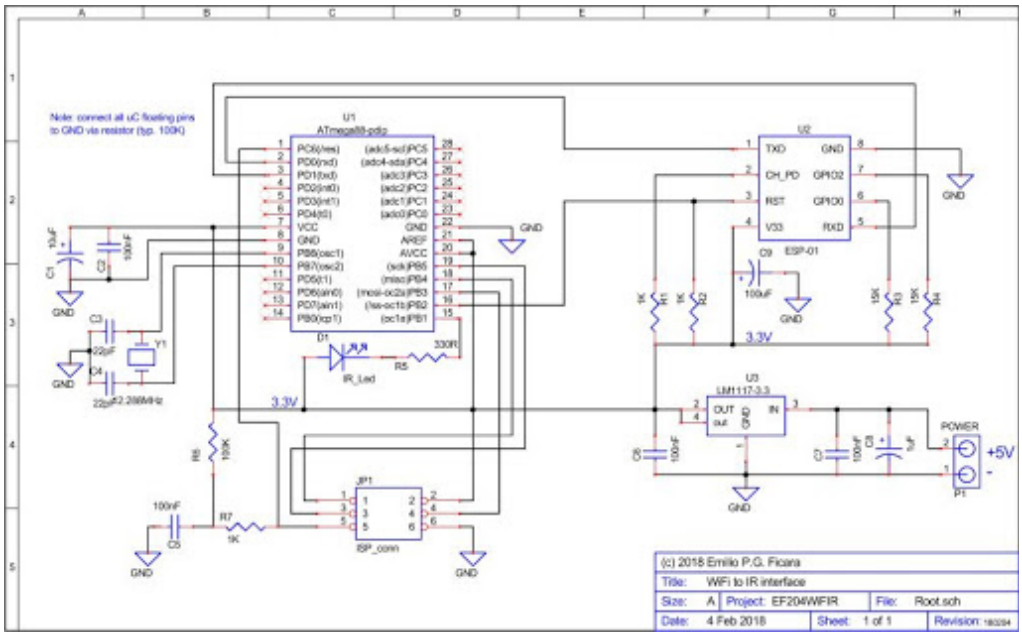
IBSS is useful for quickly and easily setting up a wireless network at anyplace where a wireless infrastructure does not exist or is not required for services, such as a hotel room, convention center, or airport, or where access to the wired network is barred (such as for consultants at a client site). Generally, Ad hoc implementations cover a limited area and aren’t connected to any larger network.

Infrastructure Networks

In this mode - also called an AP topology - client devices link up to a wired network through an access point (AP). This is a more common configuration emphasizing that the WLAN does not replace the wired LAN but extends the functionality to wireless devices. A single AP can typically support between 15 and 250 users depending on technology, configuration and usage with a range of between 20 and 500m [1]. This is called a Basic service Set (BSS). WLANs are scalable with multiple APs to reduce congestion and increase the coverage area. A set of two or more APs forming a subnetwork is called an Extended Service Set (ESS).



Schematic View:

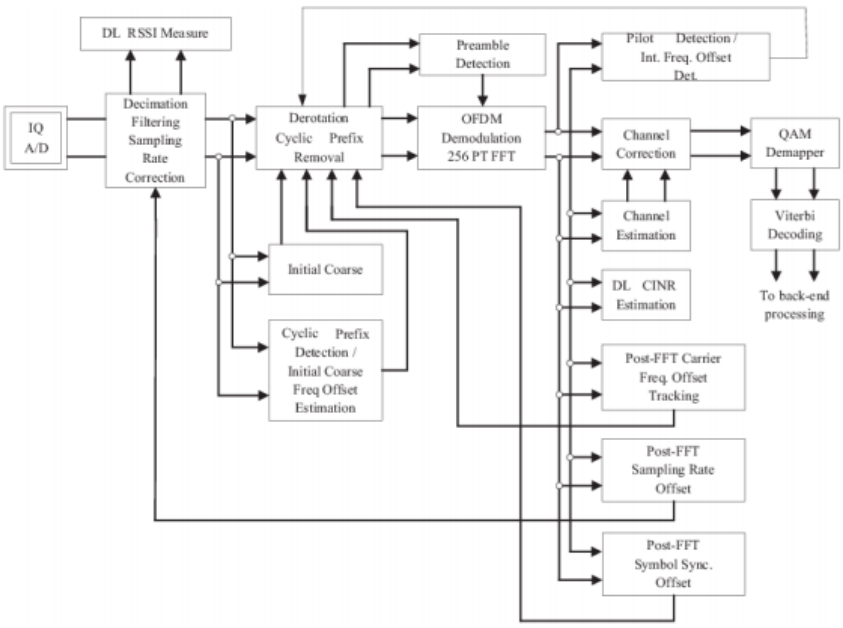


3.WiMAX(IEEE 802.16)

The IEEE 802.16, the Air Interface for Fixed Broadband Wireless Access Systems, also known as the IEEE WirelessMAN air interface, is an emerging suite of standards for fixed, portable and mobile BWA in MAN. These standards are issued by IEEE 802.16 work group that originally covered the wireless local loop (WLL) technologies in the 10.66 GHz radio spectrum, which were later extended through amendment projects to include both licensed and unlicensed spectra from 2 to 11 Ghz.

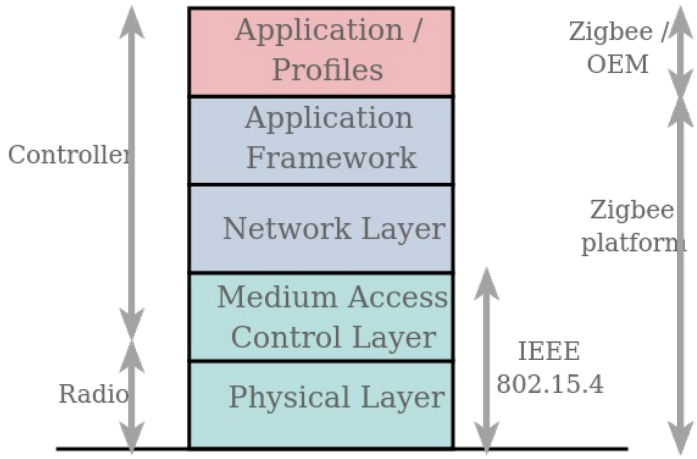
Characteristics	802.16	802.16a	802.16e
Spectrum	10 -66 GHz	2-11 GHz	< 6 GHz
Configuration	Line of sight	Non-line of sight	Non-line of sight
Bit rate	32 to 134 Mbps	< 70 or 100Mbps	Upto 15 Mbps
Modulation	QPSK, 16-QAM, 64-QAM	256 Sub-Carrier OFDM using QPSK, 16-QAM, 64-QAM, 256-QAM	256 Sub-Carrier OFDM using QPSK, 16-QAM, 64-QAM, 256-QAM
Mobility	Fixed	Fixed	< 75 MPH
Channel Bandwidth	20, 25, 28 MHz	Selectable 1.25-20 MHz	5 MHz (Planned)
Typical Cell Radius	1-3 Miles	1-3 Miles	1-3 Miles
Scalability	WAN	WAN	WAN

Schematic View:



4.ZIGBEE(IEEE 802.15. 4)

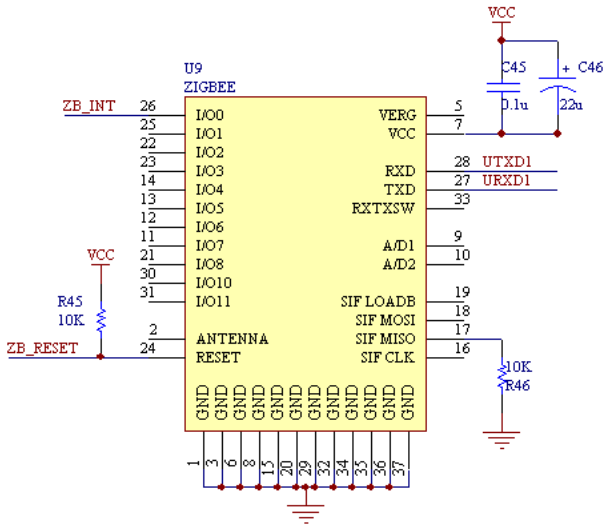
Zigbee is a wireless technology developed as an open global standard to address the unique needs of low-cost, low-power wireless IoT networks. The Zigbee standard operates on the IEEE 802.15.4 physical radio specification and operates in unlicensed bands including 2.4 GHz, 900 MHz and 868 Mhz.



The technology defined by the Zigbee specification is intended to be simpler and less expensive than other wireless personal area networks (WPANs), such as Bluetooth or more general wireless networking such as Wi-Fi.

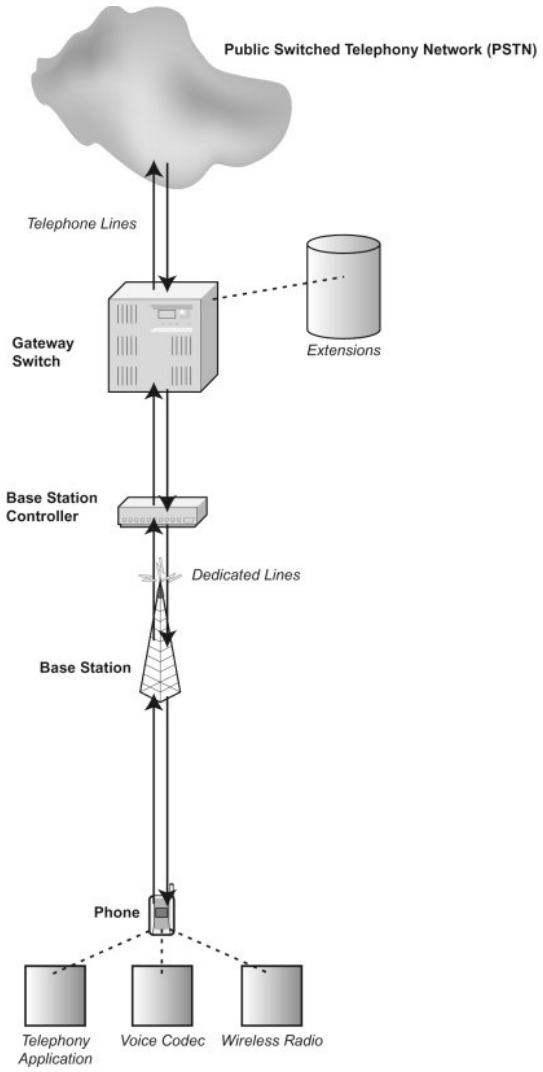
	Z-Wave	ZigBee	WeMo	Thread
Operating range	100 feet	35 feet	100 feet	100 feet (theoretical)
Max no. devices	232	65,000	Router-dependent	250-300
Data rate	9.6-100 kbps	40-250 kbps	Router-dependent	250 kbps
Frequency	908/916 MHz (U.S.)	915 MHz/2.4 GHz	2.4 GHz	2.4 GHz
Network type	Mesh	Mesh	Star	Mesh
Needs hub?	Yes	Yes	No	Yes

Schematic View:



5.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.



Cellular network technologies are often split into 2nd generation 2G, 3G and 4G networks. Originally **2G networks** were voice centric or even voice only digital cellular systems (as opposed to the analog 1G networks). Typical 2G standards include GSM and IS-95 with extensions via GPRS, EDGE and 1xRTT, providing Internet access to users of originally voice centric 2G networks. Both EDGE and 1xRTT are 3G standards, as defined by the ITU, but are usually marketed as 2.9G due to their comparatively low speeds and high delays when compared to true 3G technologies.

True **3G systems** such as EV-DO, W-CDMA (including HSPA) provide combined circuit switched and packet switched data and voice services from the outset, usually at far better data rates than 2G networks with their extensions. All of these services can be used to provide combined mobile voice access and Internet access at remote locations.

4G networks provide even higher bitrates and many architectural improvements, which are not necessarily visible to the consumer. The current 4G systems that are deployed widely are HSPA+, WIMAX and LTE. The latter two are pure packet based networks without traditional voice circuit capabilities. These networks provide voice services via VoIP.

Features	1G	2G	3G	4G	5G
Start/Devlopment	1970/1984	1980/1999	1990/2002	2000/2010	2010/2015
Technology	AMPS, NMT, TACS	GSM	WCDMA	LTE, WiMax	MIMO, mm Waves
Frequency	30 KHz	1.8 Ghz	1.6 - 2 GHz	2 - 8 GHz	3 - 30 Ghz
Bandwidth	2 kbps	14.4 - 64 kbps	2 Mbps	2000 Mbps to 1 Gbps	1 Gbps and higher
AccessSystem	FDMA	TDMA/CDMA	CDMA	CDMA	OFDM/BDMA
Core Network	PSTN	PSTN	Packet Network	Internet	Internet

Major telecommunications providers have deployed voice and data cellular networks over most of the inhabited land area of Earth. This allows mobile phones and mobile computing devices to be connected to the public switched telephone network and public Internet. Private cellular networks can be used for research or for large organizations and fleets, such as dispatch for local public safety agencies or a taxicab company.

CONCLUSION:1. In the above experiment, I learned about various wired and wireless connections in physical layer of OSI reference model.
2. I understood the scalability factors like the range, data rate, modulation, etc.

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