

NAME: BHARGAVI S POYEKAR

BATCH: C

UID NO: 2018130040

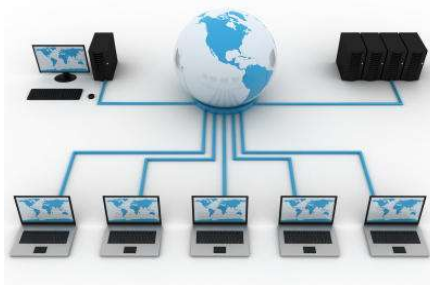
DATE: 09/08/2020

EXPERIMENT 1

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

➤ WIRED CONNECTIONS:

A wired network uses cables to connect devices, such as laptop or desktop computers, to the Internet or another network. A wired network allows for a faster and more secure connection and can only be used for distances shorter than 2,000 feet.



➤ WIRELESS CONNECTIONS:

A wireless network, which uses high-frequency radio waves rather than wires to communicate between nodes, is another option for home or business networking. Wireless allows for devices to be shared without networking cable which increases mobility but decreases range.



IEEE shorthand identifiers, such as 10Base5, 10Base2, 10BaseT, and 10BaseF include three pieces of information:

- **The number 10:** At the front of each identifier, 10 denotes the standard data transfer speed over these media - ten megabits per second (10Mbps).
- **The word Base:** Short for Baseband, this part of the identifier signifies a type of network that uses only one carrier frequency for signalling and requires all network stations to share its use.
- **The segment type or segment length:** This part of the identifier can be a digit or a letter:
 - Digit - shorthand for how long (in meters) a cable segment may be before attenuation sets in. For example, a 10Base5 segment can be no more than 500 meters long.
 - Letter - identifies a specific physical type of cable. For example, the T at the end of 10BaseT stands for twisted-pair.

TYPES OF WIRED CONNECTIONS:

- Ethernet - IEEE 802.3: [7]

Ethernet is the fastest wired network protocol, with connection speeds of 10 megabits per second (Mbps) to 100 Mbps or higher.

Different variants of Ethernet technologies are designated according to the type and diameter of the cables used as given below:

- 10Base2: The cable used is a thin coaxial cable: thin Ethernet.
- 10Base5: The cable used is a thick coaxial cable: thick Ethernet.
- 10Base-T: The cable used is a twisted-pair and the speed achieved is around 10 Mbps.

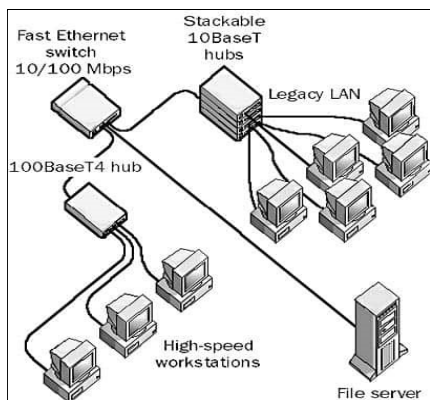
There are several types of Ethernet networks, such as Fast Ethernet and Gigabit Ethernet.

1. FAST ETHERNET (IEEE 802.3u): [6]

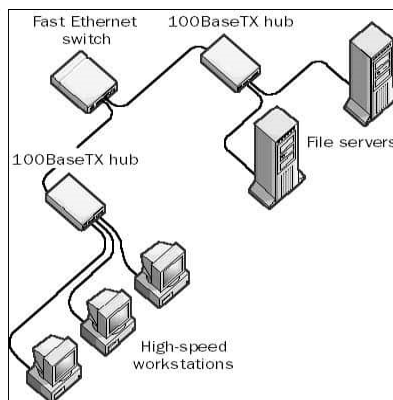
- ✓ Fast Ethernet was introduced in 1995 as the IEEE 802.3u standard and remained the fastest version of Ethernet for three years before the introduction of Gigabit Ethernet.
- ✓ They are generally wired in a star topology using special Fast Ethernet hubs and switches.
- ✓ Modulation: PAM-3 (Pulse Amplitude Modulation).
- ✓ Fast Ethernet can be implemented in three different transmission schemes or cabling options:

Fast Ethernet [IEEE 802.3u]

Name	Cable	Max. segment	Advantages
100Base-T4	Twisted pair	100 m	Uses category 3 UTP
100Base-TX	Twisted pair	100 m	Full duplex at 100 Mbps
100Base-FX	Fiber optics	2000 m	Full duplex at 100 Mbps; long runs



100Base-T4



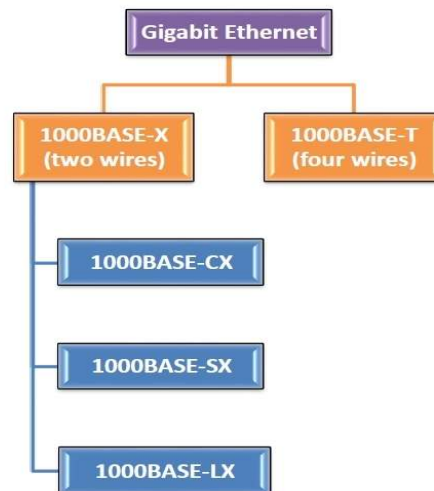
100Base-TX



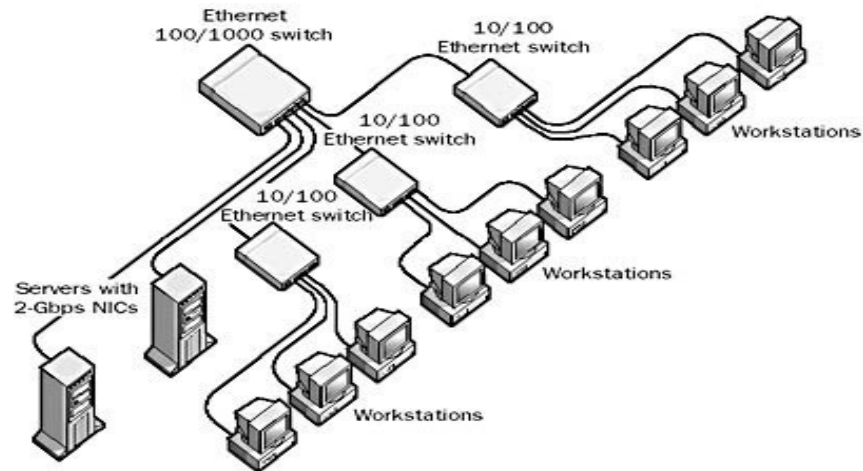
100Base-FX

2. GIGABIT ETHERNET (IEEE 802.3ab): [5]

- ✓ 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 carried primarily on optical fiber (with very short distances possible on copper media).
- ✓ Existing Ethernet LANs with 10 and 100 Mbps cards can feed into a Gigabit Ethernet backbone.
- ✓ Modulation: Four dimensional Trellis Code Modulation (TCM).
- ✓ The popular varieties of fast Ethernet are 1000Base-SX, 1000Base-LX, 1000BASE-T and 1000Base-CX.



Name	Standard	Cable	Max Segment	Encoding
1000Base-CX	802.3z	STP cables	25 metres	NRZ-8B/6B
1000Base-SX	802.3z	Fibre Optic cables	220 – 550 metres	NRZ-8B/6B
1000Base-LX	802.3z	Fibre Optic cables	500 metres	NRZ-8B/6B
1000Base-T	802.ab	Twisted Pair	100 metres	trellis code

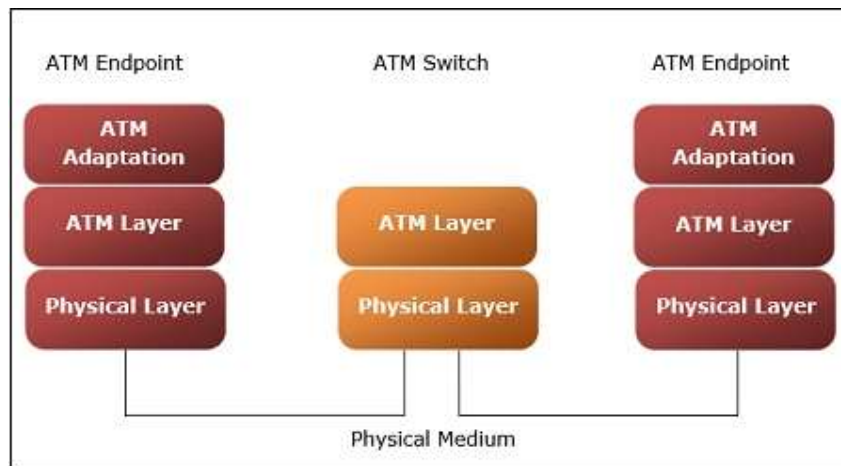


GIGABIT ETHERNET

Alternate technologies of Ethernet include the “Token Ring” protocol designed by IBM, and the robust Asynchronous Transfer Mode (ATM) technology. ATM allows devices to be connected over very long distances to create WANs (Wide Area Networks) that behave like LANs.

- **ATM and ATM Networks:** [4]

- ✓ ATM stands for Asynchronous Transfer Mode. It is a switching technique that uses time division multiplexing (TDM) for data communications.
- ✓ ATM networks are connection-oriented networks for cell relay that supports voice, video and data communications. It encodes data into small fixed - size cells so that they are suitable for TDM and transmits them over a physical medium.
- ✓ The size of an ATM cell is 53 bytes: 5-byte header and 48-byte payload. There are two different cell formats - user-network interface (UNI) and network-network interface (NNI). The below image represents the Functional Reference Model of the Asynchronous Transfer Mode.



ATM reference model comprises of three layers:

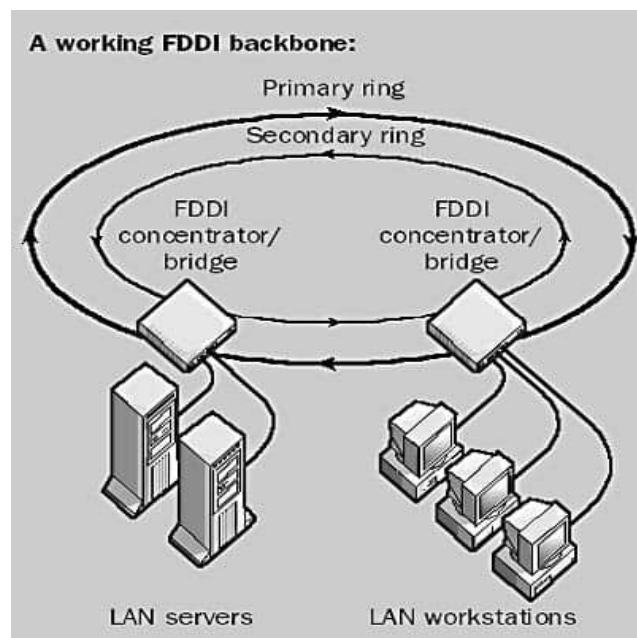
- **Physical Layer** – This layer corresponds to physical layer of OSI model. At this layer, the cells are converted into bit streams and transmitted over the physical medium. This layer has two sub layers: PMD sub layer (Physical Medium Dependent) and TC (Transmission Convergence) sub layer.
- **ATM Layer** – This layer is comparable to data link layer of OSI model. It accepts the 48 byte segments from the upper layer, adds a 5 byte header to each segment and converts into 53 byte cells. This layer is responsible for routing of each cell, traffic management, multiplexing and switching.
- **ATM Adaptation Layer (AAL)** – This layer corresponds to network layer of OSI model. It provides facilities to the existing packet switched networks to connect to ATM network and use its services. It accepts the data and converts them into fixed sized segments. The transmissions can be of fixed or variable data rate. This layer has two sub layers – Convergence sub layer and Segmentation and Reassembly sub layer.
- **ATM endpoints** – It contains ATM network interface adaptor. Examples of endpoints are workstations, routers, CODECs, LAN switches, etc.
- **ATM switch** – It transmits cells through the ATM networks. It accepts the incoming cells from ATM endpoints (UNI) or another switch (NNI), updates cell header and retransmits cell towards destination.

- **Fiber Distribution Data Interface (FDDI):** [8]

- ✓ Fiber Distributed Data Interface (FDDI) is a set of ANSI and ISO standards for transmission of data in local area network (LAN) over fiber optic cables.
- ✓ It is applicable in large LANs that can extend up to 200 kilometers in diameter.
- ✓ Modulation: ADPCM (Adaptive differential pulse-code modulation).

Features:

- FDDI uses optical fiber as its physical medium.
- It provides high data rate of 100 Mbps and can support thousands of users.
- It is used in LANs up to 200 kilometres for long distance voice and multimedia communication.
- It uses ring-based token passing mechanism and is derived from IEEE 802.4 token bus standard.
- It contains two token rings, a primary ring for data and token transmission and a secondary ring that provides backup if the primary ring fails.
- FDDI technology can also be used as a backbone for a wide area network (WAN).



- USB: [13]

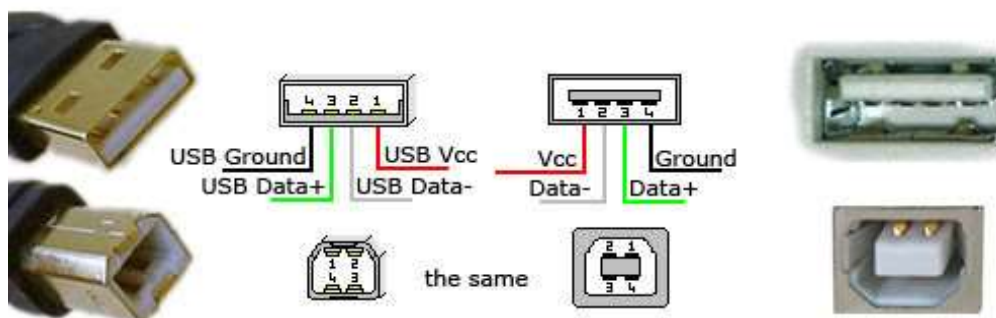
Universal Serial Bus is an industry standard that establishes specifications for cables and connectors and protocols for connection, communication and power supply between computers, peripherals and other computers.

➤ USB Speeds:

- USB 1.x: 12 Mbps
- USB 2.0 (high speed USB): 480 megabits per second (Mbps), or 60 megabytes per second (MBps).
- USB 3.0 (superspeed USB): 5.0 gigabits per second (Gbps), or 640 megabytes per second (MBps).
- USB 3.1 (Superspeed+): 10 Gbps.
- USB 3.2: 20 Gbps.

- USB networks use a tiered-star topology.
- Range: Maximum - 16 feet.
- Modulation: Pulse Width Modulation.
- Frequency Range: 480 MHz - 960 MHz.
- Used in PAN.

USB pinout



USB is a serial bus. It uses 4 shielded wires: two for power (+5v & GND) and two for differential data signals (labelled as D+ and D- in pinout)

http://pinouts.ru/Slots/USB_pinout.shtml

TYPES OF WIRELESS CONNECTIONS:[1]

- WIFI(IEEE 802.11): [2],[3]

The 802.11 standard is defined through several specifications of WLANs. It defines an over-the-air interface between a wireless client and a base station or between two wireless clients.

There are several specifications in the 802.11 family –

➤ 802.11

- This pertains to wireless LANs.
- Speed - 1 - or 2-Mbps
- Frequency Band: 2.4-GHz band.
- Transmission Range: 20 feet indoors.
- Modulation: DSSS (Direct Sequence Spread Spectrum), FHSS (Frequency-hopping spread spectrum).

➤ 802.11a –

- This is an extension to 802.11 that pertains to wireless LANs.
- Speed: 54 Mbps.
- Frequency Band: 5-GHz band.
- Transmission Range: 25 to 75 feet indoors.
- Modulation: OFDM(Orthogonal Frequency Division Multiplexing).

➤ 802.11b –

- The 802.11 high rate WiFi is an extension to 802.11 that pertains to wireless LANs
- Speed: 11 Mbps transmission (with a fallback to 5.5, 2, and 1 Mbps depending on strength of signal)
- Frequency Band: 2.4-GHz band.
- Transmission Range: Up to 150 feet.
- Modulation: DSSS (Direct Sequence Spread Spectrum).

- 802.11g –
 - This pertains to wireless LANs.
 - Speed: provides 20+ Mbps.
 - Frequency Band: 2.4-GHz band.
 - Transmission Range: Up to 150 feet.
 - Modulation: OFDM.

- 802.15 family of Wireless PAN: [9]

The 802.15 standard is defined through several specifications of WPANs.

- 802.15.1(Bluetooth):

- ✓ 802.15.1, more commonly known as Bluetooth, is a low-data-rate, lowpower wireless networking standard aimed at replacing cables between lightweight devices.
- ✓ A Bluetooth network is called piconet and a collection of interconnected piconets is called scatternet.
- ✓ Bluetooth has master slave configuration.

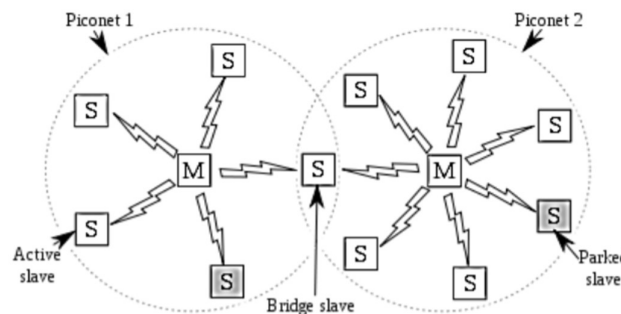


Fig. SCATTERNET

- 802.15.4 ZigBee:

- ✓ The IEEE 802.15.4 standard is defined for very low-power, low-duty network links.
- ✓ This standard is intended for deployment on long-lived systems with low data rate requirements, where devices must be able to operate autonomously for months or even years without recharging the battery.

- ✓ The 802.15.4 standard only defines the PHY and MAC layers.
- ✓ ZigBee builds on top of 802.15.4's radio layer, specifying network, security, and application layers.

Name	Bluetooth (802.15.1)	802.15.4 ZigBee
Radio Spectrum	2.4 GHz	868 MHz, 915 MHz, 2.4 GHz
Max. Data Rate	3 Mbps	250Kbps
Radio Power	< 100mW	> 1mW
Max Range	1m – 100m	1m – 100m
Network Topology	cluster	Star, cluster, Mesh
Application	Low-bandwidth	cable replacement Sensors, home automation
Modulation techniques	PSK, FSK, SS	PSK, ASK, SS

PSK: Phase Shift-keying.

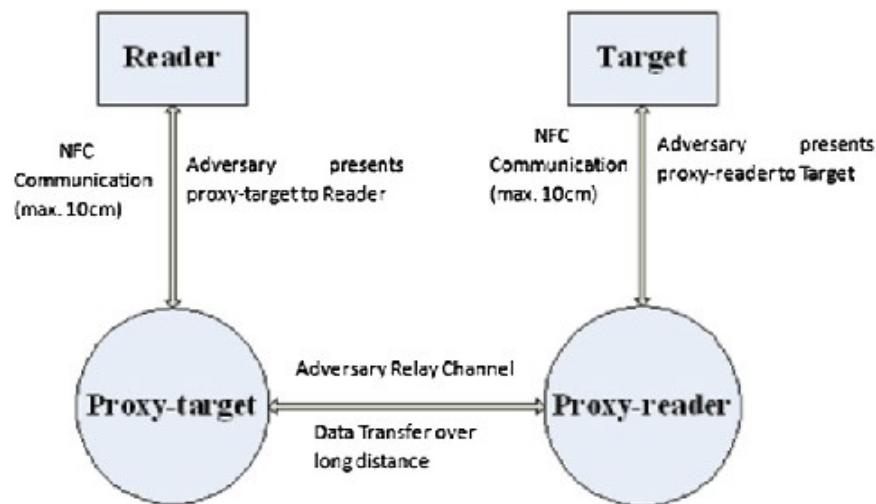
FSK: Frequency Shift-keying.

ASK: Amplitude Shift-keying.

SS: Spread Spectrum



- NFC: [12]
 - Near-Field-Communication (NFC) is a set of communication protocols for communication between two electronic devices over a distance of 4 cm (1½ in) or less. NFC offers a low-speed connection with simple setup that can be used to bootstrap more-capable wireless connections.
 - Network Type: Point-to-point
 - Range: <20cm
 - Frequency: 13.56 MHz.
 - Bit Rate: 424 Kbit/s.
 - With NFC, instead of performing manual configurations to identify devices, the connection between two NFC devices is automatically established in less than .1 second.



- IEEE 802.16 WiMAX: [9].
 - 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.
 - The 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
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
Bit rate	32 to 134 Mbps	< 70 or 100Mbps	Upto 15 Mbps
Channel Bandwidth	20, 25, 28 MHz	Selectable 1.25-20 MHz	5 MHz (Planned)

- **CELLULAR NETWORKS: [10]**

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.

- **3G: [11]**

- 3G is short for 3GPP, with its full name is the 3rd Generation Partner Project, so it is also referred to as the third generation.
- Speed: 3G (Basic) - 0.3 Mbit/s, H- 7.2 Mbit/s, H+ - 21Mbit/s.
- Frequency Band: 1.8 - 2.5 GHz.
- Modulation Technique: QAM and QPSK.
- Bandwidth: 5-20 MHz

- 4G: [11]
 - 4G is the short name for fourth-generation wireless, the stage of broadband mobile communications that will supercede the third generation (3G).
 - Speed: Up to 20 Mbps or more.
 - Frequency Band: 2 - 8 GHz.
 - Bandwidth: 5-20 MHz
 - Modulation Technique: OFDM.

- LIFI: [14]
 - Li-Fi (short for *light fidelity*) is wireless communication technology which utilizes light to transmit data and position between devices.
 - In technical terms, Li-Fi is a light communication system that is capable of transmitting data at high speeds over the visible light, ultraviolet, and infrared spectrums. In its present state, only LED lamps can be used for the transmission of visible light.
 - In terms of its end use, the technology is similar to Wi-Fi -- the key technical difference being that Wi-Fi uses radio frequency to induce a voltage in an antenna to transmit data. Whereas Li-Fi uses the modulation of light intensity to transmit data.
 - Li-Fi can theoretically transmit at speeds of up to 100 Gbit/s.
 - Frequency: 10,000 times frequency spectrum of the radio.
 - Range: About 10 meters.
 - Modulation: Single Carrier Modulation.
 - This pertains to wireless LANs.

REFERENCES:

1. <https://www.link-labs.com/blog/complete-list-iot-network-protocols>
2. https://www.tutorialspoint.com/wi-fi/wifi_ieee_standards.htm
3. <https://www.tutorialspoint.com/Wireless-LAN-and-IEEE-802-11>
4. https://en.wikipedia.org/wiki/Asynchronous_transfer_mode
5. <https://searchnetworking.techtarget.com/definition/Gigabit-Ethernet>
6. <https://networkencyclopedia.com/fast-ethernet/>
7. <https://www.elprocus.com/what-is-ethernet-and-different-types-of-ethernet-networks/>
8. <https://searchnetworking.techtarget.com/definition/FDDI>
9. <https://www.cse.wustl.edu/~jain/cse574-06/ftp/wpans/index.html>

10. <https://www.gearbest.com/blog/how-to/global-network-types-2g-3g-4g-5g-2843>
11. <https://www3.nd.edu/~mhaenggi/NET/wireless/4G/>
12. https://en.wikipedia.org/wiki/Near-field_communication
13. <https://en.wikipedia.org/wiki/USB>
14. <https://en.wikipedia.org/wiki/Li-Fi>