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Batch B

Exp 1 : Study of different types of physical layer wired/wireless connections

In the seven-layer OSI model of computer networking, the physical layer or layer 1 is the first and lowest layer. The physical layer defines the means of transmitting raw bits over a physical data link connecting network nodes. The bitstream may be grouped into code words or symbols and converted to a physical signal that is transmitted over a transmission medium.

1) Functions of Physical Layer :

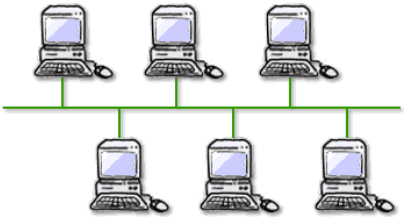
- Physical Layer is the lowest layer of the OSI Model.
- It activates, maintains and deactivates the physical connection.
- It is responsible for transmission and reception of the unstructured raw data over network.
- Voltages and data rates needed for transmission is defined in the physical layer.
- It converts the digital/analog bits into electrical signal or optical signals.
- Data encoding is also done in this layer.

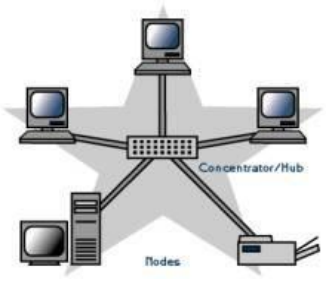
2) Range and Modulation

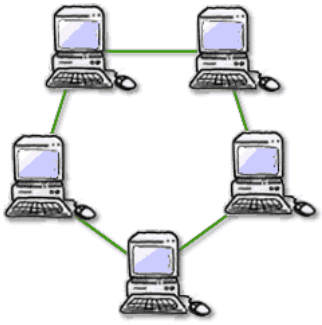
Wired networking has different hardware requirements and the range and benefits are different. Wireless networking takes into consideration the range, mobility, and the several types of hardware components needed to establish a wireless network.

Wired Network

Typically the range of a wired network is within a 2,000-foot-radius. The disadvantage of this is that data transmission over this distance may be slow or nonexistent. The benefit of a wired network is that bandwidth is very high and that interference is very limited through direct connections. Wired networks are more secure and can be used in many situations; corporate LANs, school networks and hospitals. The biggest drawback to this type of network is that it must be rewired every time it is moved.







The media carries signals, one at a time, to represent the bits that make up the frame. There are three basic forms of network media on which data is represented also The representation of the bits - that is, the type of signal - depends on the type of media :

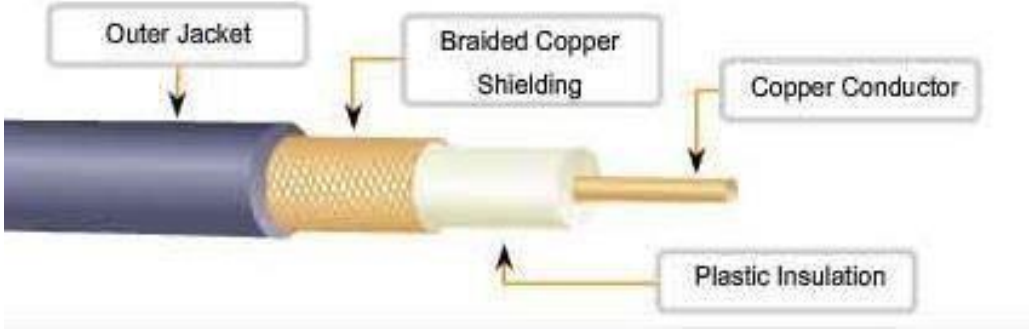
- For **Copper cable** media, the signals are patterns of electrical pulses.

The most commonly used media for data communications is cabling that uses copper wires to signal data and control bits between network devices

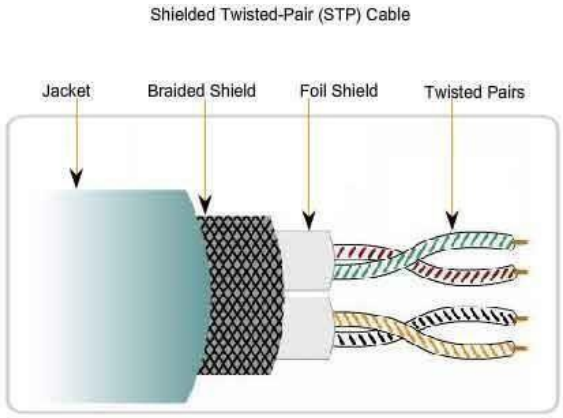
Unshielded Twisted Pair (UTP) Cable

Two other types of copper cable are used:

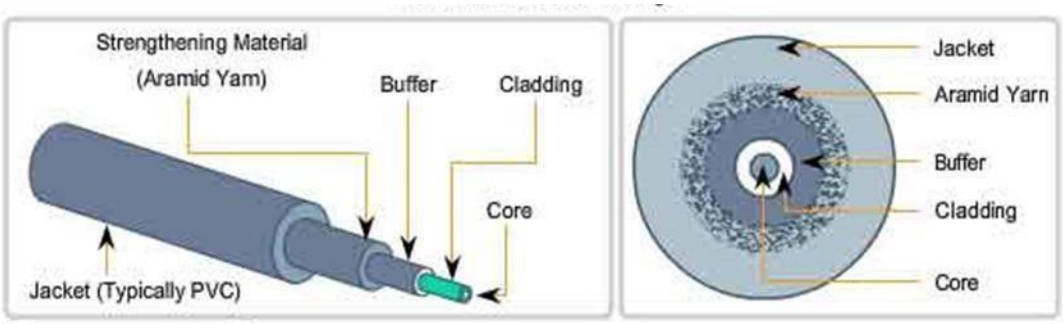
. Coaxial Cable



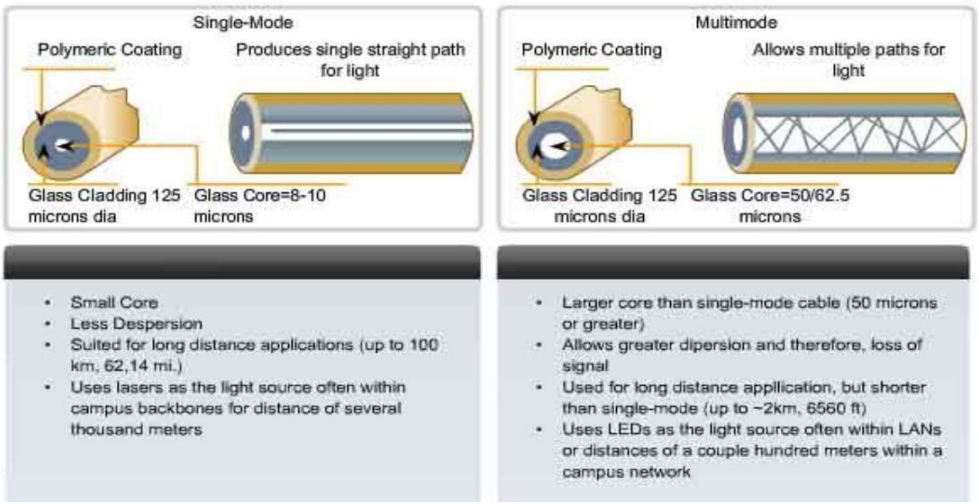
. Shielded Twisted-Pair (STP) Cable



- For **Fiber**, the signals are patterns of light.



Single-mode and Multimode Fiber :



- For **Wireless Media,** the signals are patterns of radio transmission

LAN Technology Specifications

Name	IEEE Standard	Data Rate	Media Type	Maximum Distance
Ethernet	802.3	10 Mbps	10Base-T	100 meters
Fast Ethernet/ 100Base-T	802.3u	100 Mbps	100Base-TX 100Base-FX	100 meters 2000 meters
Gigabit Ethernet/ GigE	802.3z	1000 Mbps	1000Base-T 1000Base-SX 1000Base-LX	100 meters 275/550 meters 550/5000 meters
10 Gigabit Ethernet	IEEE 802.3ae	10 Gbps	10GBase-SR 10GBase-LX4 10GBase-LR/ER 10GBase-SW/LW/EW	300 meters 300m MMF/ 10km SMF 10km/40km 300m/10km/40km

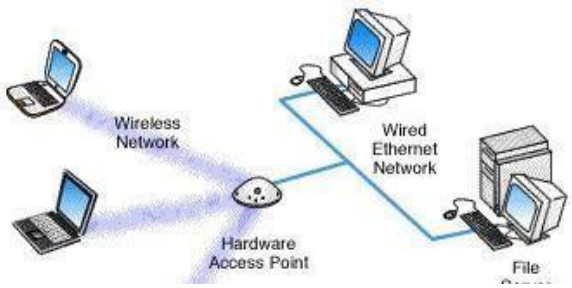
Physical Media - Characteristics

Ethernet Media

	10BASE-T	100BASE-TX	100BASE-FX	1000BASE-CX	1000BASE-T	1000BASE-SX	1000BASE-LX	1000BASE-ZX	10GBASE-ZR
Media	EIA/TIA Category 3, 4, 5 UTP - four pair	EIA/TIA Category 5 UTP - two pair	50/62.5 mmulti mode fiber	STP	EIA/TIA Category 5 (or greater) UTP, four pair	50/62.5 micron multimode fiber	50/62.5 micron multimode fiber or 9 micron single mode fiber	9m single mode fiber	9m single mode fiber
Maximum Segment Length	100m (328 feet)	100m (328 feet)	2 km (6562 ft)	25 m (82 feet)	100 m (328 feet)	Up to 550 m (1,804 ft) depending on fiber used	550 m (MMF)10 km (SMF)	Approx. 70 km	Up to 80 km
Topology	Star	Star	Star	Star	Star	Star	Star	Star	Star
Connector	ISO 8877 (RJ-45)	ISO 8877 (RJ-45)		ISO 8877 (RJ-45)	ISO 8877 (RJ-45)				

3) Wireless Media :

Wireless media carry electromagnetic signals at radio and microwave frequencies that represent the binary digits of data communications. As a networking medium, wireless is not restricted to conductors or pathways, as are copper and fiber media. Wireless data communication technologies work well in open environments. However, certain construction materials used in buildings and structures, and the local terrain, will limit the effective coverage. As there is no access to a physical strand of media, devices and users who are not authorized for access to the network can gain access to the transmission. Therefore, network security is a major component of wireless network administration.



range

Wireless allows for devices to be shared without networking cable which increases mobility but decreases range. Wireless networks are reliable, but when interfered with it can reduce the range and the quality of the signal. Interference can be caused by other devices operating on the same radio frequency and it is very hard to control the addition of new devices on the same frequency. Usually if your wireless range is compromised considerably, more than likely, interference is to blame. Mobile computers do not need to be tied to an Ethernet cable and can roam freely within the wireless network range

Wireless Protocols

Specification	Data Rate	Modulation Scheme	Security

802.11	1 or 2 Mbps in the 2.4 GHz band	FHSS, DSSS	WEP and WPA
802.11a	54 Mbps in the 5 GHz band	OFDM	WEP and WPA
802.11b/High Rate/Wi-Fi	11 Mbps (with a fallback to 5.5, 2, and 1 Mbps) in the 2.4 GHz band	DSSS with CCK	WEP and WPA
802.11g/Wi-Fi	54 Mbps in the 2.4 GHz band	OFDM when above 20Mbps, DSSS with CCK when below 20Mbps	WEP and WPA

Protocol	Standard	Frequency	Data Rate	Network Type	Network Size	Range	Power
Wi-Fi	IEEE 802.11	2.4 / 5.0 GHz	Up to 72 Mbps[2]	Star	100	40-100m	High
Bluetooth	Bluetooth SIG	2.4 GHz	1 – 3 Mbps	P2P, Star	8	40-100m	Medium
Bluetooth LE	Bluetooth SIG	2.4 GHz	125 kbps – 2 Mbps	P2P, Star, Broadcast	20[3]	40-1000m	Low
Bluetooth Mesh	Bluetooth SIG	2.4 GHz	125 kbps – 2 Mbps	Mesh	32768	40-100m	Medium to low
ZigBee	IEEE 802.15.4	2.4 GHz	250 kbps	Mesh	250+[1]	40-100m	Medium
Thread	IEEE 802.15.4	2.4 GHz	250 kbps	Mesh	250+[1]	40-100m	Medium
Z-Wave	proprietary	868 - 926 MHz	100 kbps	Mesh	232	40-100m	Medium
NFC	ISO 13157	13.56 MHz	106 kbps - 424 kbps	P2P	2	1-10cm	Low
Sigfox	proprietary	868 MHz – Europe 915 MHz – US 921 MHz – Japan	0.1 kbps	Star	very large[4]	10-50km	Medium
LoRaWAN	proprietary	433 MHz, 868 MHz, 915 MHz (137 MHz – 1020 MHz)	Down:290 bps Up: 50 kbps	Star	very large[4]	5-15km	Medium
LTE Cat 1	3GPP	700 MHz - 2.6 GHz 452.5 – 467.5 MHz	Down:10 Mbps Up: 5 Mbps	Star	very large[4]	1km	Very high
LTE-M	3GPP	700 MHz – 2.2 GHz 452.5 – 467.5 MHz	1 Mbps	Star	very large[4]	5km	High
NB-IoT	3GPP	700 MHz – 2.2 GHz 452.5 – 467.5 MHz	~200 kbps	Star	very large[4]	5km	High

7) Wired vs. Wireless Networking

Although wireless networking is a lot more mobile than wired networking the range of the network is usually 150-300 indoors and up to 1000 feet outdoors depending on the terrain The greater mobility of wireless LANs helps offset the performance disadvantage. Mobile computers do not need to be tied to an Ethernet cable and can roam freely within the wireless network range
A wired network allows for a faster and more secure connection and can only be used for distances shorter than 2,000 feet

Scalability showing their applicability in various network architecture e.g LAN, WAN, MAN, HAN etc

For the most part, the differentiating factor in the types of networks is how large of a system it is, or how many devices are included in the network's area, as well as how those devices are connected to one another.

LAN

The most basic and common type of network, a LAN, or local area network, is a network connecting a group of devices in a "local" area, usually within the same building The defining characteristics of a LAN, in contrast to a wide area network (WAN), include higher data transfer rates, limited geographic range, and lack of reliance on leased lines to provide connectivity. Current Ethernet or other IEEE 802.3 LAN technologies operate at data transfer rates up to 100 Gbit/s

A WLAN, or wireless LAN, is a subtype of LAN. It uses WiFi to make the LAN wireless through the use of a wireless router.

HAN

A HAN, or home area network, is a network connecting devices within a home. These networks are a type of LAN. All the devices inside the household, including computers, smartphones, game consoles, televisions, and home assistants that are connected to the router are a part of the HAN.

CAN

A CAN, or campus area network, usually comprises several LANs. They cover a campus, connecting several buildings to the main firewall. A university could use a CAN, as could a corporate headquarters.

MAN

Even larger than a CAN, a MAN is a metropolitan area network. These can cover an area as large as a city, linking multiple LANs through a wired backhaul. An example of a MAN would be a citywide WiFi network.

WAN

In contrast to the smaller LAN and HANs, a WAN is a wide area network, covering any distance necessary. The Internet could be considered a WAN that covers the entire Earth.

4) Major Types of Wireless Networks :

Standard IEEE 802.11 - Commonly referred to as Wi-Fi, is a Wireless LAN (WLAN) technology that uses a contention or non-deterministic system with a Carrier Sense Multiple Access/Collision Avoidance (CSMA/CA) media access process.

Standard IEEE 802.15 - Wireless Personal Area Network (WPAN) standard, commonly known as "Bluetooth", uses a device pairing process to communicate over distances from 1 to 100 meters.

Standard IEEE 802.16 - Commonly known as WiMAX (Worldwide Interoperability for Microwave Access), uses a point-to-multipoint topology to provide wireless broadband access.

10) Global System for Mobile Communications (GSM) - Includes Physical layer specifications that enable the implementation of the Layer 2 General Packet Radio Service (GPRS) protocol to provide data transfer over mobile cellular telephony networks.

5) What is CDMA vs GSM vs LTE?

GSM and CDMA are different technologies that phones use to connect. They were both developed in the early nineties for 2G connectivity. But engineers couldn't agree on which one was the best. So, in the US the FCC settled on a "dual-mode" route that required either GSM or CDMA. That's why we have 2 different technologies.

Europeans though, agreed on GSM, as did the rest of the world. That's why GSM is the de-facto system for the rest of the world.

For 3G, carriers only improved the original GSM and CDMA technology. So the duality remained.

Fortunately, engineers agreed on a new cellular system for 4G connectivity. And that's LTE. Carriers designed LTE for data. But it's been working so well that they replacing everything else with it. For example, they've introduced VoIP solutions like VoLTe to replace traditional calls.

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6) The Wireless LAN :

A common wireless data implementation is enabling devices to wirelessly connect via a LAN. In general, a wireless LAN requires the following network devices:

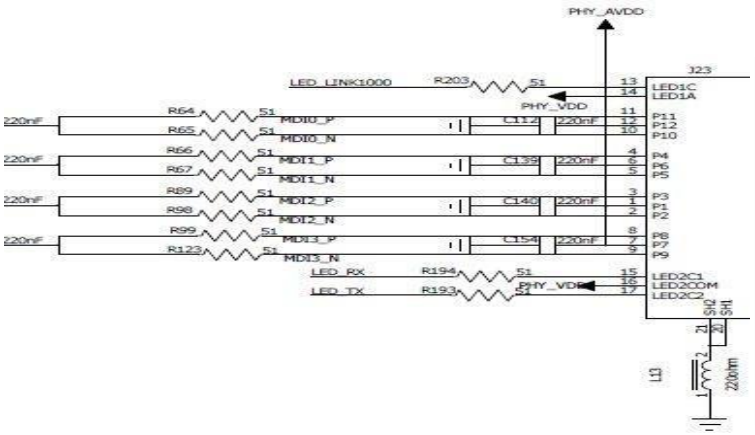
Wireless Access Point (AP) - Concentrates the wireless signals from users and connects, usually through a copper cable, to the existing copper-based network infrastructure such as Ethernet.
Wireless NIC adapters - Provides wireless communication capability to each network host.

11) As the technology has developed, a number of WLAN Ethernet-based standards have emerged. Care needs to be taken in purchasing wireless devices to ensure compatibility

Standards include:

IEEE 802.11a - Operates in the 5 GHz frequency band and offers speeds of up to 54 Mbps
IEEE 802.11b - Operates in the 2.4 GHz frequency band and offers speeds of up to 11 Mbps..
IEEE 802.11g - Operates in the 2.4 GHz frequency band and offers speeds of up to 54 Mbps.
IEEE 802.11n – is standard is currently in draft form. The proposed standard defines frequency of 2.4 Ghz or 5 GHz. The typical expected data rates are 100 Mbps to 210 Mbps with a distance range of up to 70 meters.

8) Provide Schematic view of physical connector RJ45 connector schematic view (10baseT Ethernet)



RJ45 is a type of connector commonly used for Ethernet networking. It looks similar to a telephone jack, but is slightly wider. Since Ethernet cables have an RJ45 connector on each end, Ethernet cables are sometimes also called RJ45 cables.

The "RJ" in RJ45 stands for "registered jack," since it is a standardized networking interface. The "45" simply refers to the number of the interface standard. Each RJ45 connector has eight pins, which means an RJ45 cable contains eight separate wires. If you look closely at the end of an Ethernet cable, you can actually see the eight wires, which are each a different color. Four of them are solid colors, while the other four are striped.

RJ45 cables can be wired in two different ways. One version is called T-568A and the other is T-568B. These wiring standards are listed below:

9) T-568A

1. White/Green (Receive +)
2. Green (Receive -)
3. White/Orange (Transmit +)
4. Blue
5. White/Blue
6. Orange (Transmit -)
7. White/Brown
8. Brown

T-568B

1. White/Orange (Transmit +)
2. Orange (Transmit -)
3. White/Green (Receive +)
4. Blue
5. White/Blue
6. Green (Receive -)
7. White/Brown
8. Brown

References:

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2) https://www.studytonight.com/computer-networks/osi-model-physical-layer
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