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**TE COMPS**

### **Data Communication and Computer Network Lab (DCCN) – EXP1**

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

#### **Physical Layer:**

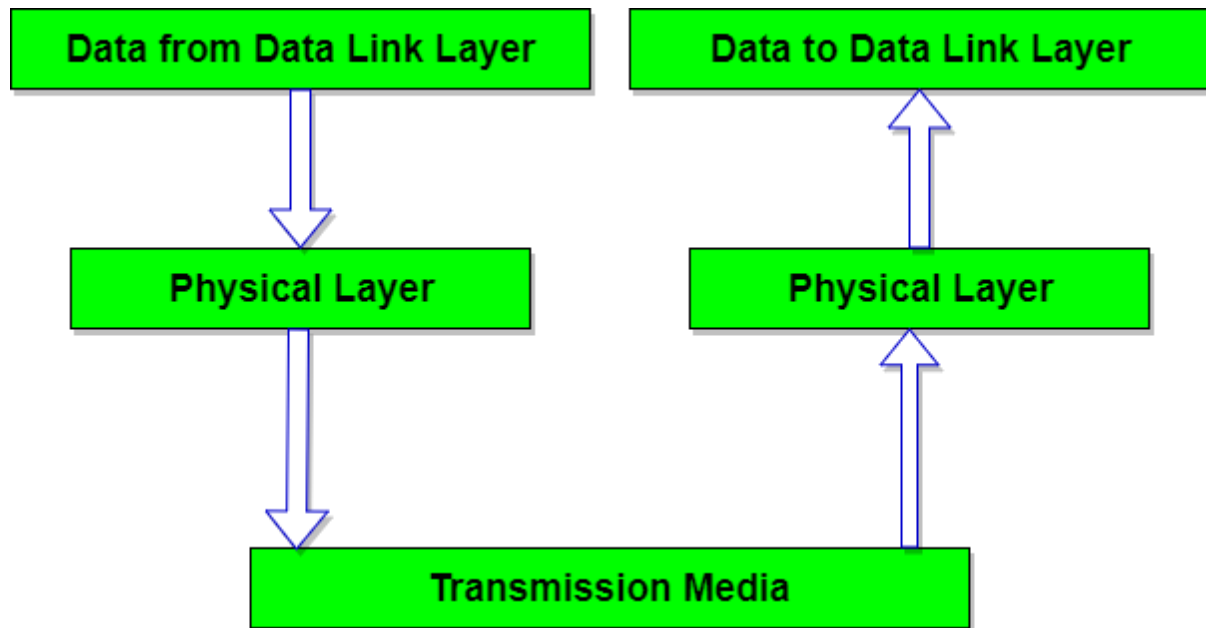
Physical layer is the lowest layer of the OSI reference model. It is responsible for sending bits from one computer to another. This layer is not concerned with the meaning of the bits and deals with the setup of physical connection to the network and with transmission and reception of signals.

#### **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 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.



### **Wired Connection:**

In computing terminology, the term "wired" is used to differentiate between wireless connections and those that involve cables. While wireless devices communicate over the air, a wired setup uses physical cables to transfer data between different devices and computer systems.




A wired network is a common type of wired configuration. Most wired networks use Ethernet cables to transfer data between connected PCs. In a small wired network, a single router may be used to connect all the computers. Larger networks often involve multiple routers or switches that connect to each other. One of these devices typically connects to a cable modem, T1 line, or other type of Internet connection that provides Internet access to all devices connected to the network.

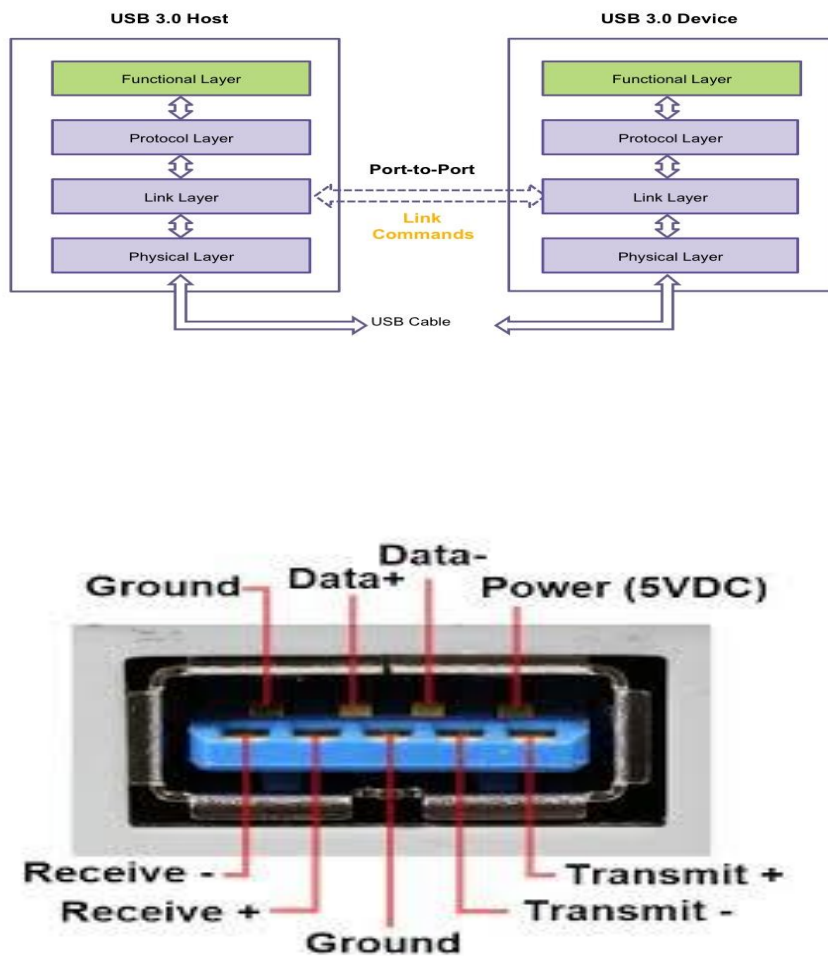
### **USB 3.2:**

- A Universal Serial Bus (USB) is a common interface that enables communication between devices and a host controller such as a personal computer (PC) or smartphone. It connects peripheral

devices such as digital cameras, mice, keyboards, printers, scanners, media devices, external hard drives and flash drives. Because of its wide variety of uses, including support for electrical power, the USB has replaced a wide range of interfaces like the parallel and serial port.

- There are several types of USB connectors. In the past the majority of USB cables were one of two types, type A and type B. The USB 2.0 standard is type A; it has a flat rectangle interface that inserts into a hub or USB host which transmits data and supplies power. A keyboard or mouse are common examples of a type A USB connector. A type B USB connector is square with slanted exterior corners. It is connected to an upstream port that uses a removable cable such as a printer. The type B connector also transmits data and supplies power. Some type B connectors do not have a data connection and are used only as a power connection.
- **Range:** The USB specification limits the length of a cable between full speed devices to 5 meters (a little under 16 feet 5 inches). For a low speed device the limit is 3 meters (9 feet 10 inches).
- **Modulation:** Pulse-position modulation (PPM) is a form of signal modulation in which  $M$  message bits are encoded by transmitting a single pulse in one of possible required time shifts. This is repeated every  $T$  seconds, such that the transmitted bit rate is bits per second.
- **Specification:** A personal area network, or PAN, is a computer network that enables communication between computer devices near a person. PANs can be wired, such as USB. The range of a PAN typically is a few meters.

Specification	Name	Previous name	USB-IF branding	Data rate	Transfer speed	Logo
USB 3.0	USB 3.2 Gen 1	USB 3.1 Gen 1	SuperSpeed USB 5Gbps	5 Gbit/s	500 MB/s	
USB 3.1	USB 3.2 Gen 2	USB 3.1 Gen 2	SuperSpeed USB 10Gbps	10 Gbit/s	1.21 GB/s	
USB 3.2	USB 3.2 Gen 2 x 2	N/A	SuperSpeed USB 20Gbps	20 Gbit/s	2.42 GB/s	



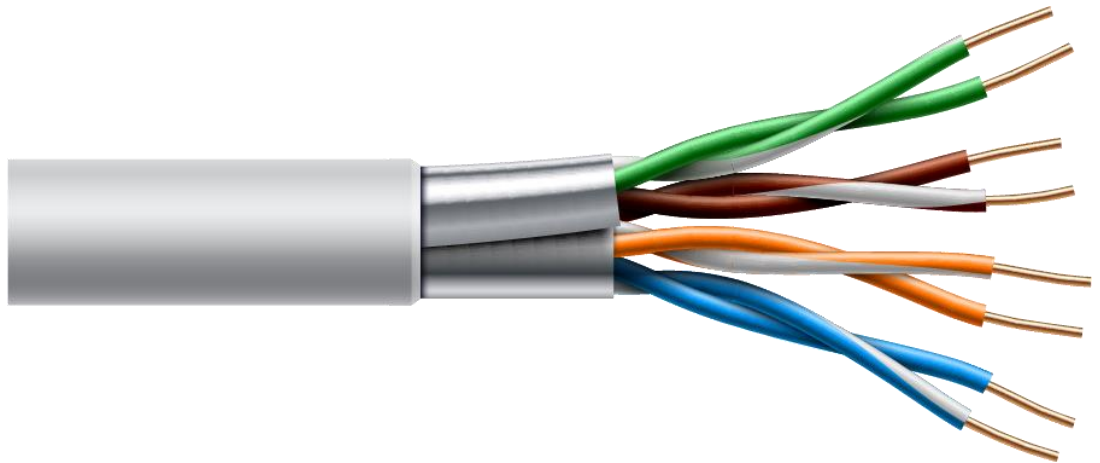
### **Ethernet IEEE 802.3:**

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

- Connected devices accessing a geographically localized network with a cable -- that is, with a wired rather than wireless connection -- likely use Ethernet. From businesses to gamers, diverse end users depend on the benefits of Ethernet connectivity, which include reliability and security.
- **Type of Ethernet Cables:**
- **Coaxial Cabling:** A coaxial cable has an inner conductor that runs down the middle of the cable. The conductor is surrounded by a layer of insulation which is then surrounded by another conducting shield, which makes this type of cabling resistant to outside interference. This type of cabling comes in two types – thinnet and thicknet. Both types have maximum transmission speed of 10 Mbps.



- **Twisted Pair:** A twisted-pair cable has four pair of wires. These wires are twisted around each other to reduce crosstalk and outside interference. This type of cabling is common in current LANs.  
Twisted-pair cabling can be used for telephone and network cabling. It comes in two versions, **UTP (Unshielded Twisted-Pair)** and **STP (Shielded Twisted-Pair)**. The difference between these two is that an STP cable has an additional layer of insulation that protects data from outside interferences.



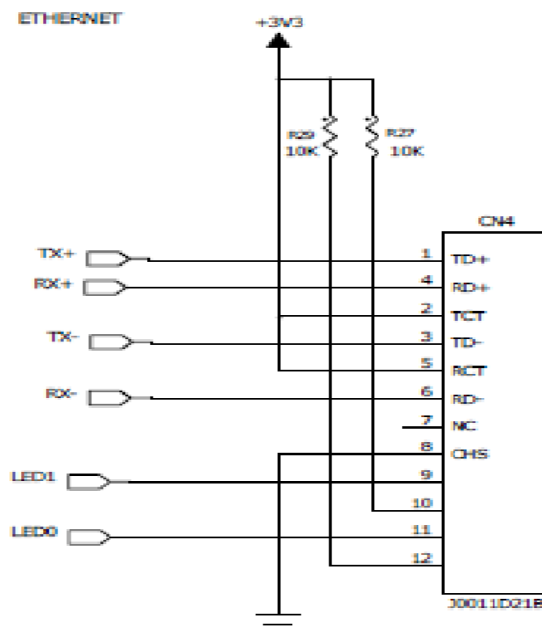
- **Fibre Optic Cable:** This type of cabling can support greater cable lengths than any other cabling type (up to a couple of miles). The cables are also immune to electromagnetic interference. As you can see, this cabling method has many advantages over other methods but its main drawback is that it is more expensive.
  - There are two types of fiber-optic cables:
  - **Single-mode fiber (SMF)** – uses only a single ray of light to carry data. Used for larger distances.
  - **Multi-mode fiber (MMF)** – uses multiple rays of light to carry data. Less expensive than SMF.



- **Range:**

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

- **Modulation:** Not Applicable
- **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).
- **Schematic View:**



## Wireless Connection:

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

### **Types of Wireless Networks:**

- Wireless LANs – Connects two or more network devices using wireless distribution techniques.
- Wireless MANs – Connects two or more wireless LANs spreading over a metropolitan area.
- Wireless WANs – Connects large areas comprising LANs, MANs and personal networks.

### **Advantages of Wireless Networks:**

- It provides clutter-free desks due to the absence of wires and cables.
- It increases the mobility of network devices connected to the system since the devices need not be connected to each other.
- Accessing network devices from any location within the network coverage or Wi-Fi hotspot becomes convenient since laying out cables is not needed.
- Installation and setup of wireless networks are easier.
- New devices can be easily connected to the existing setup since they needn't be wired to the present equipment. Also, the number of equipment that can be added or removed to the system can vary considerably since they are not limited by the cable capacity. This makes wireless networks very scalable.
- Wireless networks require very limited or no wires. Thus, it reduces the equipment and setup costs.

### **802.11 Wi-Fi:**

- Wi-Fi is a wireless networking technology that allows devices such as computers (laptops and desktops), mobile devices (smart phones and wearables), and other equipment (printers and video cameras) to interface with the Internet. It allows these devices--and many more--to exchange information with one another, creating a network.
- Internet connectivity occurs through a wireless router. When you access Wi-Fi, you are connecting to a wireless router that



allows your Wi-Fi-compatible devices to interface with the Internet.

- **Range:** 66feet-330feet

- **Modulation:**

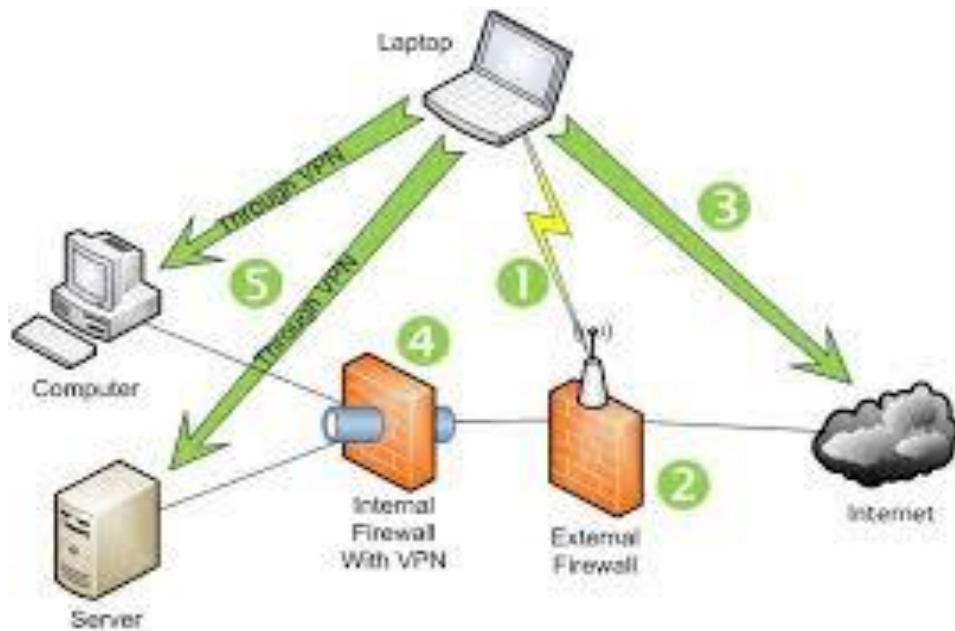
WiFi uses adaptive modulation and varying levels of forward error correction to optimize transmission rate and error performance.

As a radio signal loses power or encounters interference, the error rate will increase. Adaptive modulation means that the transmitter will automatically shift to a more robust, though less efficient, modulation technique in those adverse conditions.

- **Scalibility:** Wi-Fi stands for Wireless Fidelity. It is a technology for wireless local area networking with devices based on IEEE 802.11 standards.

Wi-Fi compatible devices can connect to the internet via WLAN network and a wireless access point abbreviated as AP. Every WLAN has an access point which is responsible for receiving and transmitting data from/to users. Access Point is a wireless LAN base station that can connect one or many wireless devices simultaneously to internet.

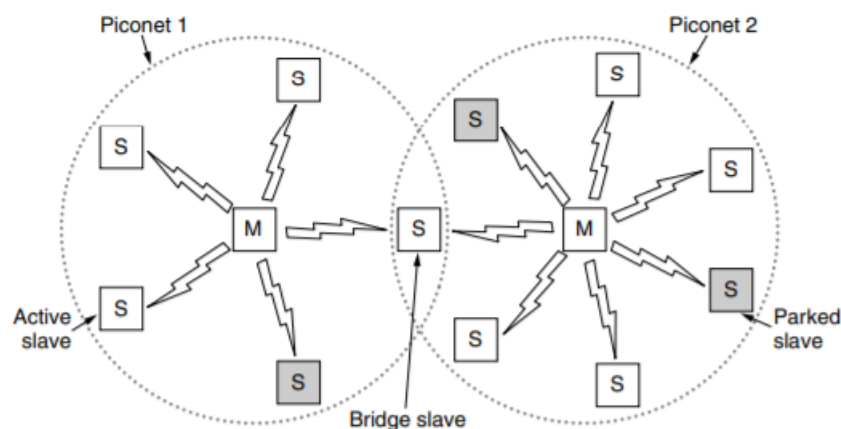
IEEE Standard	802.11a	802.11b	802.11g	802.11n	802.11ac	802.11ax
Year Released	1999	1999	2003	2009	2014	2019
Frequency	5Ghz	2.4GHz	2.4GHz	2.4Ghz & 5GHz	2.4Ghz & 5GHz	2.4Ghz & 5GHz
Maximum Data Rate	54Mbps	11Mbps	54Mbps	600Mbps	1.3Gbps	10-12Gbps



### **Bluetooth IEEE 802.15.1:**

- **Architecture:**

The basic unit of a Bluetooth system is a piconet, which consists of a master node and up to seven active slave nodes within a distance of 10 meters. Multiple piconets can exist in the same (large) room and can even be connected via a bridge node that takes part in multiple piconets, as in Fig. 4-34. An interconnected collection of piconets is called a scatternet. In addition to the seven active slave nodes in a piconet, there can be up to 255 parked nodes in the net. These are devices that the master has switched to a lowpower state to reduce the drain on their batteries. In parked state, a device cannot



**Figure 4-34.** Two piconets can be connected to form a scatternet.

do anything except respond to an activation or beacon signal from the master. Two intermediate power states, hold and sniff, also exist, but these will not concern us here

- **Range:** 50m
- **Modulation:**

The format originally chosen for Bluetooth in version 1 was Gaussian frequency shift keying, GFSK, however with the requirement for higher data rates two forms of phase shift keying were introduced for Bluetooth 2 to provide the Enhanced Data Rate, EDR capability.

***Gaussian frequency shift keying:*** When GFSK is used for the chosen form of Bluetooth modulation, the frequency of the carrier is shifted to carry the modulation.

***Phase shift keying:*** Phase shift keying is the form of Bluetooth modulation used to enable the higher data rates achievable with Bluetooth 2 EDR (Enhanced Data Rate). Two forms of PSK are used:

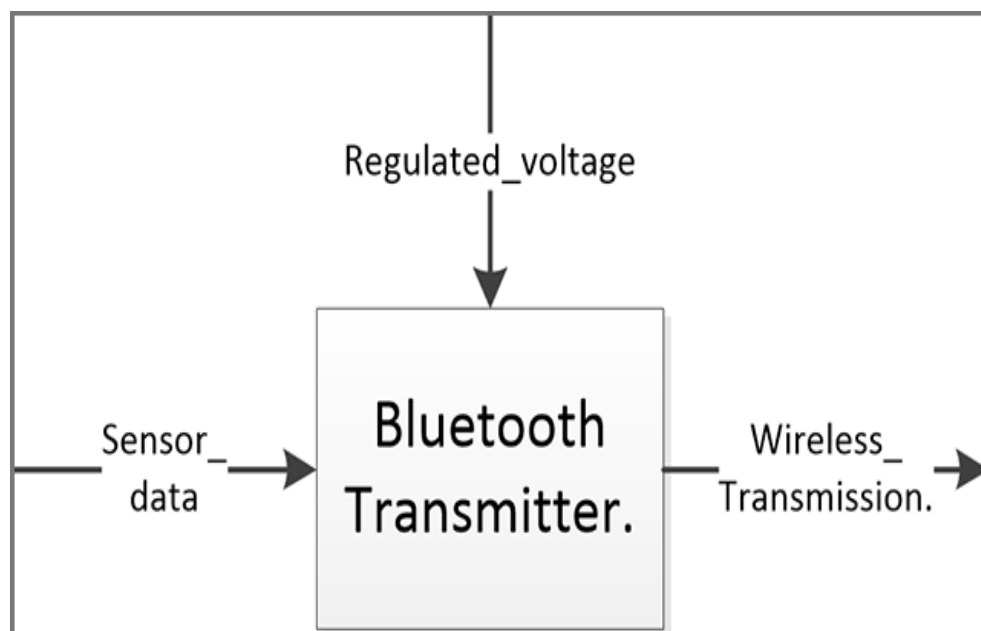
***$\pi/4$  DQPSK:*** This is a form of phase shift keying known as  $\pi/4$  differential phase shift keying. It enables the raw data rate of 2 Mbps to be achieved.

***8DPSK:*** This form of Bluetooth modulation is eight point or 8-ary phase shift keying. It is used when link conditions are good and it allows raw data rates of up to 3 Mbps to be achieved.

- **Specification:** Bluetooth network technology connects mobile devices wirelessly over a short-range to form a personal area network (PAN).

## ► Bluetooth Spec. Evolution

Specifications	1.1	1.2	2.0 + EDR	2.1 + EDR	3.0 +HS	4.0
Adopted	2002	2005	2004	2007	2009	2010
Transmission Rate	723.1 kbps	723.1 kbps	2.1 Mbps	3 Mbps	24 Mbps	25 Mbps
Standard PAN Range	10 m	10 m	10 m	10 m	10 m	50 m
Improved Pairing (without a PIN)				Yes	Yes	Yes
Improved Security		Yes	Yes	Yes	Yes	Yes
NFC Support			Yes	Yes	Yes	Yes



### Conclusion:

Understood the concept of physical interface and various wired and wireless physical layers their range, modulation and schematic view.

### Reference:

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2. [https://en.wikipedia.org/wiki/USB\\_3.0](https://en.wikipedia.org/wiki/USB_3.0)
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6. <https://en.wikipedia.org/wiki/Bluetooth>
7. [https://en.wikipedia.org/wiki/IEEE\\_802.11](https://en.wikipedia.org/wiki/IEEE_802.11)