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Data Communication and Computer Networks

Experiment 1 – Implementing different physical interfaces.

Aim – Finding different physical interfaces and checking their usability.

Theory – Some of the most commonly implemented and used physical interfaces are –

1. Bluetooth devices
2. Infrared Devices
3. Modem
4. Wi-Fi
5. Li-Fi
6. Zigbee
7. WiMAX
8. Start Link

Bluetooth – Bluetooth is an industry specification for short-range radio frequency (RF)-based connectivity for portable personal devices. The IEEE 802.15.1 Task Group has reviewed and provided a standard adaptation of the Bluetooth specifications (version 1.1).

A Bluetooth is a computing and telecommunication specification that describes that how devices communicate with each other. Devices that uses Bluetooth includes computers, computer keyboards and mouse, personal digital assistance and smartphones.

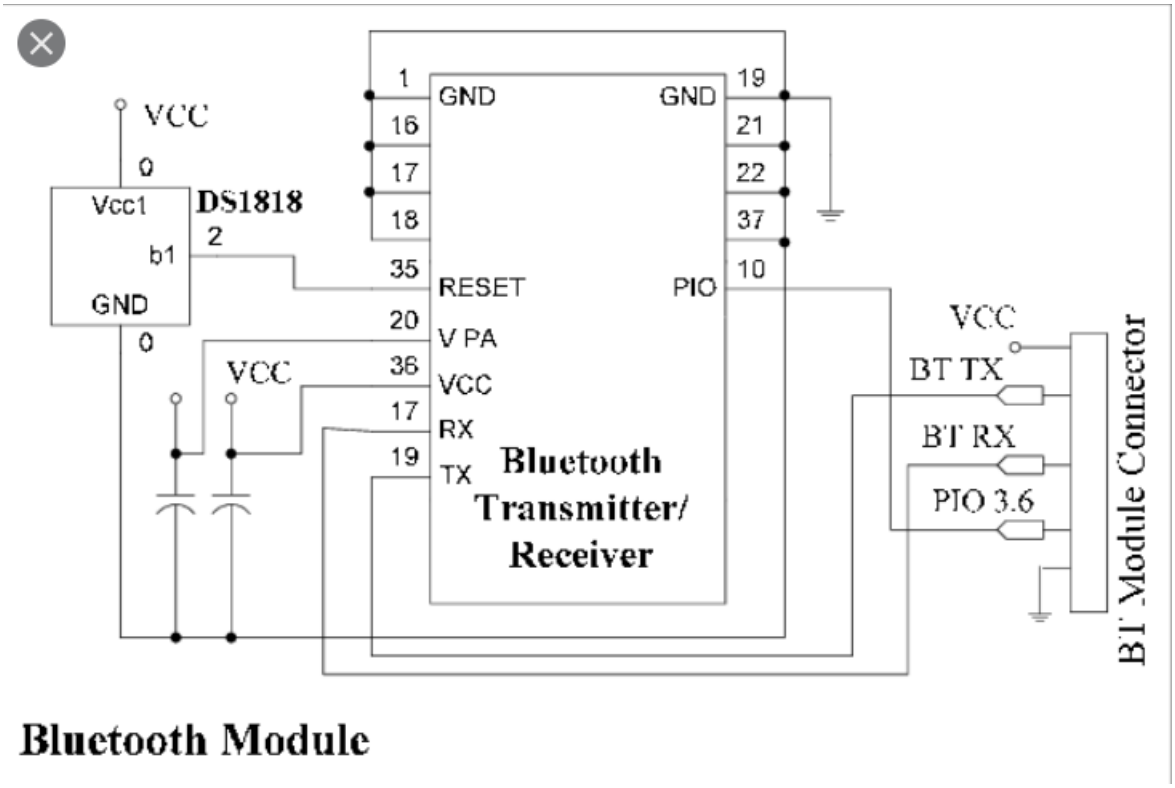
Bluetooth is an RF technology operating at 2.4 GHz, has an effective range of 32-feet (10 meters), varying by power class, a transfer rate of 1 Mbps and a throughput of 721 Kbps

Examples where Bluetooth is used are –

1. Bluetooth earphones

2. Bluetooth mouse and keyboards
3. Bluetooth speakers, watch

Schematic diagram of **Bluetooth** is –



Bluetooth Module

<u>Infrared</u> – Method of transferring data without the use of wires.

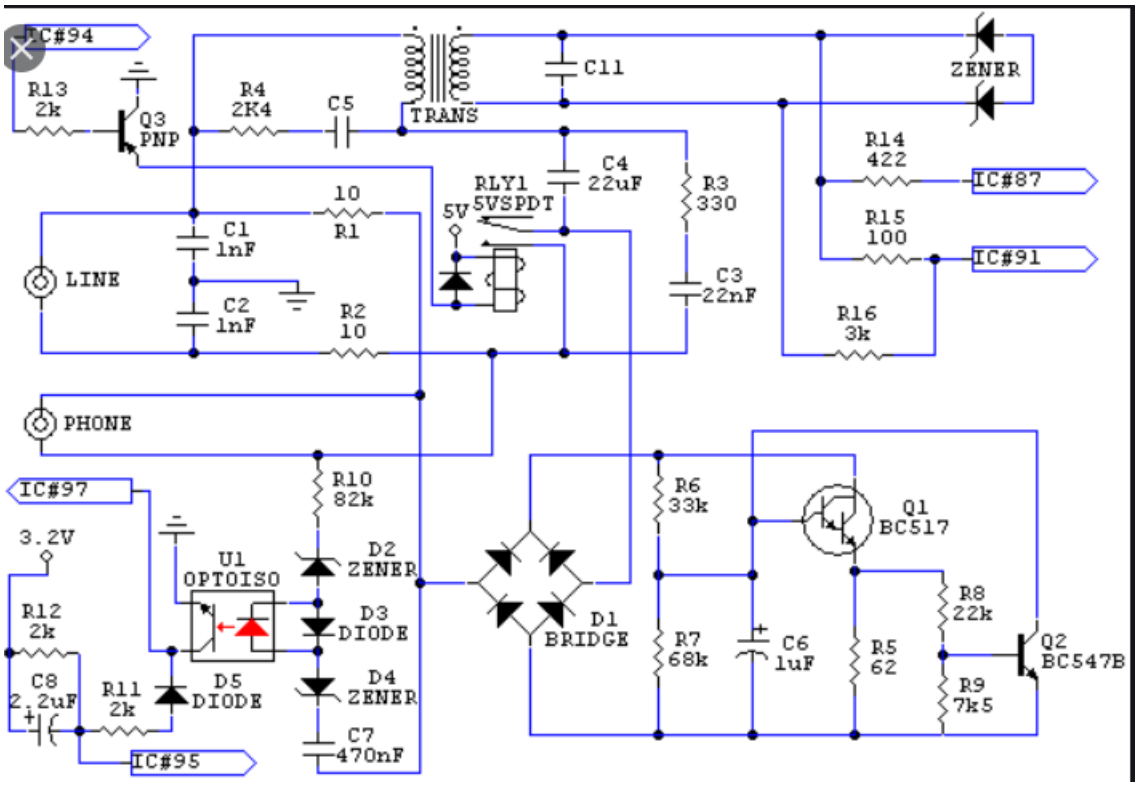
The new IEEE 802.11 standard for wireless local area networks defines a specification for an infrared physical layer. The infrared physical layer was designed for diffuse systems supporting two data rates (1 and 2 Mb/s) and includes provisions for a smooth migration to higher data rates. The specification is suitable for low-cost transceivers but allows interoperability with higher-performance systems. The main application envisaged for IEEE 802.11 infrared wireless local area networks is ad hoc networks.

A common example of infrared device is TV remote. However, infrared is also used in cordless keyboards, cordless mouse and infrared touch screen

Modem – This Standard detail the criteria required for communication between a device and a client conforming to ANSI C12.21 via a modem connected to the switched telephone network. The C12.21 Client could be a laptop or portable computer, a master station system or some other electronic communications device.

A modem is a modulator and demodulator device. This device is connected commonly to a computer. This device converts the digital signals of the computer to the analog signals when transferring data from the computer to the outside world and also converts the analog signal coming from the outside world to the digital signal and pass it on to the computer.

Schematic diagram of **modem** –



Wi-Fi – The 802.11 standard is defined through several specifications of WLANs.

There are several specifications in the 802.11 family –

1. **802.11** - This pertains to wireless LANs and provides 1 - or 2-Mbps transmission in the 2.4-GHz band using either frequency-hopping spread spectrum (FHSS) or direct-sequence spread spectrum (DSSS).
2. **802.11a** – This is an extension to 802.11 that pertains to wireless LANs and goes as fast as 54 Mbps in the 5-GHz band. 802.11a employs the orthogonal frequency division multiplexing (OFDM) encoding scheme as opposed to either FHSS or DSSS.
3. **802.11b** – The 802.11 high rate Wi-Fi is an extension to 802.11 that pertains to wireless LANs and yields a connection as fast as 11 Mbps transmission (with a fallback to 5.5, 2, and 1 Mbps depending on strength of signal) in the 2.4-GHz band. The 802.11b specification uses only DSSS. Note that 802.11b was actually an amendment to the original 802.11 standard added in 1999 to permit wireless functionality to be analogous to hard-wired Ethernet connections.
4. **802.11g** – This pertains to wireless LANs and provides 20+ Mbps in the 2.4-GHz band.
5. **802.11ac –** Is a wireless networking standard in the 802.11 set of protocols (which is part of the Wi-Fi networking family), providing high-throughput wireless local area networks (WLANs) on the 5 GHz band. The standard was developed in the IEEE Standards Association from 2008 (PAR approved 2008-09-26) through 2013 and published in December 2013 (ANSI approved 2013-12-11). The standard has been retroactively labelled as **Wi-Fi 5** by Wi-Fi Alliance.
6. **802.11n –** Is a wireless-networking standard that uses multiple antennas to increase data rates. The Wi-Fi Alliance has also retroactively labelled the technology for the standard as **Wi-Fi 4**. It standardized support for multiple-input multiple-output, frame aggregation, and security improvements, among other features, and can be used in the 2.4 GHz or 5 GHz frequency bands.

A home wireless network uses a wireless access point or router to broadcast a signal using WAP or WEP encryption to send and receive signals from a wireless device on a network.

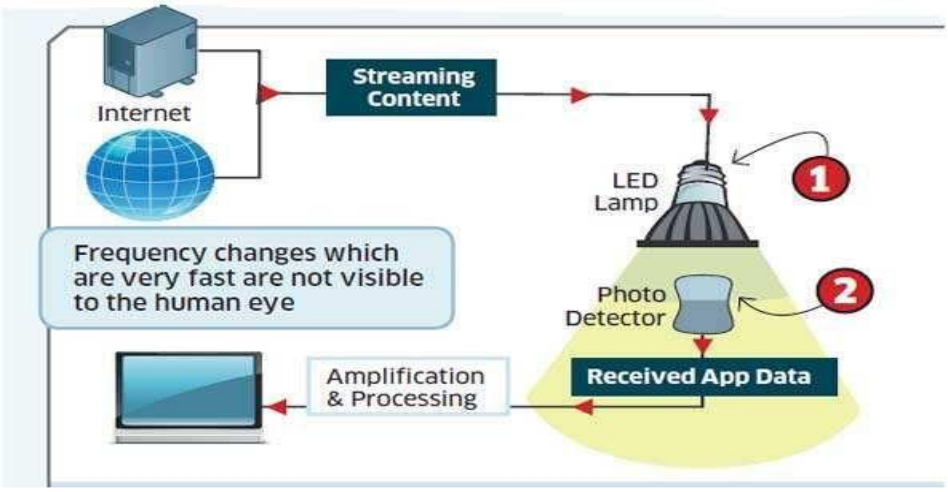
Li-Fi - **Li-Fi** (short for *light fidelity*) is wireless communication technology which utilizes light to transmit data and position between devices. The term was first introduced by Harald Haas during a 2011 TEDGlobal talk in Edinburgh.

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. Li-Fi's ability to safely function in areas otherwise susceptible to electromagnetic interference (e.g. aircraft cabins, hospitals, military) is an advantage. The technology is being developed by several organizations across the globe.

Scalability:

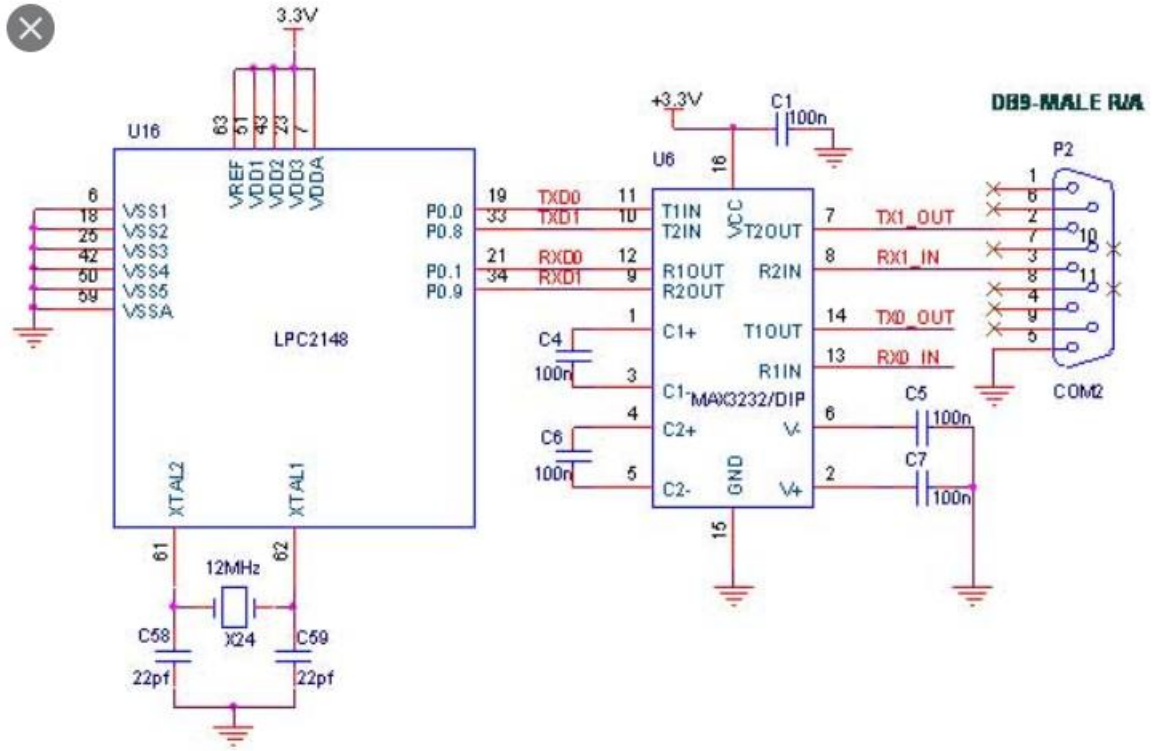
The applications of LiFi are endless because light is available everywhere. It can be used in a meeting room environment (LAN). Since the light cannot pass through walls, the data is secure. It can also be used in intelligent transportation systems. Car headlights and tail lights offer the prospect of car-to-car communication over LiFi, allowing development of anti-collision systems and exchange of information on driving conditions between vehicles. Traffic lights already use LED lighting, so that there is also the prospect offered of city-wide traffic management systems (MAN).



Zigbee – ZigBee Wireless Technology is the leading global standard for implementing low-cost, low-data-rate, short-range wireless networks with extended battery life. The specification documents released by the ZigBee Alliance and IEEE 802.15 WPAN Working Group are the official sources for implementing ZigBee and IEEE 802.15.4-based wireless networks.

Zigbee is used to create personal area networks with small, low-power digital radios, such as home automation, medical device data collection. Hence Zigbee is a low-power, low data rate and close proximity wireless ad hoc network.

Schematic diagram of **Zigbee**



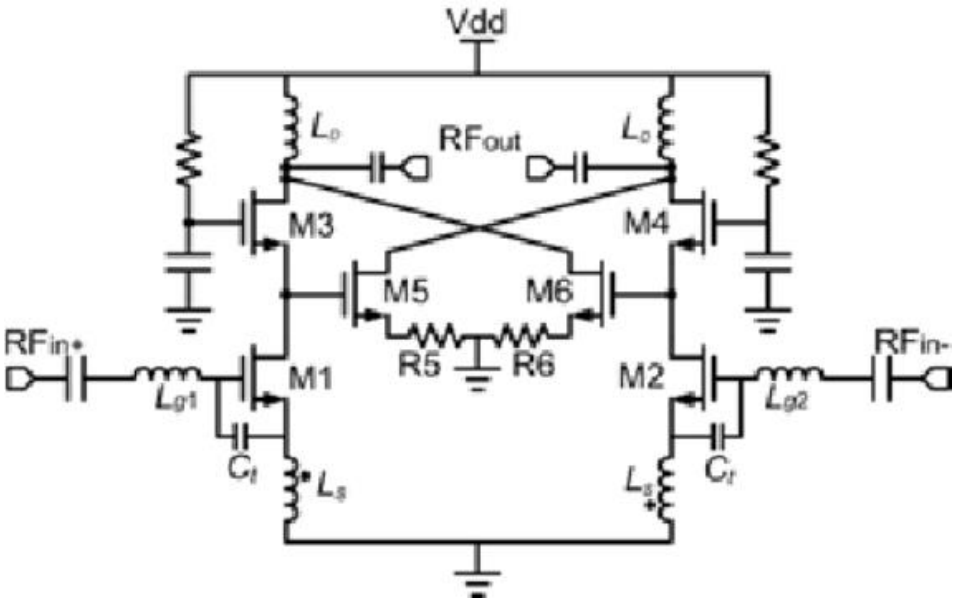
WiMAX – WiMAX technology is based on IEEE 802.16. The IEEE standard serve as the basis for the WiMAX Forum's.

There are three versions of the IEEE 802.16 standard that are key to the WiMAX Forum Certified program:

1. **IEEE 802.16-2004 (or 802.16d)**: Based on Orthogonal Frequency Division Multiplexing (OFDM), it supports fixed and nomadic access. WiMAX Forum Certified equipment was certified for conformance only to this standard until mid-2008.
2. **IEEE 802.16e-2005 (or 802.16e)** – Based on Orthogonal Frequency Division Multiple Access (OFDMA), this standard version supports fixed and nomadic access, but it also includes additional capabilities to serve mobile access. The WiMAX Forum Certification program issued the first certifications for the 2.3GHz band in April 2008 and for the 2.5GHz band in June 2008.

3. **IEEE 802.16m** – Currently under development, the new version of the standard will include improved mobile access and voice services and is a candidate for inclusion as one of the future ITU IMT-Advanced technologies. The WiMAX Forum is committed to preserving compatibility with the IEEE 802.16e-2005 standard, which will enable operators to roll out 802.16m-based equipment within their existing networks.

Schematic diagram of WiMAX –



Ethernet –

Ethernet is a family of computer networking technologies commonly used in local area networks, metropolitan area networks and wide area networks. It was commercially introduced in 1980 and first standardized in 1983 as IEEE 802.3.

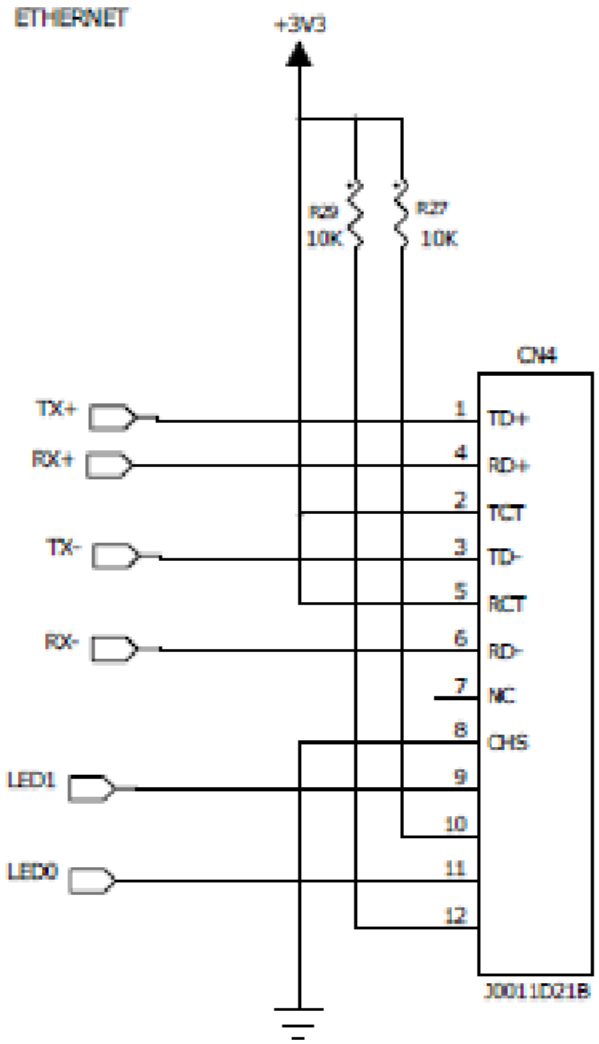
10BASE5 - thick and stiff coaxial cable up to 500 meters (1,600 ft) in length. Up to 100 nodes can be connected to the cable. The data rate is 10 Mbps.
10BASE2 - thin coax cables have a maximum length of 200 metres. The maximum number of nodes that can be connected to it is 30. It offers a 10 Mbps of bandwidth.

10BASET - twisted pair of wires and have a maximum length of 100m. Up to 1024 nodes can be connected to it and it offers a bandwidth of 10 Mbps.

Scalability:

Ethernet has lasted well since its inception in the 1970s with Ethernet frame-structure and addressing remaining ubiquitous in the data centre environment as in many others. However, Ethernet exhibits scalability issues when used to build broadcast domains of more than a few thousand devices, such as costly and energy-dense address table logic and storms of broadcast traffic. The traditional method of avoiding such problems is the artificial subdivision of a network, but this introduces an administrative burden, requires significant routing equipment and with current protocols also precludes live migration.

Schematic Diagram –



Cellular Interfaces –

3G – **3G** (short for third generation) is the third generation of wireless mobile telecommunications technology. It is the upgrade for 2.5G and 2.5G GPRS networks, for faster data transfer. This is based on a set of standards used for mobile devices and mobile telecommunications use services and networks that comply with the International Mobile Telecommunications-2000 (IMT-2000) specifications by the International Telecommunication Union. 3G finds application in wireless voice telephony, mobile Internet access, fixed wireless Internet access, video calls and mobile TV.

3G telecommunication networks support services that provide an information transfer rate of at least 144 kbit/s. Later 3G releases, often denoted 3.5G and 3.75G, also provide mobile broadband access of several Mbit/s to smartphones and mobile modems in laptop computers. This ensures it can be applied to wireless voice telephony, mobile Internet access, fixed wireless Internet access, video calls and mobile TV technologies.

4G – **4G** is the fourth generation of broadband cellular network technology, succeeding 3G. A 4G system must provide capabilities defined by ITU in IMT Advanced. Potential and current applications include amended mobile web access, IP telephony, gaming services, high-definition mobile TV, video conferencing, and 3D television.

The first-release Long Term Evolution (LTE) standard was commercially deployed in Oslo, Norway, and Stockholm, Sweden in 1998, and has since been deployed throughout most parts of the world. It has, however, been debated whether first-release versions should be considered 4G LTE.

5G – In telecommunications, **5G** is the fifth generation technology standard for cellular networks, which cellular phone companies began deploying worldwide in 2019, the planned successor to the 4G networks which provide connectivity to most current cellphones. Like its predecessors, 5G networks are cellular networks, in which the service area is divided into small geographical areas called *cells*. All 5G wireless devices in a cell are connected to the Internet and telephone network by radio

waves through a local antenna in the cell. The main advantage of the new networks is that they will have greater bandwidth, giving higher download speeds, eventually up to 10 gigabits per second (Gbit/s). Due to the increased bandwidth, it is expected that the new networks will not just serve cellphones like existing cellular networks, but also be used as general internet service providers for laptops and desktop computers, competing with existing ISPs such as cable internet, and also will make possible new applications in internet of things (IoT) and machine to machine areas. Current 4G cellphones will not be able to use the new networks, which will require new 5G enabled wireless devices.

Star Link Communication –

Starlink is a satellite constellation being constructed by SpaceX to provide satellite Internet access. The constellation will consist of thousands of mass-produced small satellites in low Earth orbit (LEO), working in combination with ground transceivers. SpaceX also plans to sell some of the satellites for military, scientific, or exploratory purposes. The SpaceX satellite development facility in Redmond, Washington houses the Starlink research, development, manufacturing, and on-orbit control operations. The total cost of the decade-long project to design, build, and deploy the constellation was estimated by SpaceX in May 2018 to be about US$10 billion.

Satellite Link Communication –

A **communications satellite** is an artificial satellite that relays and amplifies radio telecommunications signals via a transponder; it creates a communication channel between a source transmitter and a receiver at different locations on Earth. Communications satellites are used for television, telephone, radio, internet, and military applications. There are about 2,000 communications satellites in Earth's orbit, used by both private and government organizations. Many are in geostationary orbit 22,236 miles (35,785 km) above the equator, so that the satellite appears stationary at the same point in the sky, so the satellite dish antennas of ground stations can be aimed permanently at that spot and do not have to move to track it.

There are various types of satellite up in the space like –

1. Satellite Constellation - A group of satellites working in concert is known as a satellite constellation. Two such constellations, intended to provide satellite phone services, primarily to remote areas, are the Iridium and Globalstar systems. The Iridium system has 66 satellites.
2. **Medium Earth orbit (MEO) -** A MEO is a satellite in orbit somewhere between 2,000 and 35,786 kilometres (1,243 and 22,236 mi) above the earth's surface. Typically, the orbit of a medium earth orbit satellite is about 16,000 kilometres (10,000 mi) above earth. In various patterns, these satellites make the trip around earth in anywhere from 2 to 8 hours. In 1962, the communications satellite, **Telstar**, was launched which was a type of MEO satellite.
3. **Geo Stationary Satellite** - To an observer on Earth, a satellite in a geostationary orbit appears motionless, in a fixed position in the sky. This is because it revolves around the Earth at Earth's own angular velocity (one revolution per sidereal day, in an equatorial orbit). A geostationary orbit is useful for communications because ground antennas can be aimed at the satellite without their having to track the satellite's motion. This is relatively inexpensive. In applications that require many ground antennas, such as DirecTV distribution, the savings in ground equipment can more than outweigh the cost and complexity of placing a satellite into orbit.

Cables - A transmission medium is required to carry every type of information that travels from source to destination. Cables and connectors are used for transmitting data along a channel. A structured cabling system is the foundation of every business network. Cabling provides connectivity between servers, computers, and other network devices. Hence cables and connectors are part and parcel of each other.

Transmission media used can be wired or wireless. In wired transmission, cables are used for transferring signals whereas in wireless transmission, electromagnetic waves are used to transmit data from one device to another. There are three types of cables used in wired transmission namely twisted pair cables, coaxial cables and fiber optic cables.

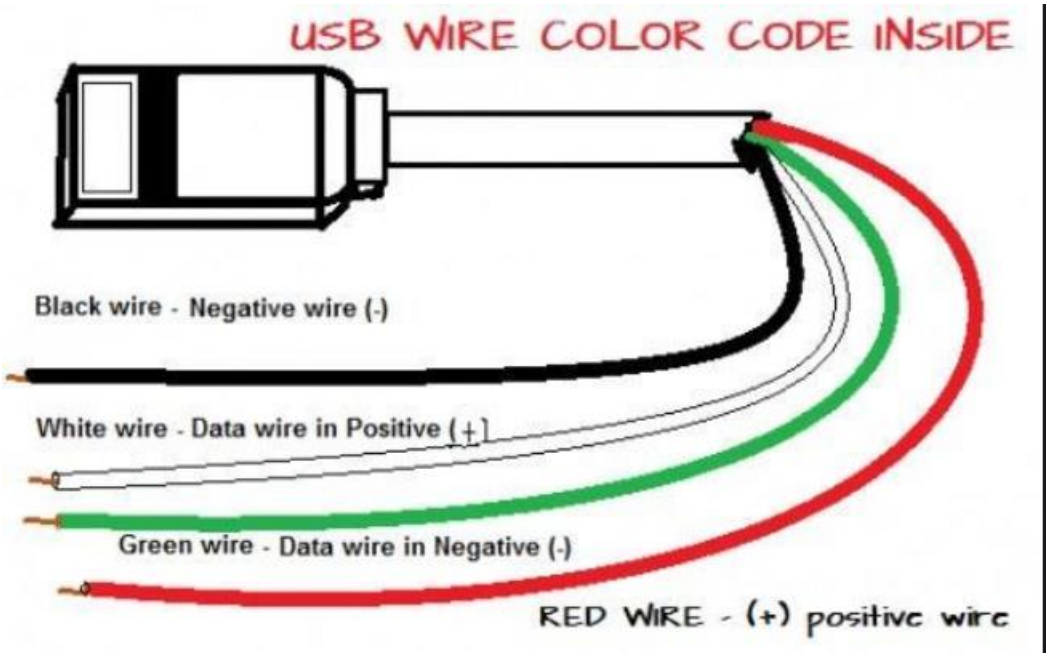
- Twisted pair cables are used for transmitting data in small areas. These cables are further divided into two types. Shielded Twisted Pair (STP) and Unshielded Twisted Pair (UTP). RJ45 connector is used for connecting UTP cables. UTP is further divided into seven categories based on quality of cable. CAT1 cables are used in telephone lines with small data rate whereas CAT6 is used in LAN connections with high rate of data transfer.

- Coaxial cables carry signals with a frequency higher than that of twisted pair cables. These cables are categorized with the help of Radio Government (RG) ratings. RG-59 cables are used for cable TVs, RG-58 for thin Ethernet and RG-11 for thick Ethernet. BNC connectors are used for connecting coaxial cables.

- Fiber Optic Cables are used for transmitting high speed, longer distance signals with minimum interference. Two types of connectors are used for connecting fiber optic cables. SC connector is used for connecting cable TVs whereas ST connectors are used for establishing connection between networking devices.

One of the important type of cable is USB cable

Schematic diagram of USB cable –



Conclusion – After completing the above experiment, I have understood the standards of various physical interfaces used in todays world like Wi-Fi, Bluetooth, Infrared, ZigBee, WiMAX, Modem etc.

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