UID	2019230064
Name	Afaan Ansari
Batch	A [TE Comps]
Subject	DCCN

Experiment : 1

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

Theory:

- **Physical Layer - OSI Model** [2]

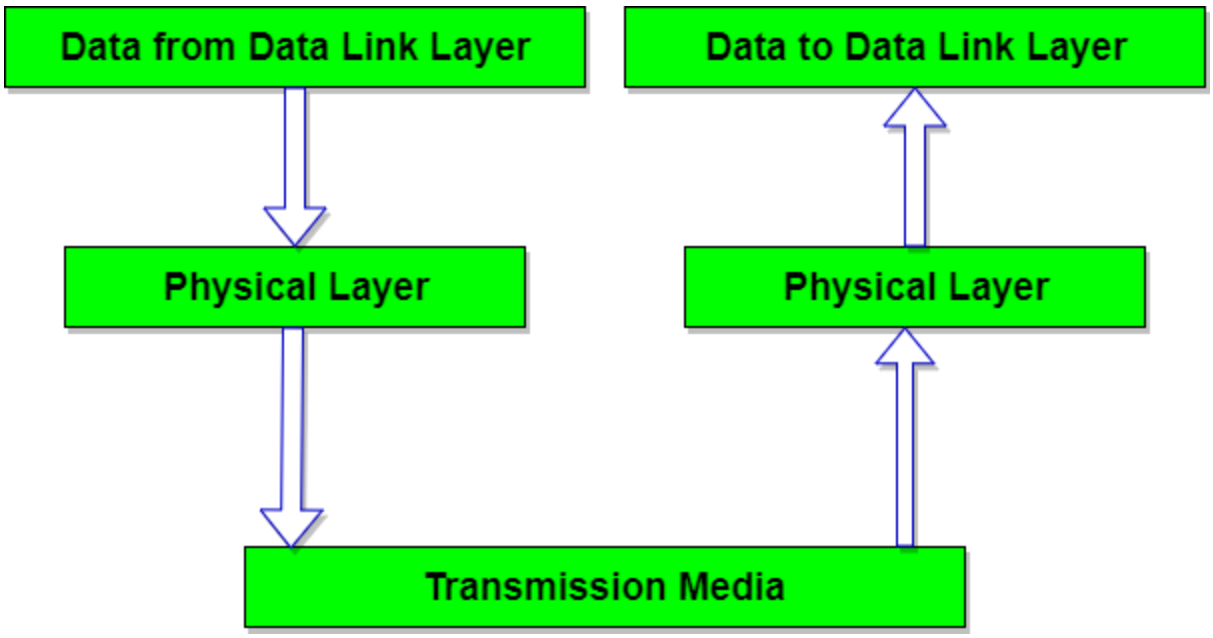
Physical layer is the lowest layer of the OSI reference model. It is responsible for sending bits from one computer to another. This layer is not concerned with the meaning of the bits and deals with the setup of physical connection to the network and with transmission and reception of signals.

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.



- **Transmission media** [3]

  The transmission media is nothing but the physical media over which communication takes place in computer networks.

Magnetic Media

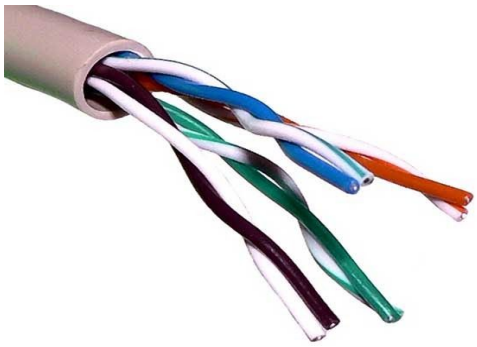
One of the most convenient way to transfer data from one computer to another, was to save it on some storage media and transfer physical from one station to another. Though it may seem old-fashion way in today's world of high speed internet, but when the size of data is huge, the magnetic media comes into play.

For example, a bank has to handle and transfer huge data of its customer, which stores a backup of it at some geographically far-away place for security reasons and to keep it from uncertain calamities. If the bank needs to store its huge backup data then its,transfer through internet is not feasible.The WAN links may not support such high speed.Even if they do; the cost too high to afford.

In these cases, data backup is stored onto magnetic tapes or magnetic discs, and then shifted physically at remote places.

Twisted Pair Cable

A twisted pair cable is made of two plastic insulated copper wires twisted together to form a single media. Out of these two wires, only one carries actual signal and another is used for ground reference. The twists between wires are helpful in reducing noise (electro-magnetic interference) and crosstalk.



There are two types of twisted pair cables:

- **Shielded Twisted Pair (STP) Cable**
- **Unshielded Twisted Pair (UTP) Cable**

STP cables comes with twisted wire pair covered in metal foil. This makes it more indifferent to noise and crosstalk.

UTP has seven categories, each suitable for specific use. In computer networks, Cat-5, Cat-5e, and Cat-6 cables are mostly used. UTP cables are connected by RJ45 connectors.

Coaxial Cable

Coaxial cable has two wires of copper. The core wire lies in the center and it is made of solid conductor.The core is enclosed in an insulating sheath.The second wire is wrapped around over the sheath and that too in turn encased by insulator sheath.This all is covered by plastic cover.

Because of its structure,the coax cable is capable of carrying high frequency signals than that of twisted pair cable.The wrapped structure provides it a good shield against noise and cross talk. Coaxial cables provide high bandwidth rates of up to 450 mbps.

There are three categories of coax cables namely, RG-59 (Cable TV), RG-58 (Thin Ethernet), and RG-11 (Thick Ethernet). RG stands for Radio Government.

Cables are connected using BNC connector and BNC-T. BNC terminator is used to terminate the wire at the far ends.

Power Lines

Power Line communication (PLC) is Layer-1 (Physical Layer) technology which uses power cables to transmit data signals.In PLC, modulated data is sent over the cables. The receiver on the other end de-modulates and interprets the data.

Because power lines are widely deployed, PLC can make all powered devices controlled and monitored. PLC works in half-duplex.

There are two types of PLC:

- **Narrow band PLC**
- **Broad band PLC**

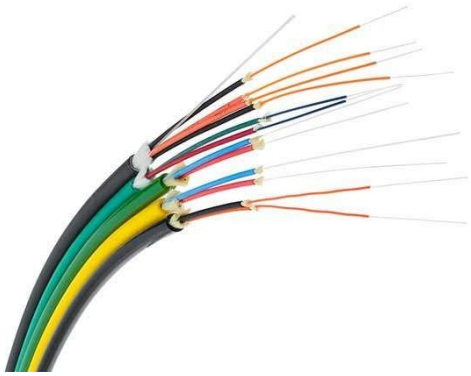
Narrow band PLC provides lower data rates up to 100s of kbps, as they work at lower frequencies (3-5000 kHz).They can be spread over several kilometers.

Broadband PLC provides higher data rates up to 100s of Mbps and works at higher frequencies (1.8 – 250 MHz).They cannot be as much extended as Narrowband PLC.

Fiber Optics

Fiber Optic works on the properties of light. When light ray hits at critical angle it tends to refracts at 90 degree. This property has been used in fiber optic. The core of fiber optic cable is made of high quality glass or plastic. From one end of it light is emitted, it travels through it and at the other end light detector detects light stream and converts it to electric data.

Fiber Optic provides the highest mode of speed. It comes in two modes, one is single mode fiber and second is multimode fiber. Single mode fiber can carry a single ray of light whereas multimode is capable of carrying multiple beams of light.



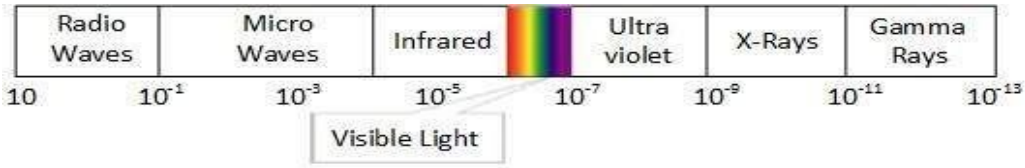
Fiber Optic also comes in unidirectional and bidirectional capabilities. To connect and access fiber optic special type of connectors are used. These can be Subscriber Channel (SC), Straight Tip (ST), or MT-RJ.

- **Wireless Transmission** [4]

Wireless transmission is a form of unguided media. Wireless communication involves no physical link established between two or more devices, communicating wirelessly. Wireless signals are spread over in the air and are received and interpreted by appropriate antennas.

When an antenna is attached to electrical circuit of a computer or wireless device, it converts the digital data into wireless signals and spread all over within its frequency range. The receptor on the other end receives these signals and converts them back to digital data.

A little part of electromagnetic spectrum can be used for wireless transmission.

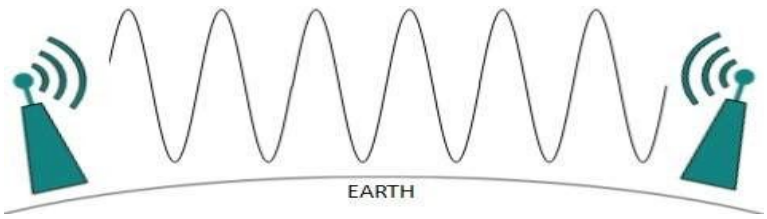


Radio Transmission

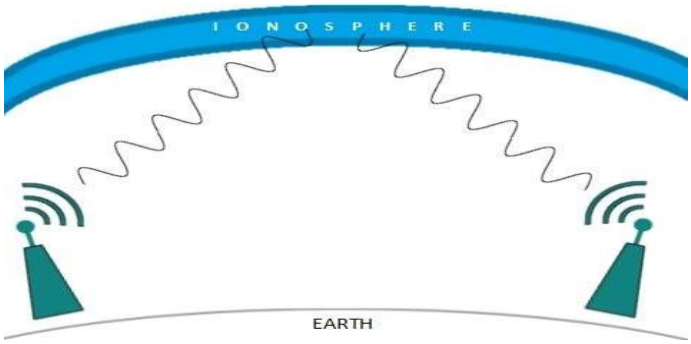
Radio frequency is easier to generate and because of its large wavelength it can penetrate through walls and structures alike.Radio waves can have wavelength from 1 mm – 100,000 km and have frequency ranging from 3 Hz (Extremely Low Frequency) to 300 GHz (Extremely High Frequency). Radio frequencies are sub-divided into six bands.

Radio waves at lower frequencies can travel through walls whereas higher RF can travel in straight line and bounce back.The power of low frequency waves decreases sharply as they cover long distance. High frequency radio waves have more power.

Lower frequencies such as VLF, LF, MF bands can travel on the ground up to 1000 kilometers, over the earth's surface.



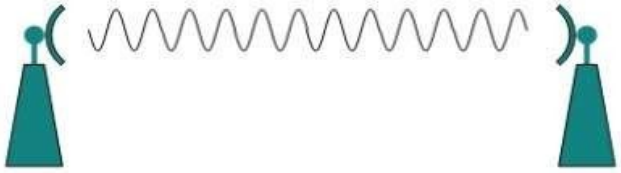
Radio waves of high frequencies are prone to be absorbed by rain and other obstacles. They use Ionosphere of earth atmosphere. High frequency radio waves such as HF and VHF bands are spread upwards. When they reach Ionosphere, they are refracted back to the earth.



Microwave Transmission

Electromagnetic waves above 100 MHz tend to travel in a straight line and signals over them can be sent by beaming those waves towards one particular station. Because Microwaves travels in straight lines, both sender and receiver must be aligned to be strictly in line-of-sight.

Microwaves can have wavelength ranging from 1 mm – 1 meter and frequency ranging from 300 MHz to 300 GHz.



Microwave antennas concentrate the waves making a beam of it. As shown in picture above, multiple antennas can be aligned to reach farther. Microwaves have higher frequencies and do not penetrate wall like obstacles.

Microwave transmission depends highly upon the weather conditions and the frequency it is using.

Infrared Transmission

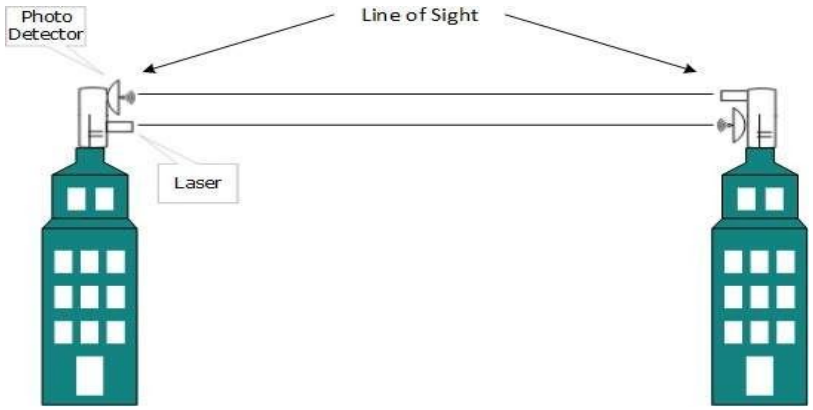
Infrared wave lies in between visible light spectrum and microwaves. It has wavelength of 700-nm to 1-mm and frequency ranges from 300-GHz to 430-THz.

Infrared wave is used for very short range communication purposes such as television and it's remote. Infrared travels in a straight line hence it is directional by nature. Because of high frequency range, Infrared cannot cross wall-like obstacles.

Light Transmission

Highest most electromagnetic spectrum which can be used for data transmission is light or optical signaling. This is achieved by means of LASER.

Because of frequency light uses, it tends to travel strictly in straight line.Hence the sender and receiver must be in the line-of-sight. Because laser transmission is unidirectional, at both ends of communication the laser and the photo-detector needs to be installed. Laser beam is generally 1mm wide hence it is a work of precision to align two far receptors each pointing to lasers source.



Laser works as Tx (transmitter) and photo-detectors works as Rx (receiver).

Lasers cannot penetrate obstacles such as walls, rain, and thick fog. Additionally, laser beam is distorted by wind, atmosphere temperature, or variation in temperature in the path.

Laser is safe for data transmission as it is very difficult to tap 1mm wide laser without interrupting the communication channel.

- **Types of Wireless Networks** [5]

  The IEEE and telecommunications industry standards for wireless data communications cover both the Data Link and Physical layers. Four common data communications standards that apply to wireless media are:

  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.

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.

Other wireless technologies such as satellite communications provide data network connectivity for locations without another means of connection. Protocols including GPRS enable data to be transferred between earth stations and satellite links. In each of the above examples, Physical layer specifications are applied to areas that include: data to radio signal encoding, frequency and power of transmission, signal reception and decoding requirements, and antenna design and construction.

- ## Types of Network [6]

  A computer network can be categorized based on geographical location and characteristic. Based on geographical location, computer networks are outlined below.

  LAN (Local Area Network)

  A LAN is a computer network which spans over a small geographical area such as home, building, office, etc. In LAN, computers are placed relatively close. Since computers are located within a small distance, they do not need special devices and cables to connect with each other.

  MAN (Metropolitan area networks)

  A MAN is a computer network which connects two or more LAN networks within same city. When due to distance connecting two LANs is not possible, MAN network is used. It is larger than LAN but smaller than WAN. It deploys special devices and cables to connect the LANs.

  WAN (Wide Area Network)

  WAN is a computer network which spans over a large geographical area such as state, region, country etc. WANs are typically used to connect two or more LANs or MANs which are located relatively very far from each other. To provide connectivity, this network uses special devices, cables and technologies.

  Above categorization (LAN, MAN and WAN) of computer network is purely based on geographical location. It has nothing to do with the number of computers in each network. For example, if one computer is located in Delhi and other computer is located in Mumbai, connecting these two computers is the example of WAN networking. Just like this, if a company starts a new branch office with 500 computers and all these

computers are installed within a building, this network will be considered as a LAN network.

There are three more types of computer network based on geographical location but they are rarely used to define the network. In real life you may skip these but if you preparing for job interview or for any networking exam, you should learn these also.

PAN (Pearson Area Network)

Same as LAN network, but it is limited to a specific person or location such as home network. This network is usually setup for sharing resources such as internet and printer within personal computers.

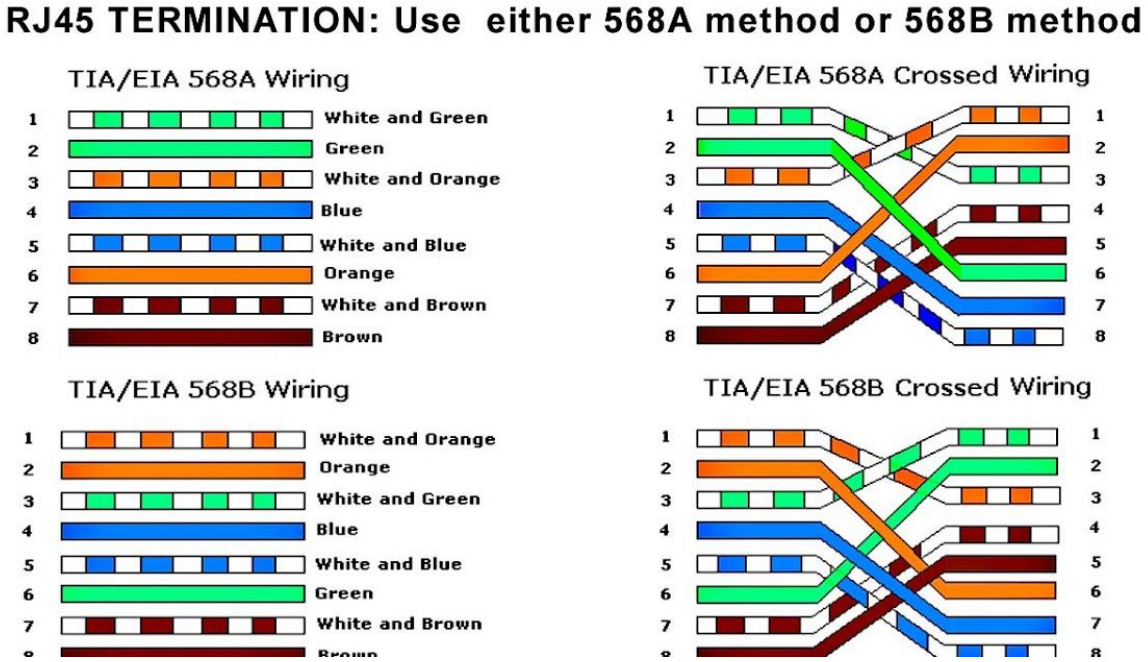
CAN (Campus Area Network)

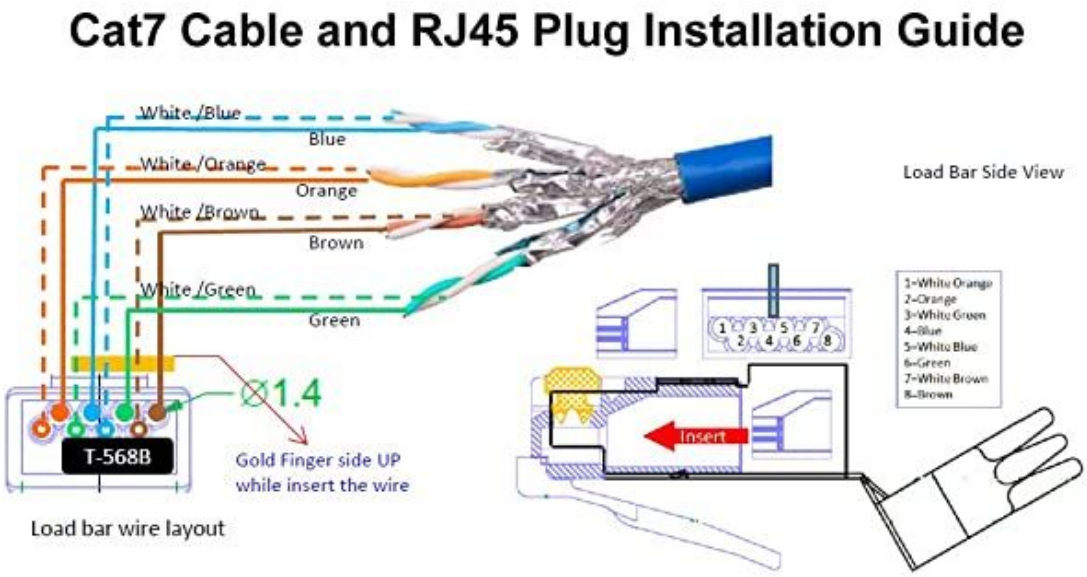
Same as MAN network, but it is limited to a university or an academy. This network is usually setup for educational activities such as classroom updates, practices labs, emails, exams, notifications, polls, etc.

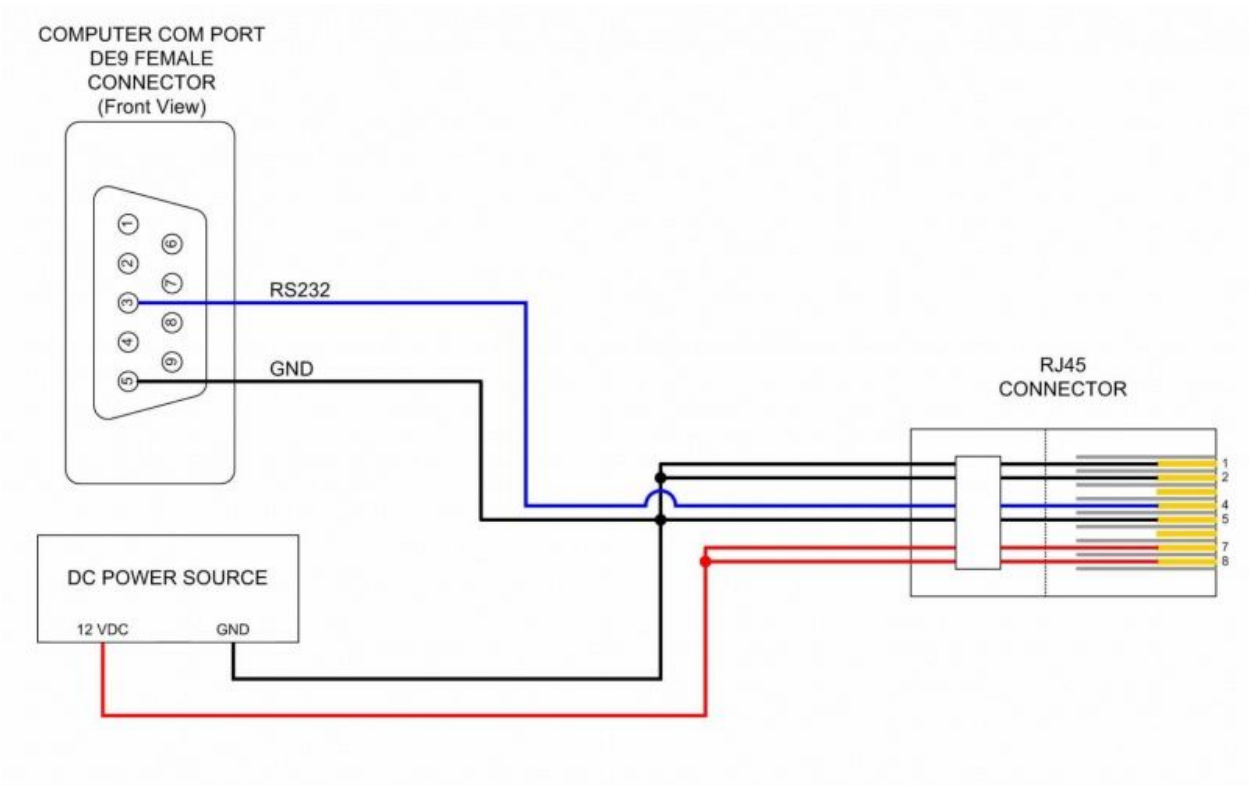
HAN

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.

- **schematic view of physical connector (rj45) [1]**







- **References**

1. Google image schematic view
2. Studytonight physical layer
3. Tutorials point transmission media
4. Tutorials point wireless media
5. Make use of Types of wireless network
6. Computer networking notes [Types of Network]