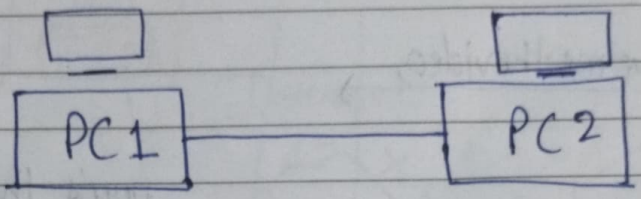
A computer Network

is a digital telecommunications network which allows nodes to share resources.



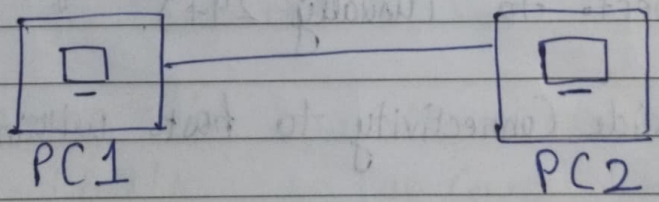
→ when we connect to pc (nodes) together it forms a network.

Clients (ex→ Mobile phones, PC (any type))

is a device that accessed a service made available by a **server**

↓

is a device that provides functions and services to the clients.



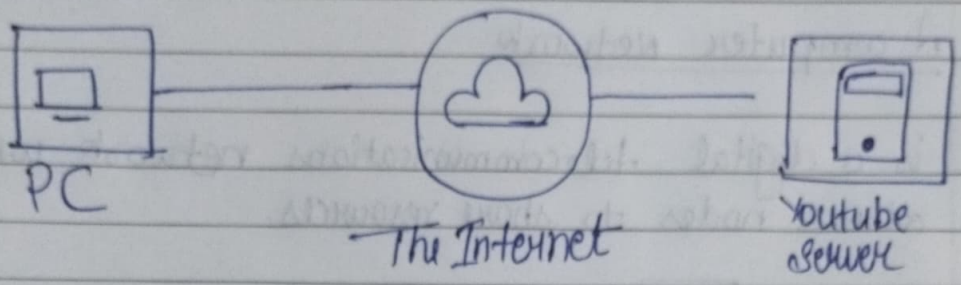
Give me image.jpg, Please →

← Here you are

PC1 requested image file from PC2 and then PC2 sends the image file to PC1.

So, PC1 will be Client and PC2 is server.

Example



Give me the video →

← Here's the video

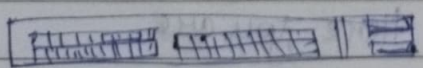
⇒ generally, the cloud symbol represent the Internet.

In the above example, youtube server is not sending the video all at once ~~but~~ instead it sends streams of data until you've watched the full video.

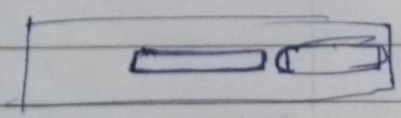
Switches

- have many network interfaces / ports for end hosts to connect to (usually 24+).
- provide Connectivity to hosts within the same LAN
- donot provide Connectivity b/w LAN's / over the Internet

Two types of switches

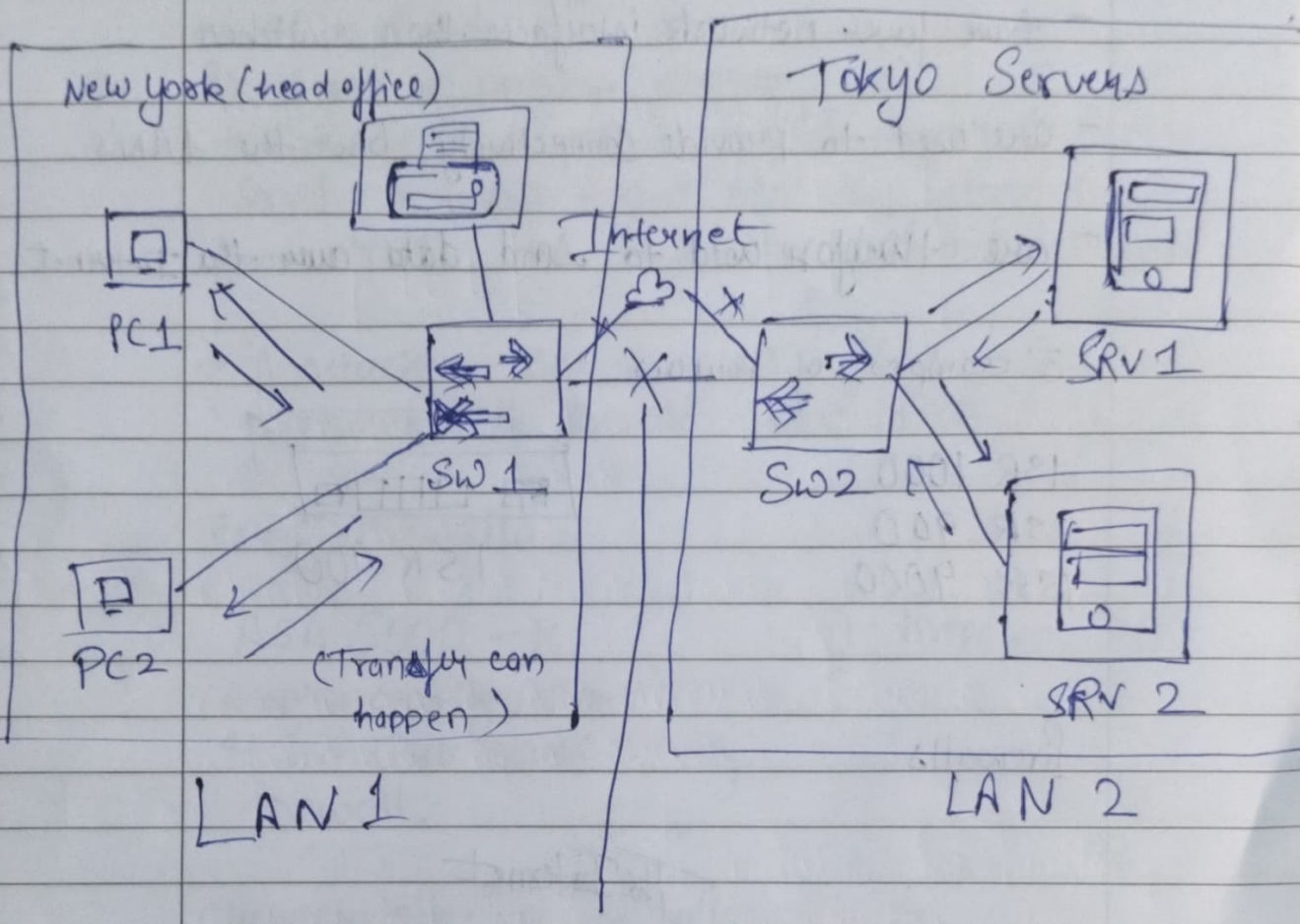


Catalyst 9200

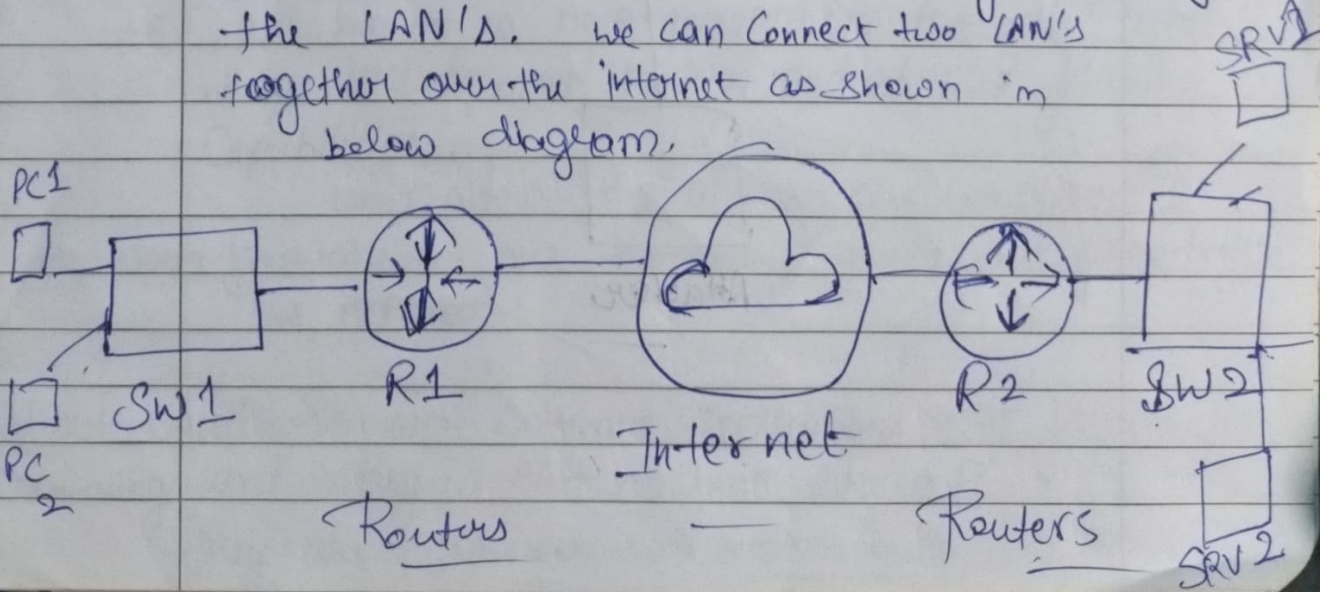


Catalyst 3650

Suppose a company has a head office ~~and~~ in other region and server house in other region.



we cannot cannot two 'Switches' over the Internet for that we need Routers in b/w them each for both of the LAN's. we can connect two LAN's together over the internet as shown in below diagram.

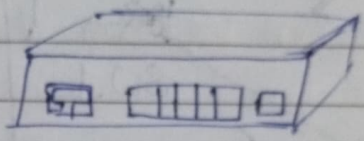


Routers

- have fewer network interfaces than switches.
- are used to provide connectivity b/w the LAN's.
- are therefore used to send data over the Internet.

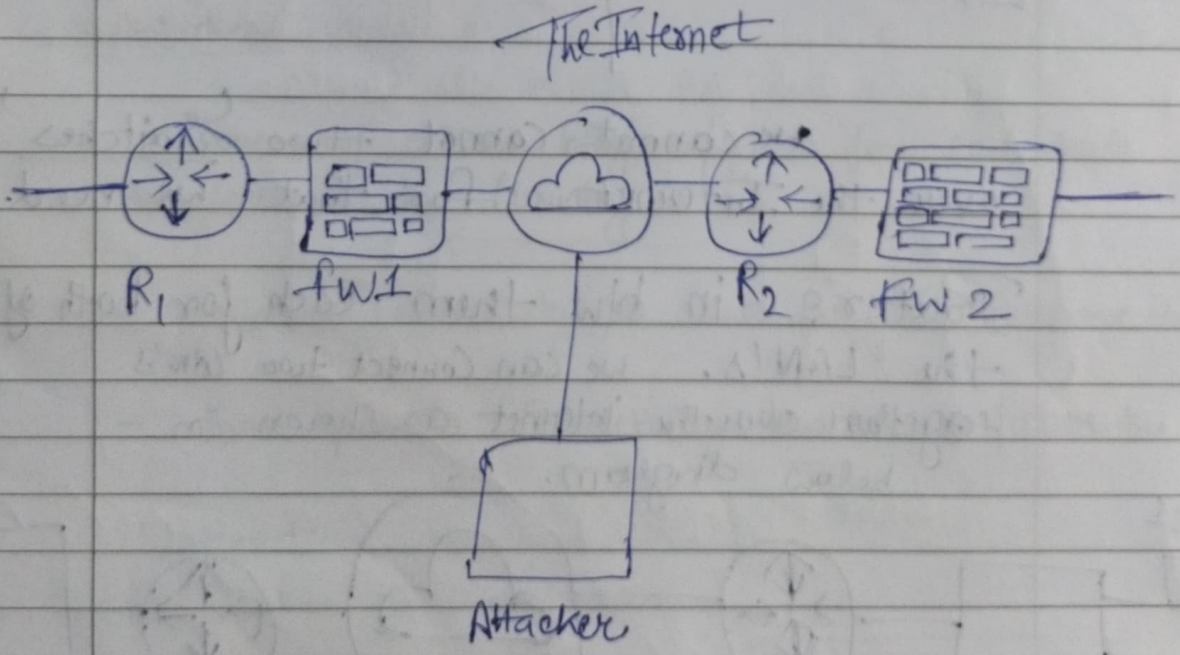
3 examples of routers.

ISR 1000
ISR 900
ISR 4000



ISR 900

firewalls



⇒ firewalls must be configured with security rules to determine which traffic should be allowed and which should be denied.

Ex- based on previous diagram

→ firewall must allow if PC1 trying to access Srv1 in tokyo. and also the return traffic from Srv1 to PC1 should also be allowed.

→ if attacker tries to access anything inside our network, the firewall should block it.

Ex- of firewalls

① ASA 5500 - X (Adaptive Security Appliance) It is a Cisco classic firewall.

② firepower 2100

Characteristics of firewalls.

⇒ Monitor and Controls (filters) network traffic based on configured rules

⇒ Can be placed inside or outside the network.

⇒ are known as next-generation firewalls when they include more modern and advanced filtering capabilities.

What about firewalls on our computer?

Network firewalls → are hardware devices that filter traffic b/w networks.

Host-based ⇒ are software applications that filter traffic entering and existing a host machine like a PC.

they are software that can be installed in our PC.

Quiz

(1) Your Company wants to purchase some network hardware to which they can plug the 30 pc's in your department. which type of network device is appropiate?

Ans. Switch
Catalyst 9200

(2) You recieved a video file from your friend's Apple iphone using AirDrop. what was his iphone functioning as in that transaction?

Ans A Server

(3) What is your Computer or Smartphone function as while you watch this video?

Ans A Client

(4) Your Company wants to purchase some network hardware to Connect its Separate networks together. What kind of network device is appropiate.?

Ans A Router

(5) Your Company wants to upgrade its old network firewall that has been in use for several years to one that provides more advance functions. what kind of

firewall should they purchase?

Ans c A next-generation firewall

Introduction to Cisco Packet tracer

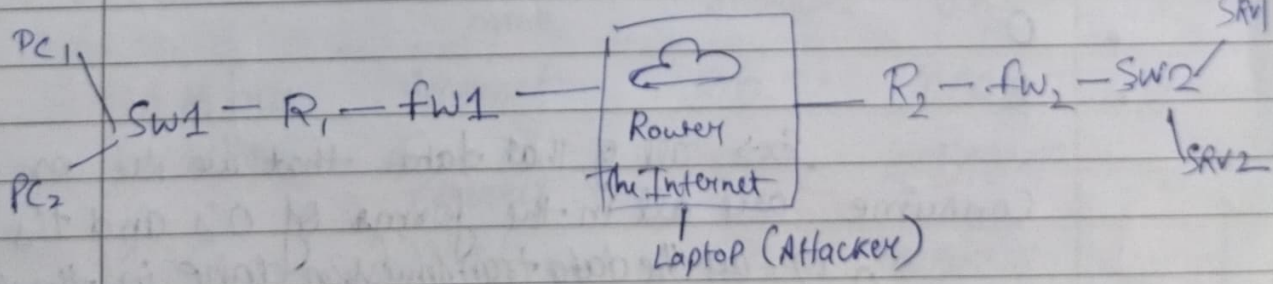
⇒ Creating the network done in previously. in packet tracer.

Lab instructions

Use the following devices

2911 routers (x2) 2960 switches (x2)
5505 firewalls (x2) PCs (2) Servers (x2)
use a laptop as attacker in the diagram.

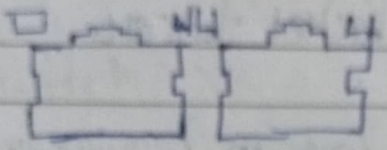
Connect these devices using packet tracer's 'Automatically Choose Connection type function".



Create this in Cisco Packet tracer and Connect all of them ~~to~~ with the help of automatic cable function ⚡.

Interfaces and Cables

Switch interface



RJ-45 ports generally we can see them in switch boards they are total of ~~48 ports~~ 24 ports.

RJ-45 (Registered Jack)

Note ⇒ It's Cable is also of a diffrent shape so that it can fit in that shape interface.

Ethernet

is a collection of network protocols/standards.

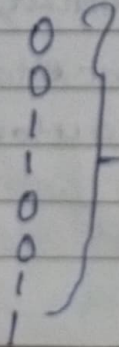
Bits and Bytes

Bit

- 0
- 1

Ex⇒ all of that data that we see or consume are all in the forms of 0's and 1's. all the data transmission done in these 0's and 1's

Byte



~~8 bytes~~

8bits ⇒ 1 byte.

⇒ The speed of transmission of data. ie. measured in bits per second.

for ex- Kbps, Mbps, Gbps, etc.

not bytes per second.

⇒ Data in a harddrive is stored in form of bytes so,

1 gigabyte is 8 times the 1 gigabit.

⇒

1 kilobit = 1000 bits
1 megabit = 1000000 bits
1 gigabit = 1000,000,000 bits
1 terabit = 1000,000,000,000 bits.

Ethernet Standards

- Defined in the IEEE 802.3 standard in 1983.
- IEEE = Institute of Electrical and Electronic Engineers

Copper

Speed	Common name	IEEE Standard	Informal name	Max. Len.
10 Mbps	Ethernet	802.3i	10BASE-T	100 m
100 Mbps	Fast Ethernet	802.3u	100BASE-T	100 m
1 Gbps	Gigabit Ethernet	802.3ab	1000BASE-T	100 m
10 Gbps	10 Gig Ethernet	802.3an	10GBASE-T	100 m.

⇒ Copper cables used in Ethernet standards are 'UTP' Cables

Unshielded Twisted Pair
- wires have no metallic shield
- Pairs of Cable twisted together
- Protects against EMI (Electromagnetic Interference)

4 pairs of wire

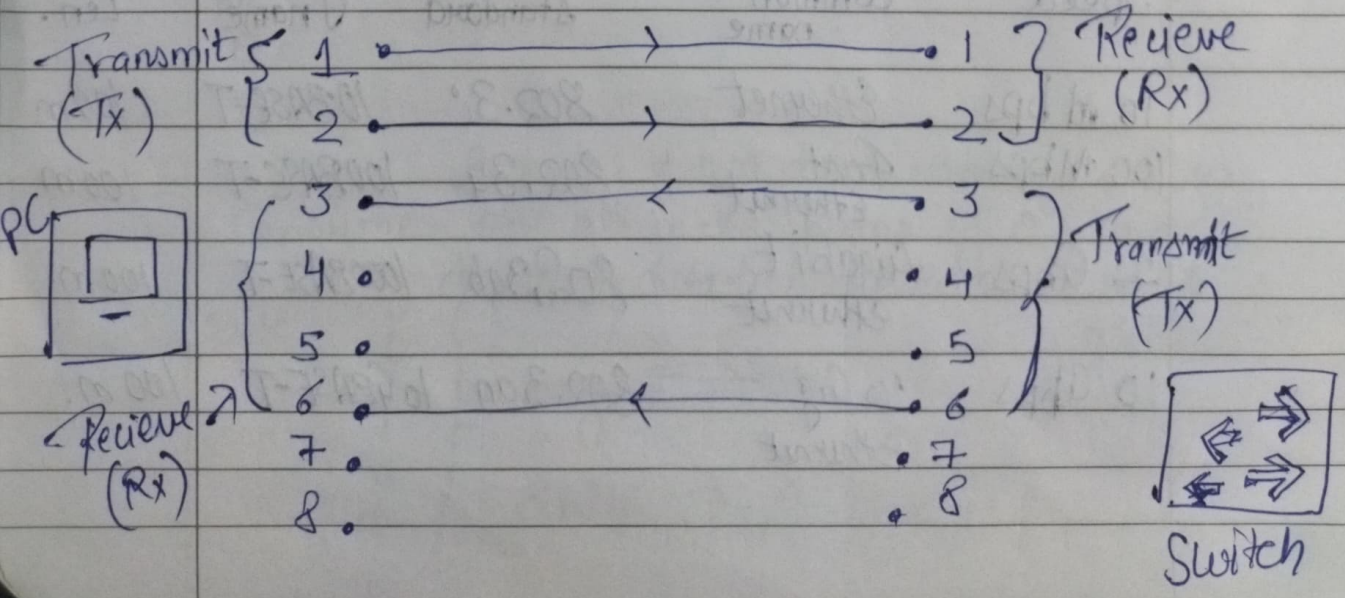
RJ-45 connector also has 8 wires slot shown.

⇒ [10 BASE-T, 100 BASE-T] = 2 pairs (4 wires)

[1000 BASE-T, 10G BASE-T] = 4 pairs (8 wires)

(10 BASE-T, 100 BASE-T)

full Duplex



In previous diagram, Both the devices can send and recieve data at the same time that is called full duplex transmission and no problem like Collisions will occur bcoz we are using diffrent wires for recieving and sending

⇒ Now, Connecting Router to a Switch.
Just change Router in place of PC in diagram on previous page and everything is same.

Note. Switches recieves data on 1 and 2 and Routers and PC's on 3 and 6.

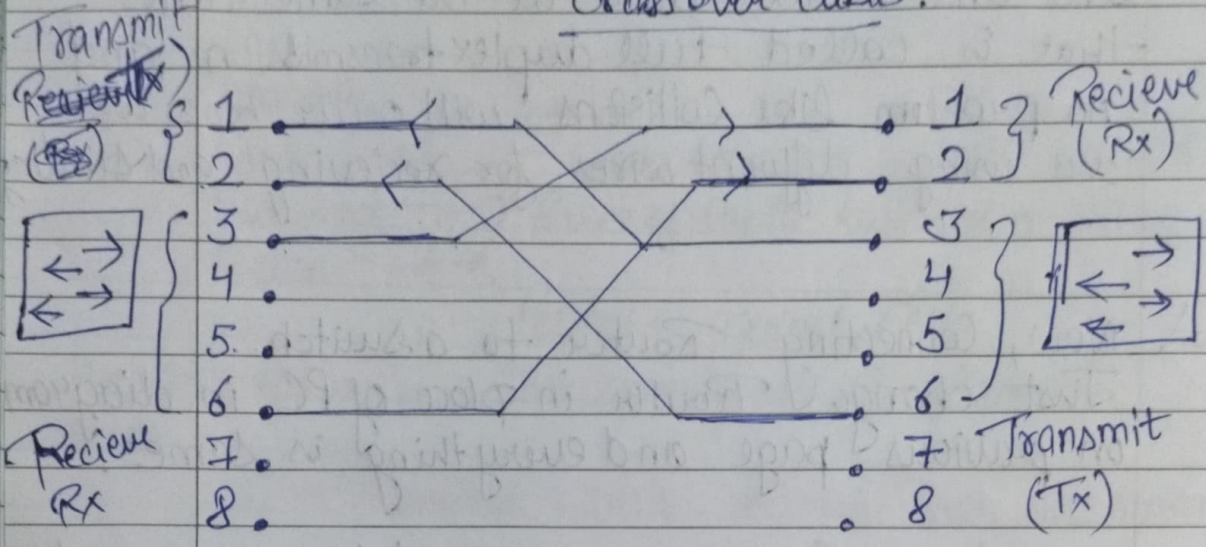
- This type of Cable is called Straight through Cable.
- A copper ethernet Cable has two RJ-45 connectors, one on each end.
- These Cables are called straight through bcoz Pin 1 connects to Pin 1 and Pin 2 connect to Pin 2 and same for others.

⇒ What if we want to connect a router to a router.
or PC to PC
or switch to switch
or PC to router.
these conditions are not possible in diagram on previous page.

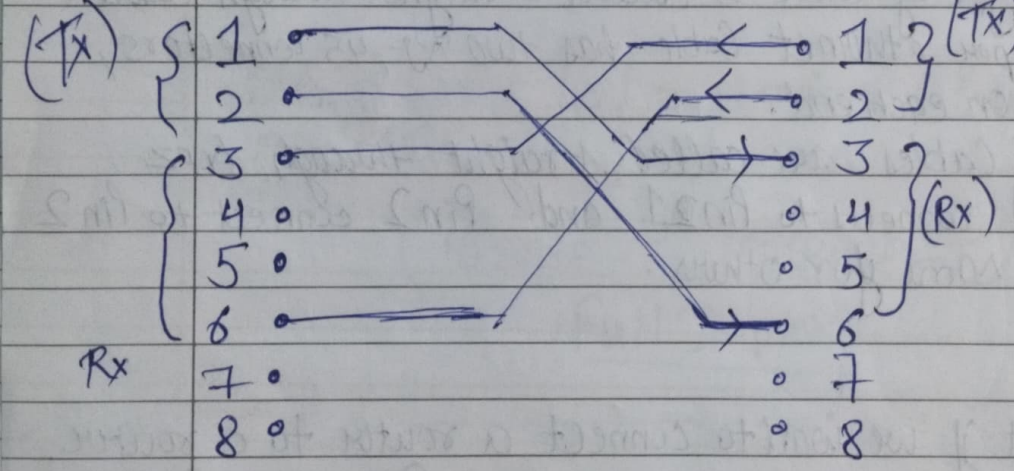
To solve this problem we will use

Crossover Cable

⇒ Transmission of data b/w Switches using Crossover Cable.



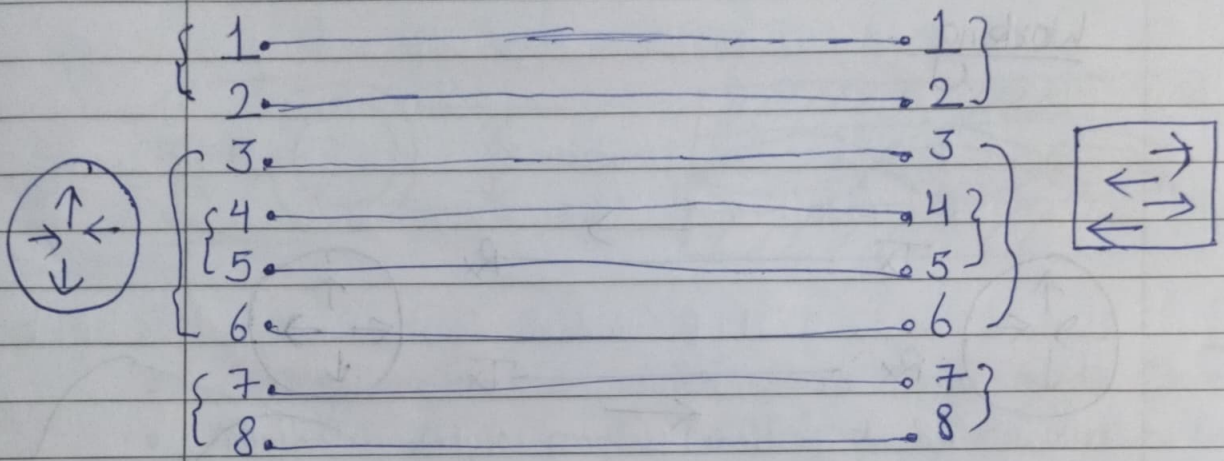
⇒ b/w PC's and routers, both transmits data through 1 and 2 and recieves on 3 and 6.



Device Type	Tx Pins	Rx Pins
Router	1 and 2	3 and 6
firewall	1 and 2	3 and 6
PC	1 and 2	3 and 6
Switch	3 and 6	1 and 2

Auto MDI-X cable
→ automatically adjusts the pins of the cable at recieving and Sender point. acc. to our requirement for data transmission

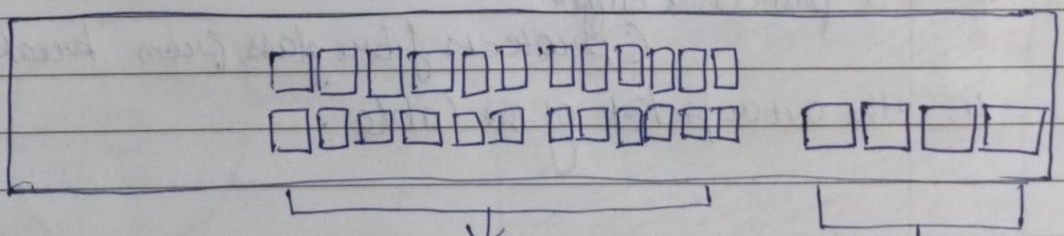
1000 BASE-T , 10GBASE-T



- Each pair is bidirectional (meaning each pair is not dedicated specifically to transmitting data or recieving data.
due to this we can operate at much faster speed.

fiber Optic Connections

Switch



24 ports for RJ-45 Connectors

(next page)

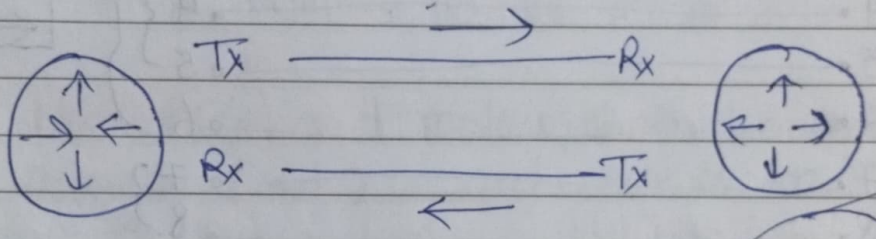
(we connects copper UTP-Cables to these 24 Ports)

In these Interfaces, we insert a SFP transceiver (small-form-factor pluggable)

and then we connect "fiber optic cables" to SFP transceiver.

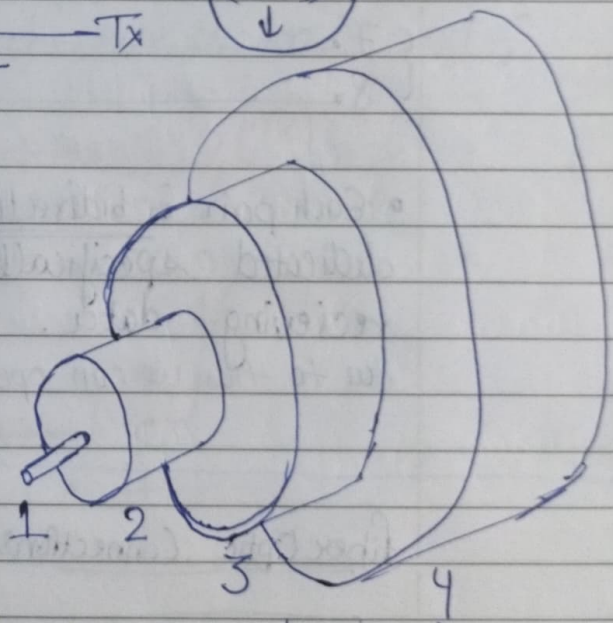
⇒ rather than electrical signal like copper wire fiber optics cables send light over glass fibres

Working



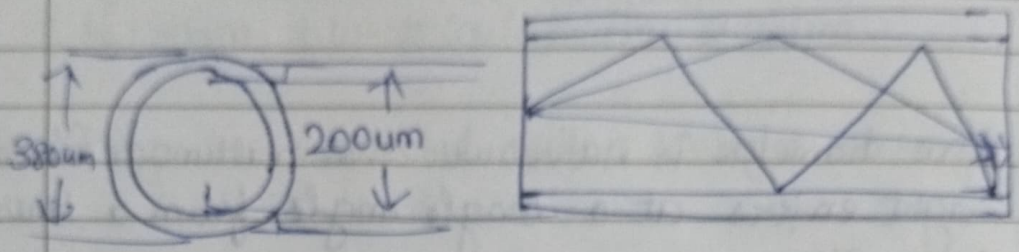
Structure of Cable

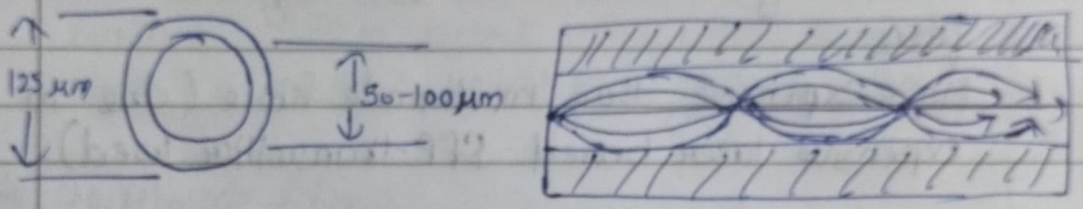
1. fiberglass core itself
2. cladding that reflects light
3. a protective buffer (protects fibre glass from breaking)
4. the outer jacket of the cable.



Types

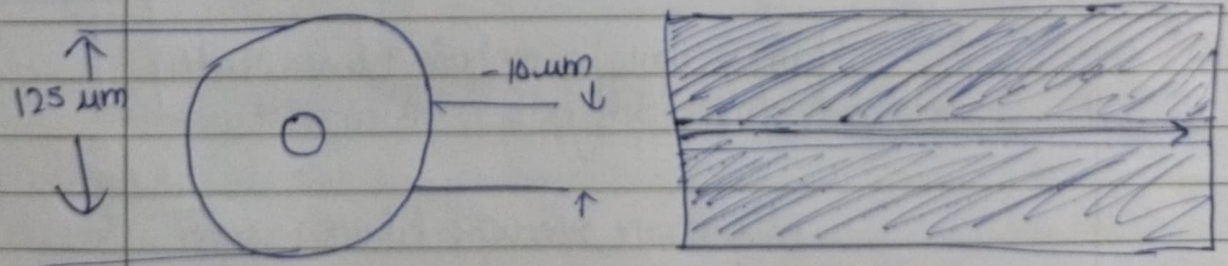
Multimode fibre





- Core diameter is wider than Single-mode fibre
- Allows multiple angles (modes) of light waves to enter the fibreglass core.
- Allows longer cables than UTP, but shorter than Single-mode fibre.
- Cheaper than Single mode fibre (due to cheaper LED-Based SFP transmitters).

Single mode fibre



Auto MDI-X cable.
⇒ automatically adjusts receiver and transmitter end acc. to requirement.

- Core diameter is narrower than multimode fibre
- Light enters at a single angle from a laser-based transmitter.
- Allows longer cables than both UTP and multimode fibre
- More expensive than multimode fibre (due to more expensive laser based SFP transmitter used).

Informal Name	IEEE Standard	Speed	Cable type	Max length
1000BASE-LX	802.3z	1Gbps	Multi or Single mode	550m(MM) 5Km(SM)
10GBASE-SR	802.3ae	10Gbps	Multimode	400 m
10GBASE-LR	802.3ae	10Gbps	Single mode	10Km
10GBASE-ER	802.3ae	10Gbps	Single mode	30Km.

__/__/__

Quiz

1. You connect two old routers together with a UTP Cable, however data is not successfully sent and recieved blw them. what could be the problem.

⇒ they are connected with a straight-through Cable.

2. Your Company wants to connect switches in two separate building 150 m apart: they want to keep costs down, if possible. what kind of cable should they use.

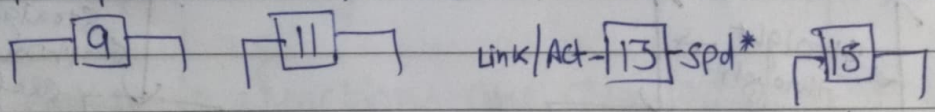
⇒ Multimode fibre.

3. Your Company wants to connect two offices that are about 3 kilometers apart. they want to keep cost down if possible. cable?

⇒ Single Mode fibre

4. A switch has following indication over its network interface

10/100/1000 BASE-T ports (1-24) - Ports are auto-MDIX



What would happen if you connect it to an identical switch with a straight through cable?

⇒ They would operate normally.

5. Your company needs to connect many end hosts to a switch which is in a wiring Cabinet on the same office floor as the hosts. Cable?

⇒ UTP Cables

Lab

__/__/____

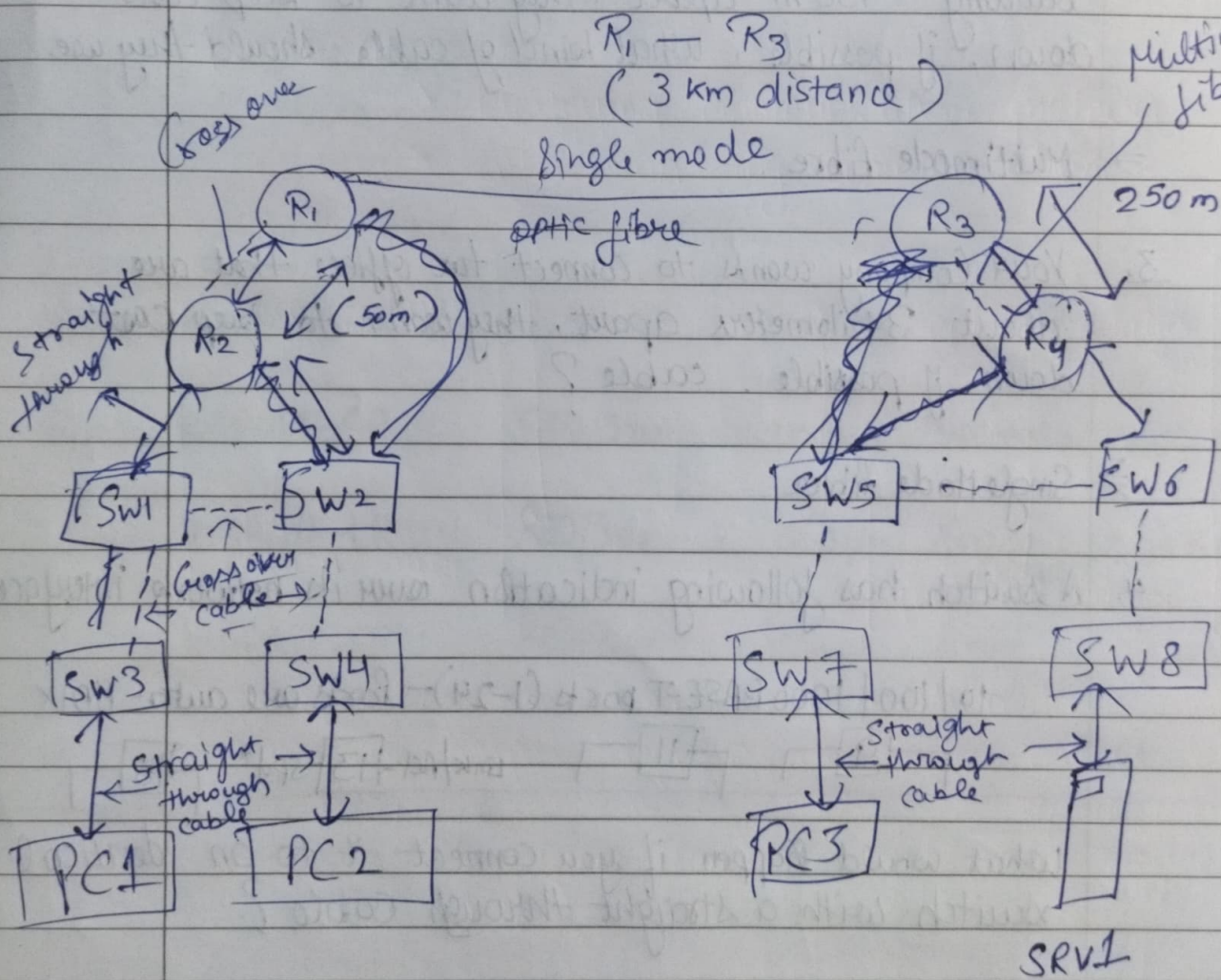
Rules

⇒ Connect the network devices together acc. to the labels.

⇒ Use the appropiate type of cable

⇒ For practice, assume that Auto MDI-X is disabled, or not supported on the devices.

Note: Packet tracer doesn't diff. b/w Single-mode & multimode fibre, but think about which one is appropiate when using fibre connection.



OSI Model & TCP/IP Suite

What is a networking model?

⇒ Networking models categorize and provide a structure for networking protocols and standards

A set of rules defining how network devices and software should work.

OSI model

Layers in OSI	Some key points
7. Application	• 'Open System Interconnection' model
6. Presentation	• A conceptual model that categorizes and standardizes the diffrent func.s in a network
5. Session	• Created by the 'International organization for standardization' (ISO)
4. Transport	• functions are divided into 7 layers
3. Network	• These layers work together to make the network work.
2. Data link	
1. Physical	

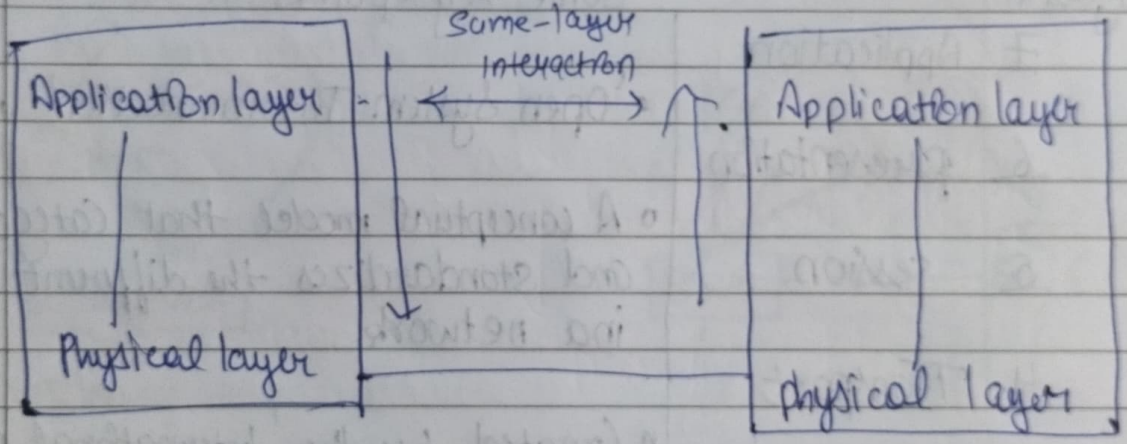
lets see all the layers

7. Application

- this layer is closest to the end user.
- Interacts with software app. like web browser.
- HTTP and HTTPs are layer 7 protocols. (https://www.cisco.com)

functions

→ Identifying Communication partners
→ Synchronizing Communication.



- Data processing ~~from~~ ~~Application~~ to physical layer when browser made the request this is called "encapsulation" (when other data through diffrent layer is added to it).

De-encapsulation

- Now, reaching till physical layer data is now in the form of electrical signal and sent to other system. and than that system perfooms opposite task goes from physical to application layer.

__/__/____

6. Presentation layer

- Data in the application layer is in 'application format'
- It needs to be 'translated' to a different format to be sent over the network.
- the presentation layer's job is to translate b/w application and network formats
- for ex → Encryption of data as it is sent, and decryption of data as it is recieved.
- Also translates btw different application layer formats.

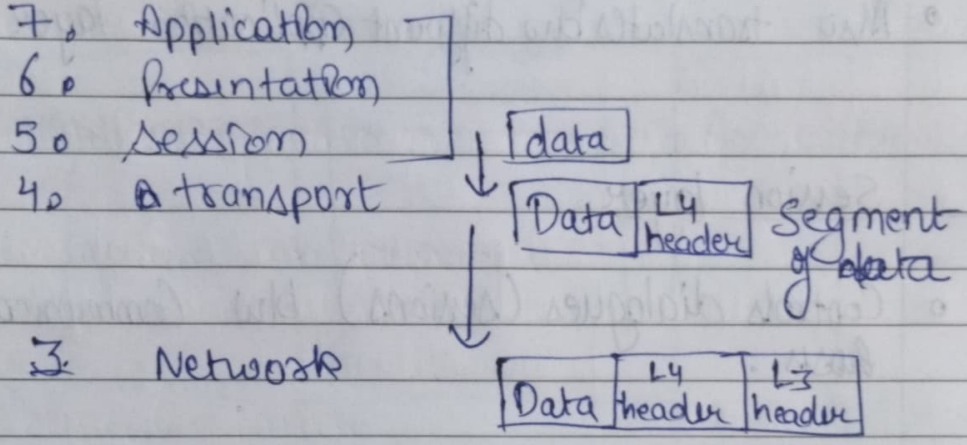
5. Session layer

- Controls dialogues (sessions) b/w Communicating hosts.
- Establishes, manages, and terminates connections btw the local application (for example, your web browser) and the remote application. (for ex → youtube).

Note ⇒ • Previous three layers are not used by network engineers.
• Application developers work with the top layers of the OSI model to connect their application over networks

4. Transport layer

- Segments and reassembles data for communication b/w end hosts.
- Breaks large pieces of data into smaller segments which can be more easily sent over the network and are less likely to cause transmission problems if error occurs.
- Provide host to host communication.

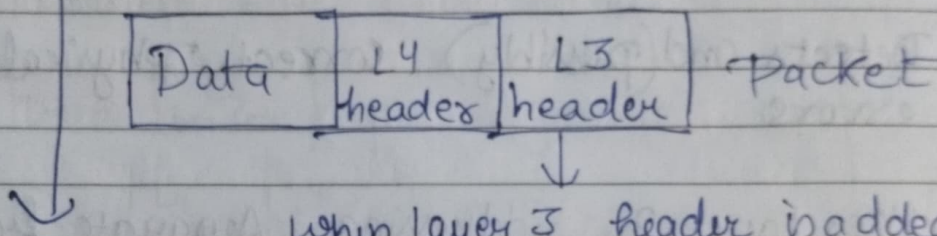


Note ⇒ when transport layer make segments it attaches all the segments with header.

⇒ then, when we go further to next layer i.e. network layer one more header is attached to the segment.

3. Network layer

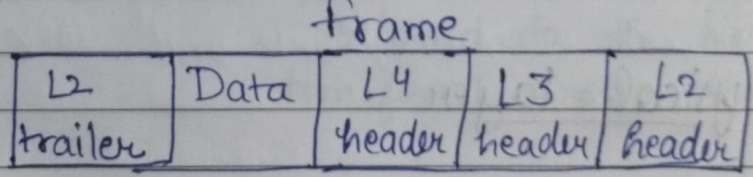
- provides connectivity btw end hosts in different networks (i.e. outside the LAN).
- provides logical Addressing (IP addresses).
- provides Path selection btw source and destination.
- routers operate at layer 3.



when layer 3 header is added to the data segment it consist of the information about the source and destinations IP addresses.

↓ further encapsulation to layer 2

then,



now, In layer 2, L2 trailer and header is also added to the packet.
now, it is called a frame

Layer 2 is the Data link layer.

2. Data link layer

- Provides node-to-node connectivity and data transfer (for ex- PC to switch, switch to router, router to router).
- Defines how data is formatted for transmission over a physical medium (for ex- copper UTP cables)
- Detects and (possibly) corrects physical layer errors.
- Uses Layer 2 addressing, separate from layer 3 addressing
- Switches operate at layer 2.

(Diagram on previous page).

1. Physical layer

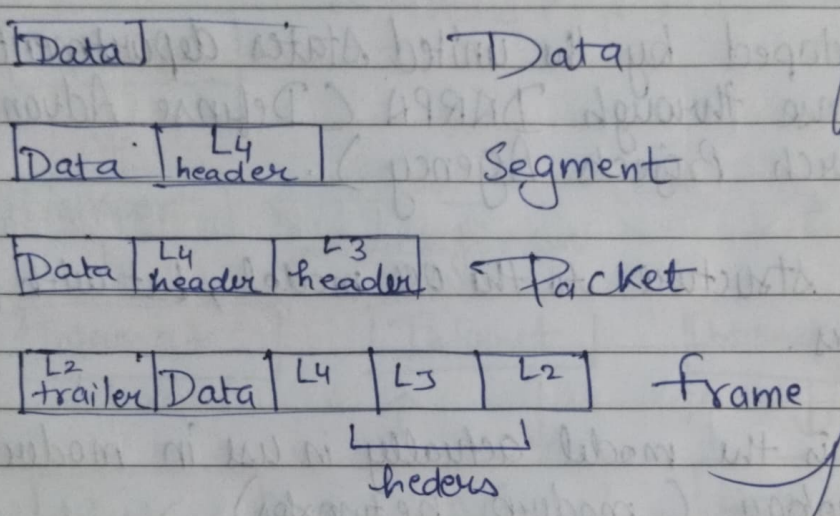
⇒ Data is not further encapsulated at this layer. this frame is then sent over the connection, whether its electrical signal over a wire. or wireless signal in case of wifi.

- Defines physical characteristics of the medium used to transfer data b/w devices
- for ex → voltage levels, maximum transmission distances, physical connectors, cable specifications, etc.

- Digital bits are converted into electrical (for wired) connections) or radio (for wireless connections) signals
- All of the information in Day 2's video (cables, pin, layouts etc.

first 3 layers

PDU's



Layer 1 PDU = Bit

↓

referred to the bits being transferred through the wire.