Computer Networks
Lab Manual

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1. Introduction

Computer Networking is the field of Computer Science which involves the intercommunication of computing devices for the transfer of data and resources. Networks can be established locally as well as globally.

Fig 1.1 - Computer Networks

Networks play a vital role in our daily life. It is crucial for various applications and for accessing the internet. It is widely used in industries to share data from one location to another.

The branch of computer networking consists of various components such as NIC , LAN , Nodes , Topologies , Links , Hubs , Switches , Routers , Access Points , Modems and many more. In the long run we are going to cover all the basic components of Computer Networking.

2. Cisco Packet Tracer

Computer Network is intangible so in order to learn the concepts of Computer Networks we would be needing stimulation. Cisco packet Tracer is one of the famous software which would be helpful in understanding the concepts of Computer Networks clearly.
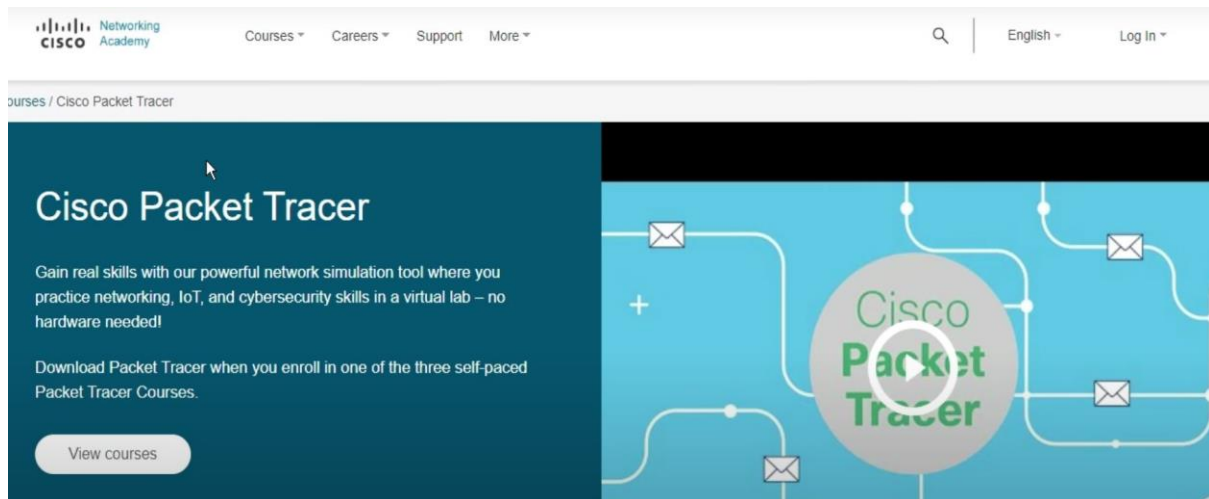
2.1. Installation and Setup

Aim : To Install and set up Cisco Packet Tracer.
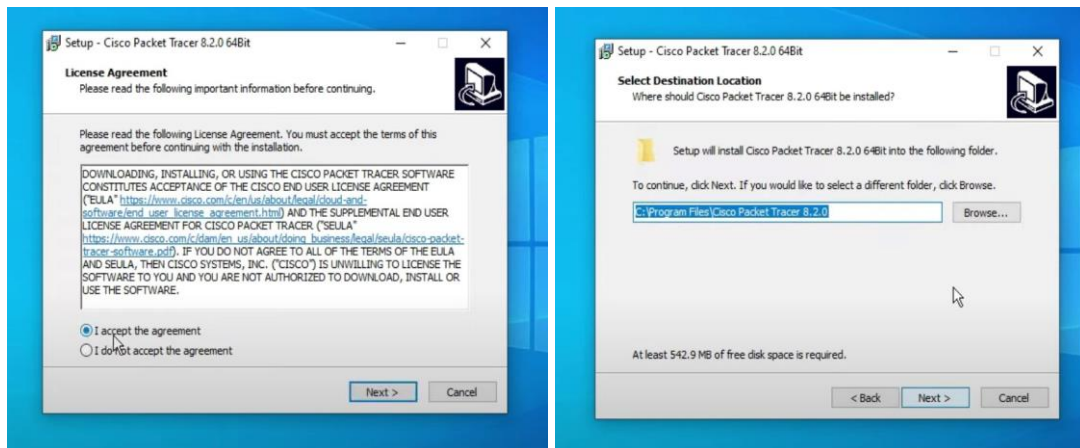
Apparatus : A pc with good internet connection.

Procedure:

1. Go to the webpage Cisco Networking Academy (netacad.com)

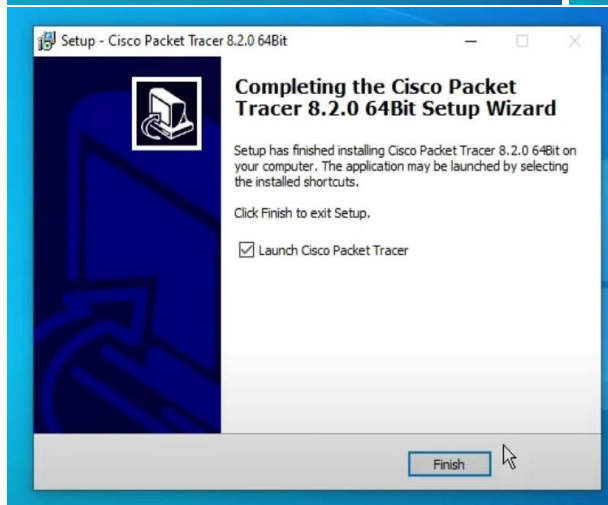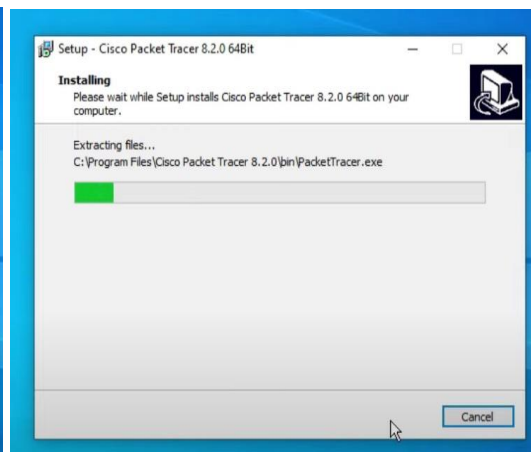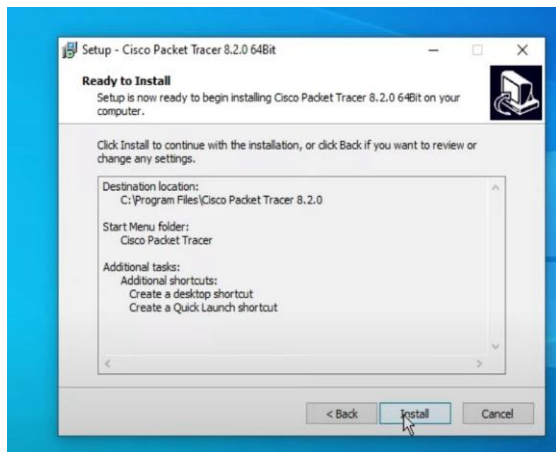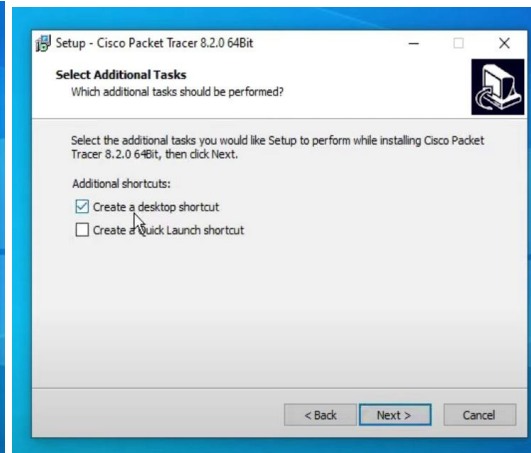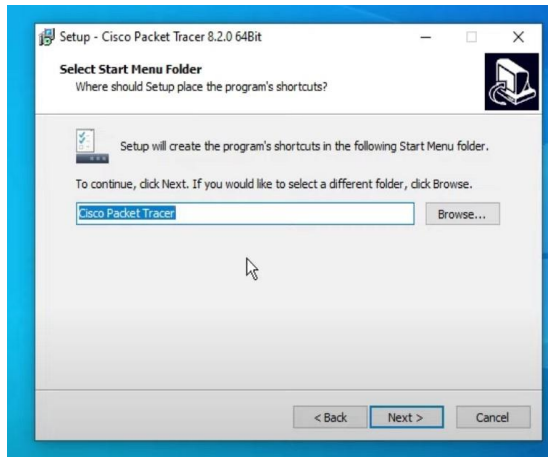2. Scroll down to find download option , click on the link based on your device

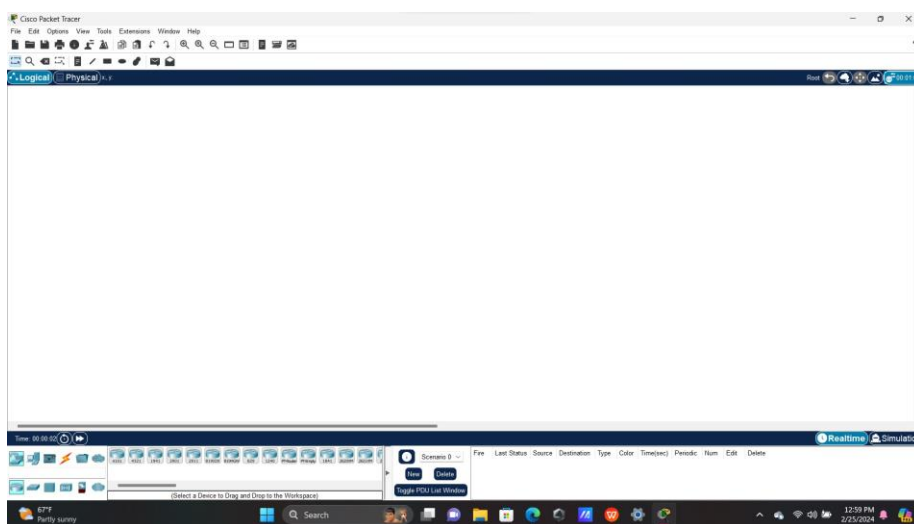3. A exe file will we downloaded , run it and keep.

4. Now open the app.

5. Login in with any of this if you don't have one sign up.

6. You have successfully installed and set up cisco packet tracer (CPT)

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3. Topologies

Network Topologies define the structures and how the components are connected in a computer network.
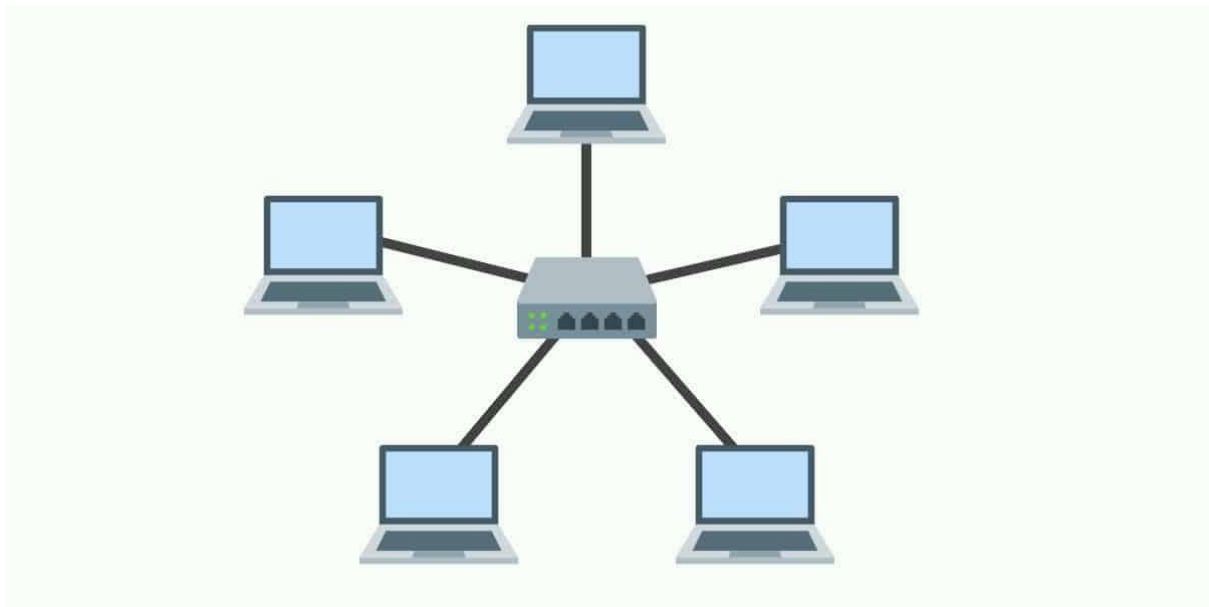
Fig 3.1 - Network Topology

3.1. Types of Topologies

The different types of topologies are:
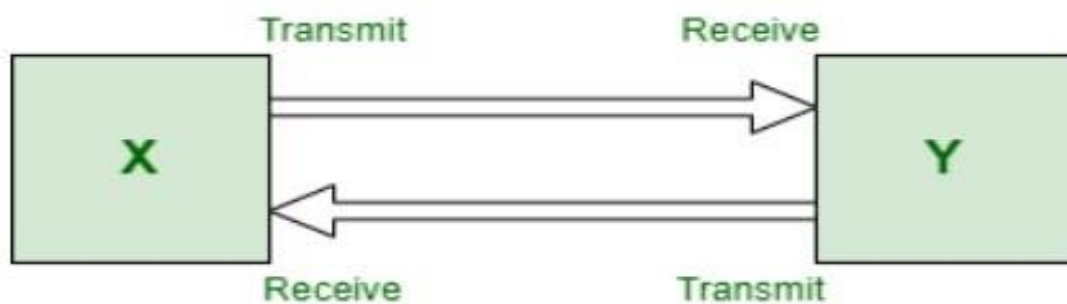
1. Point to Point Topology:

Fig 3.1.1 - Point to Point Topology

Structure : Single Node connected to other node (1 to 1)

Advantages : Simple , Low Latency , Secure , High Performance *Disadvantages* : Less Scalable , Limited Connectivity , High Cost

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2.Star Topology:
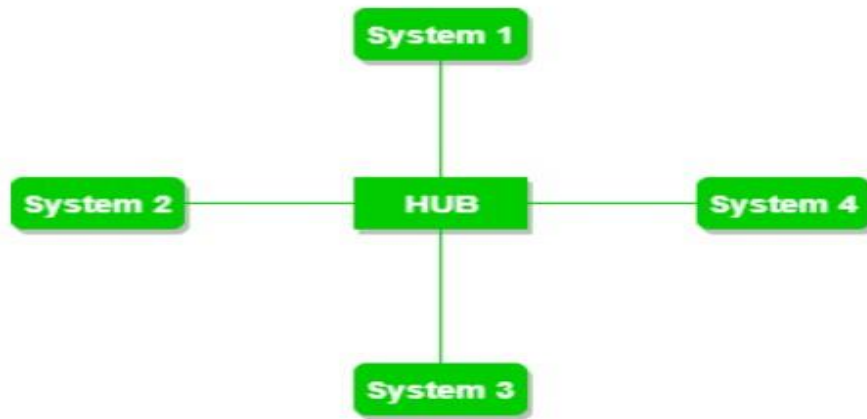
Fig 3.1.2 - Star Topology

Structure : Single Hub is connected to All Devices.

Advantages : Easy to Set Up , Less cost , Easy fault identification

Disadvantages : Hub Fail All Fail , Low Performance

3.Bus Topology:
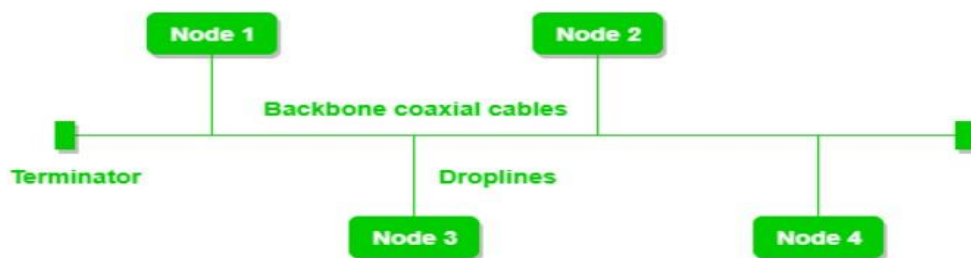

Fig 3.1.3 - Bus Topology

Structure : Single Hub is connected to All Devices.

Advantages : Easy setup , Scalable , Cost-Effective

Disadvantages : Security Concerns, Single Point of Failure, Performance Issues.

4.Mesh Topology:

Fig 3.1.4 - Mesh Topology

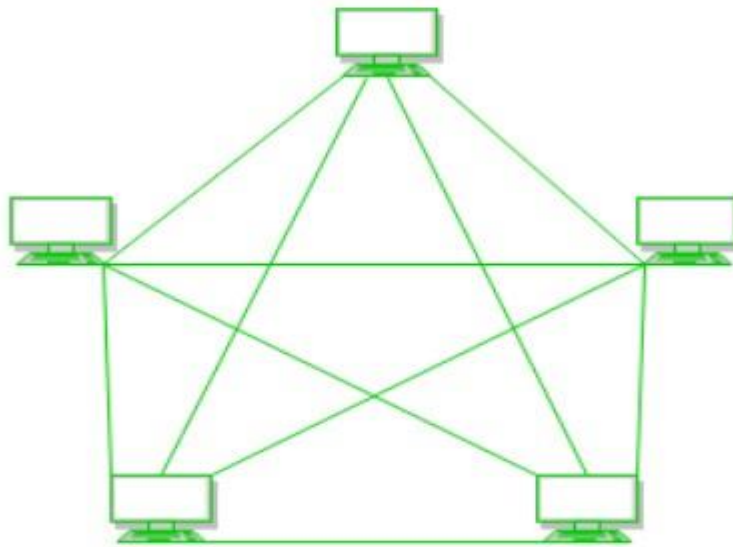**Structure** : All Devices connected to All Devices(N to N).

Advantages : Fast Communication , Secure , Faults easily Diagnosed **Disadvantages** : Hard to Set

Up , High cost

5.Ring Topology:

Structure : Station based Circular Topology

Advantages : High Speed , Low Cost , Less Collisions

Disadvantages : Less Secure , Troubleshooting is tough , single point of failure

Fig 3.1.5 - Ring Topology
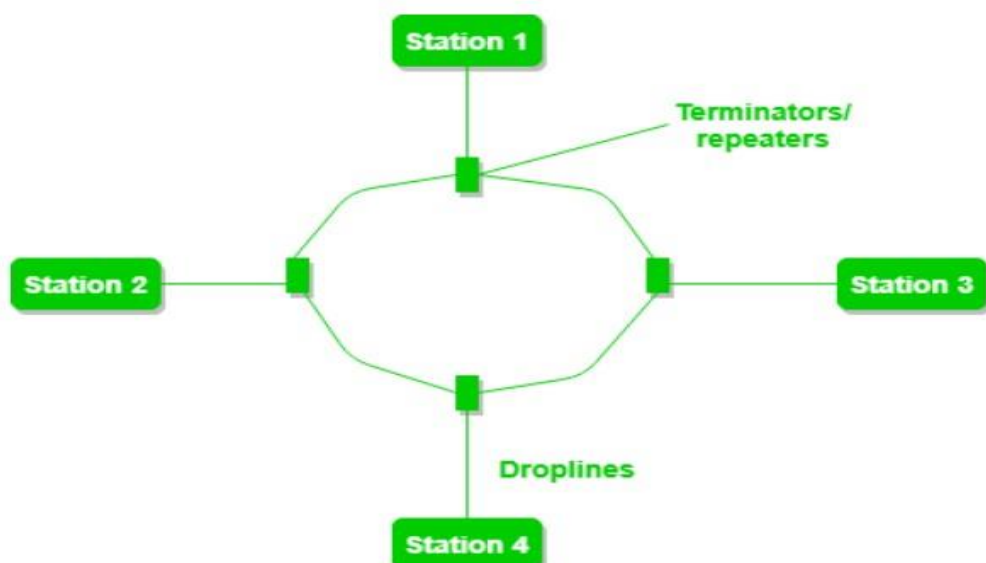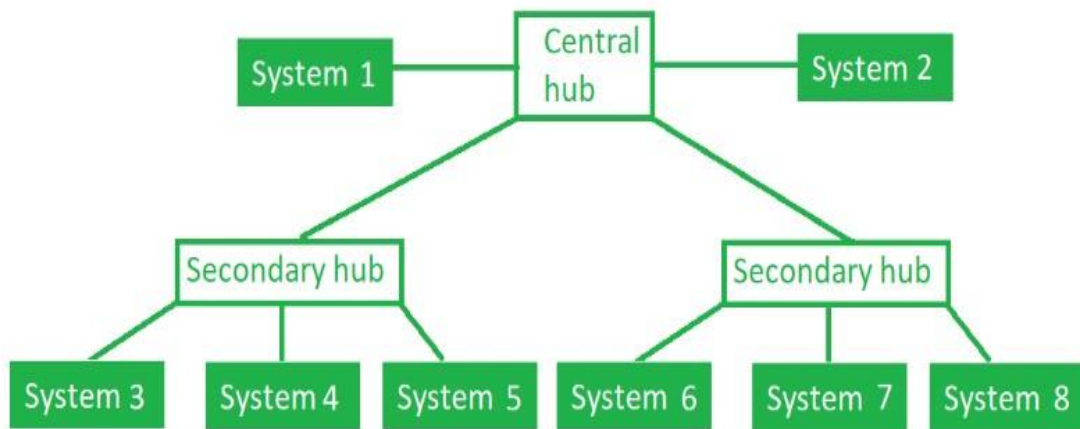

6.<u>Tree Topology:</u>

Fig 3.1.6 - Tree Topology

Structure : Like a Tree

Advantages : Isolation , Easy Error Detection

Disadvantages : High Cost , New Devices difficult to configure

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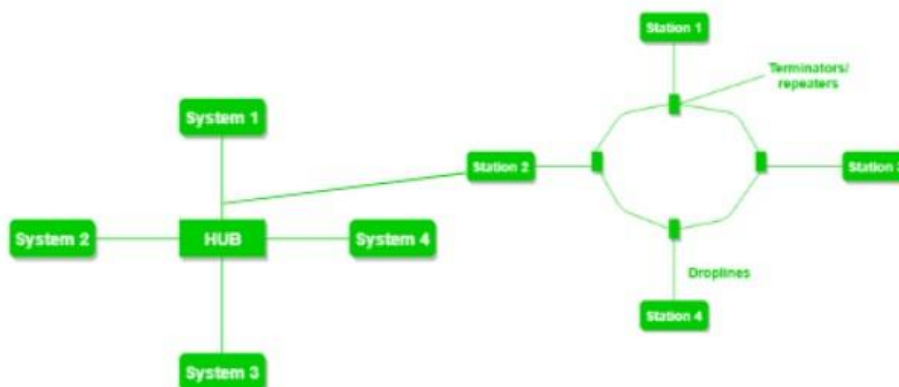## 6.<u>Hybrid Topology:</u>

Fig 3.1.7 - Hybrid Topology

Structure : Mixing of 2 or more Topologies

Advantages : More Features

Disadvantages : High Cost

3.1. Implementation of Topologies in Cisco Packet Tracer

Aim : To Implement Point Topology on CPT

Apparatus : A pc with CPT software.

Procedure:

1. Open the Cisco Packet Tracer
2. Create a new file
3. Setup the endpoints and connections as shown in figure below.
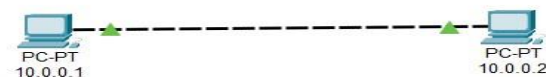

Fig 3.2.1.1 - Point Topology

4. Drag Two pc's from network devices.
5. Establish a cross-over connection between them.
6. Resolve all issues
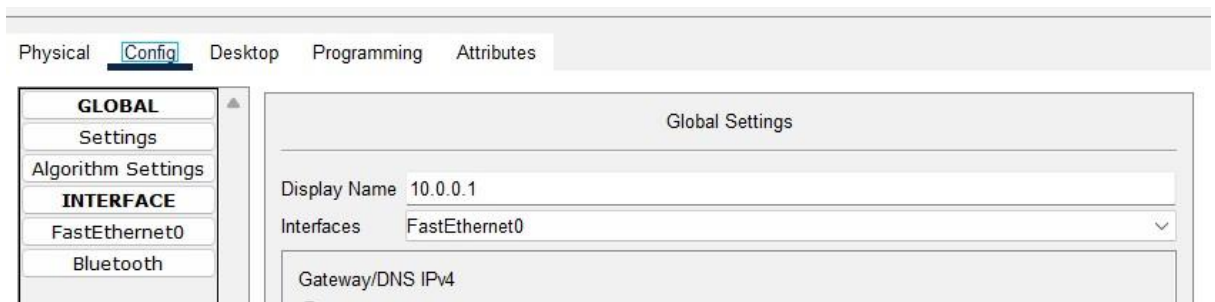7. Now configure both pc's Ip as 10.0.0.1 , 10.0.0.2 respectively

Fig 3.2.1.2 - IP Config

8. Open cmd in a device and make a ping request to another device in stimulation mode.

Fig 3.2.1.3 - Ping Req

Observation:
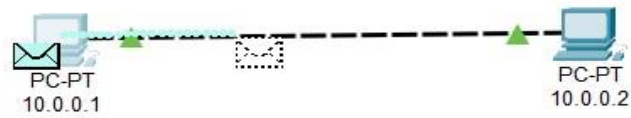
1. A message is being sent from one pc to another.
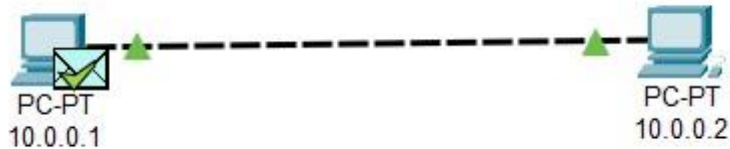
2. Another message comes back to the pc again(acknowledgment) , with a blinking green tick

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Aim : To Implement Bus Topology on CPT

Apparatus : A pc with CPT software.

Procedure:

1. Open the Cisco Packet Tracer
2. Create a new file
3. Setup the endpoints and connections as shown in figure below.

Fig 3.2.2.1 - Bus Topology

4. Drag 5 pc's from endpoints and 5 hubs from network devices
5. Establish a cross-over connection between hub-hub and straight-through connection between hub and pc..
6. Resolve all issues
7. Now configure pc's Ip as 10.0.0.1 , 10.0.0.2 …. 10.0.0.5 respectively.
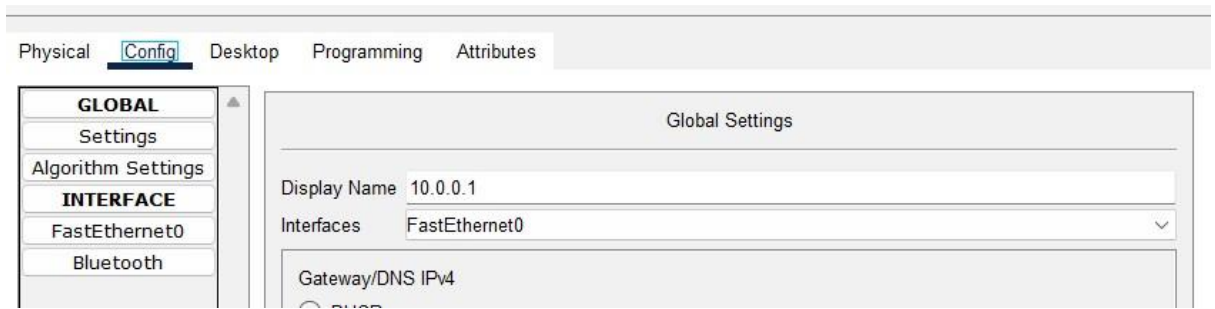
Fig 3.2.2.2 - IP Config

8. Open cmd in a device and make a ping request to other device in stimulation mode.

Fig 3.2.2.3 - Ping Req

Observation:
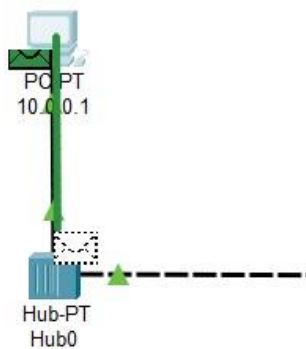
1. A message is sent to the hub from the sender.

2. Hub sends the message to all nearby hubs and devices.
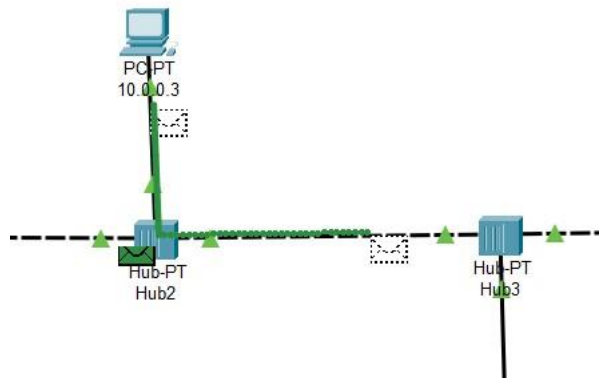
3. If message reaches wrong ip address , red cross mark flashes.

4. If the message reaches the correct ip address, the pc sends back an acknowledgement which once again repeats the process above until it reaches the sender computer and then a green tick flashes.
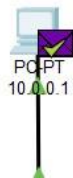
Aim : To Implement Mesh Topology on CPT

Apparatus : A pc with CPT software.

Procedure:

1. Open the Cisco Packet Tracer
2. Create a new file
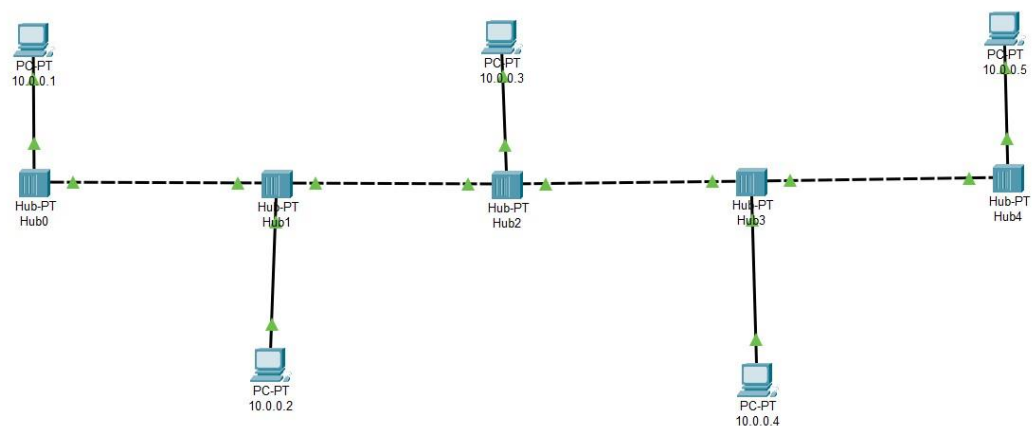3. Setup the endpoints and connections as shown in figure below.
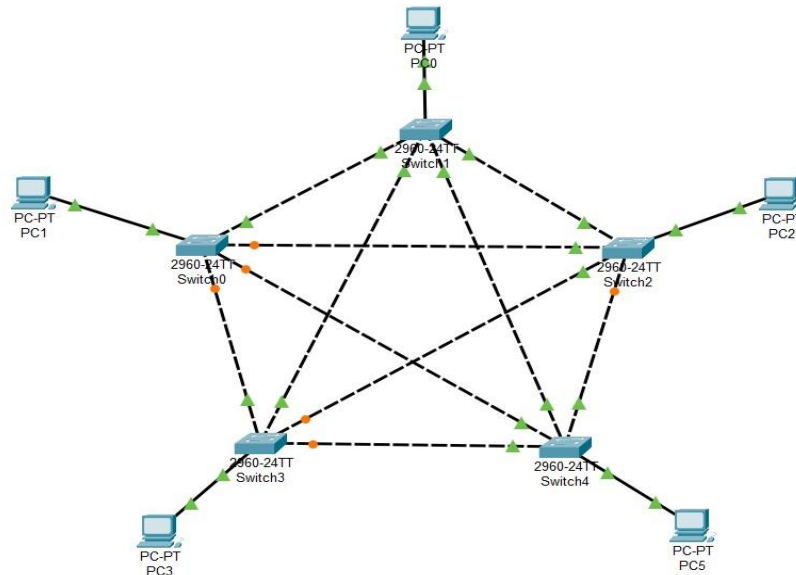
Fig 3.2.3.1 -Mesh Topology

4. Drag 5 pc's from endpoints and 5 switches from network devices

5. Establish a cross-over connection between switch-switch and straight-through connection between switch and pc..

6. Resolve all issues

7. Now configure pc's Ip as 10.0.0.1 , 10.0.0.2 …. 10.0.0.5 respectively.
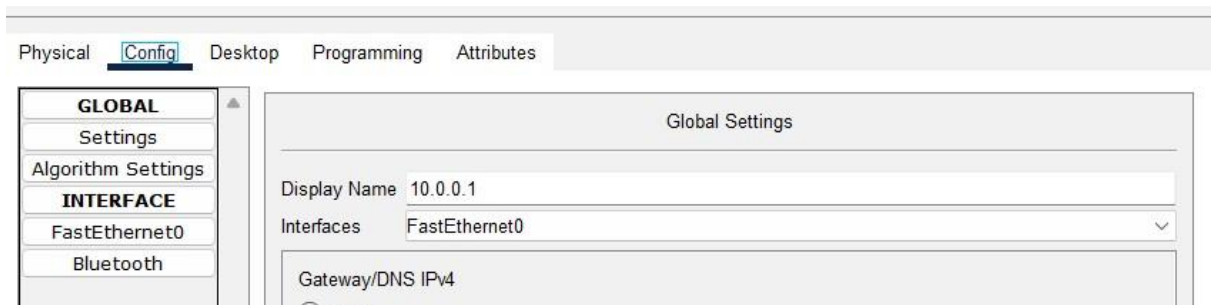
Fig 3.2.3.2 - IP Config

9. Open cmd in a device and make a ping request to another device in stimulation mode.

Fig 3.2.3.3 - Ping Req

Observation:

1. A message is sent to switch from sender.

2. Switch sends messages to all other switches as it is connected to all and further it is sent to nearby devices.

5. If message reaches wrong ip address , red cross mark flashes.

6. If the message reaches the correct ip address, the pc sends back an acknowledgement which once again repeats the process above until it reaches the sender computer and then a green tick flashes.

Aim : To Implement Ring Topology on CPT

Apparatus : A pc with CPT software.

Procedure:

1. Open the Cisco Packet Tracer
2. Create a new file
3. Setup the endpoints and connections as shown in figure below.
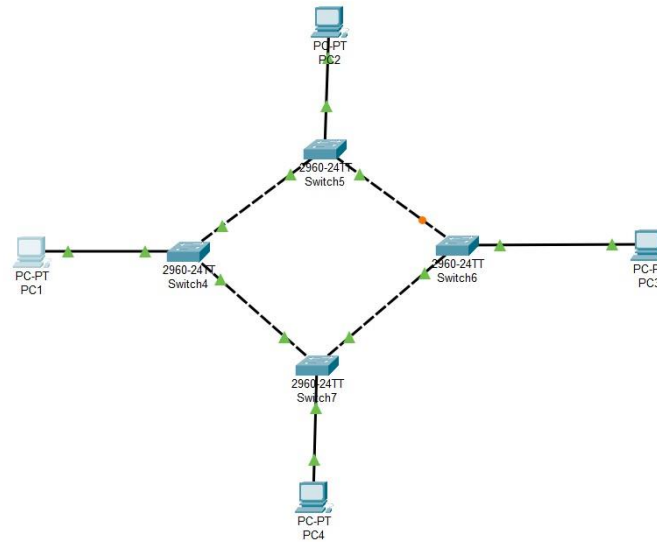
Fig 3.2.4.1 - Ring Topology

4. Drag 4 pc's from endpoints and 4 switches from network devices
5. Establish a cross-over connection between switch-switch and straight-through connection between switch and pc.
6. Resolve all issues
7. Now configure pc's Ip as 10.0.0.1 , 10.0.0.2 …. 10.0.0.4 respectively.

Fig 3.2.4.2 - IP Config

8. Open cmd in a device and make a ping request to another device in stimulation mode.

Fig 3.2.4.3 - Ping Req

Observation:

1. A message is sent to the switch from the sender.

2. Switch sends messages to all other switches as it is connected to all and further it is sent to nearby devices.

3. If message reaches wrong ip address , red cross mark flashes.

4. If the message reaches the correct ip address, the pc sends back an acknowledgement which once again repeats the process above until it reaches the sender computer and then a green tick flashes.

Aim : To Implement Star Topology on CPT
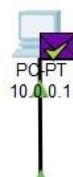
Apparatus : A pc with CPT software.

Procedure:

1. Open the Cisco Packet Tracer
2. Create a new file
3. Setup the endpoints and connections as shown in figure below.
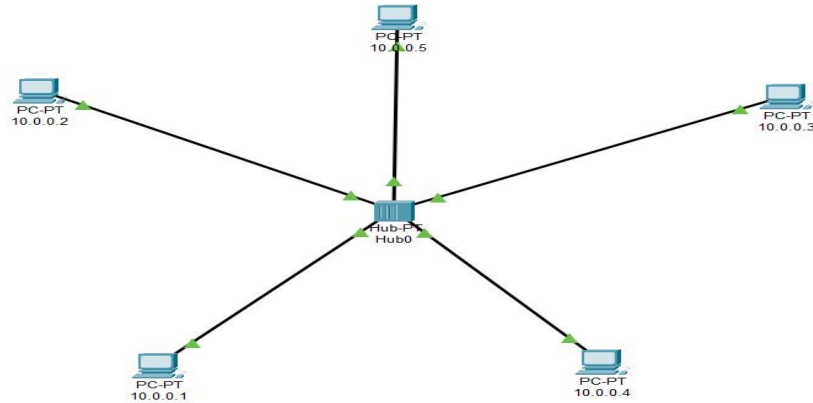
Fig 3.2.5.1 - Star Topology

4. Drag 5 pc's from end-devices and 1 hub from network devices.
9. Establish a straight-through connection between hub and pc. 10.Resolve all
issues
11. Now configure   pc's Ip as 10.0.0.1 , 10.0.0.2,....10.0.0.5 respectively

Fig 3.2.5.2 - IP Config

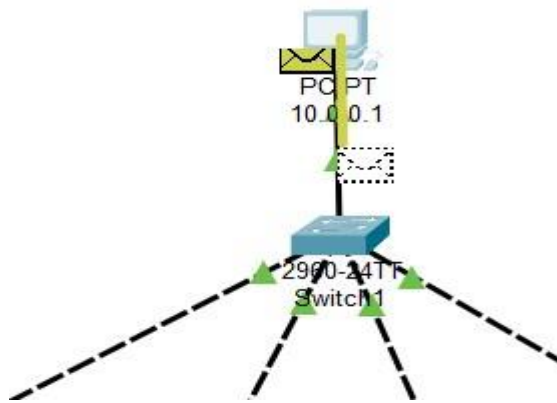12. Open cmd in a device and make a ping request to another device in stimulation mode.

Fig 3.2.5.3 - Ping Req

Observation:
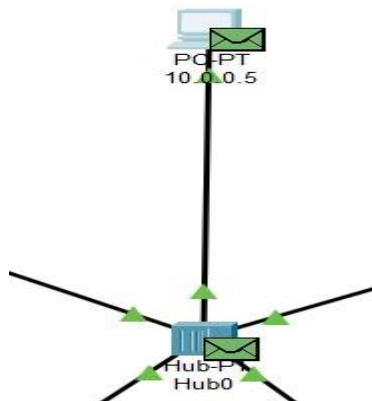
1. A message is being sent from sender to hub.
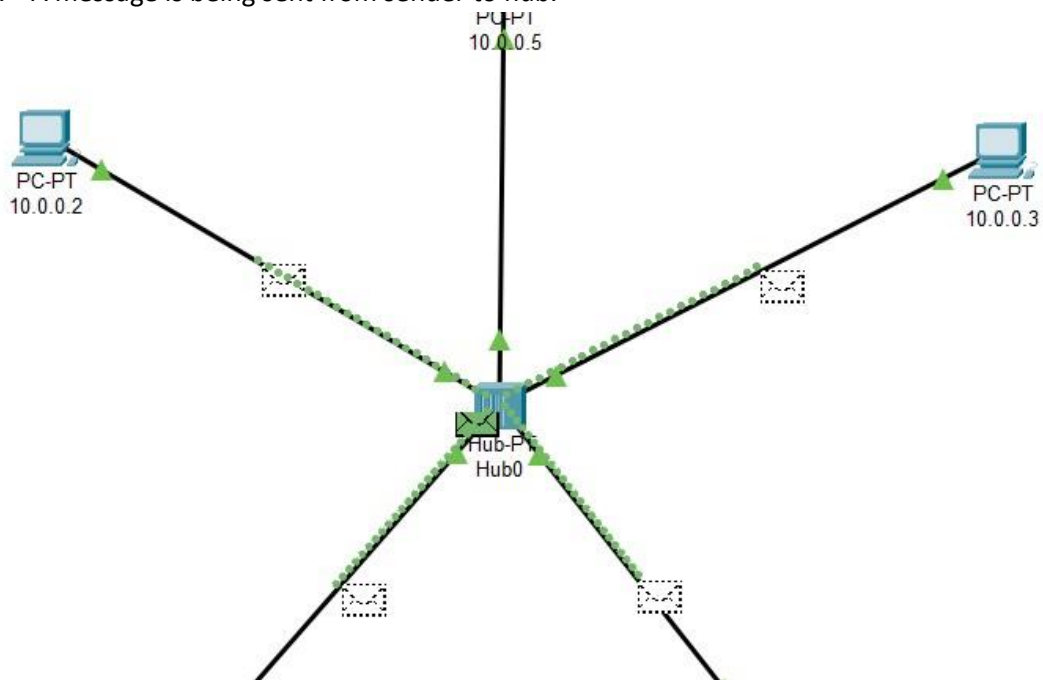
2. Hub sends it to all devices.
3. If message reaches wrong ip address , red cross mark flashes.

4. If the message reaches the correct ip address, the pc sends back an acknowledgement which once again repeats the process above until it reaches the sender computer and then a green tick flashes.

PC-PT
10.0.0.1
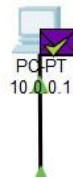
Aim : To Implement Tree Topology on CPT

Apparatus : A pc with CPT software.

Procedure:

1. Open the Cisco Packet Tracer

2. Create a new file

3. Setup the endpoints and connections as shown in figure below.
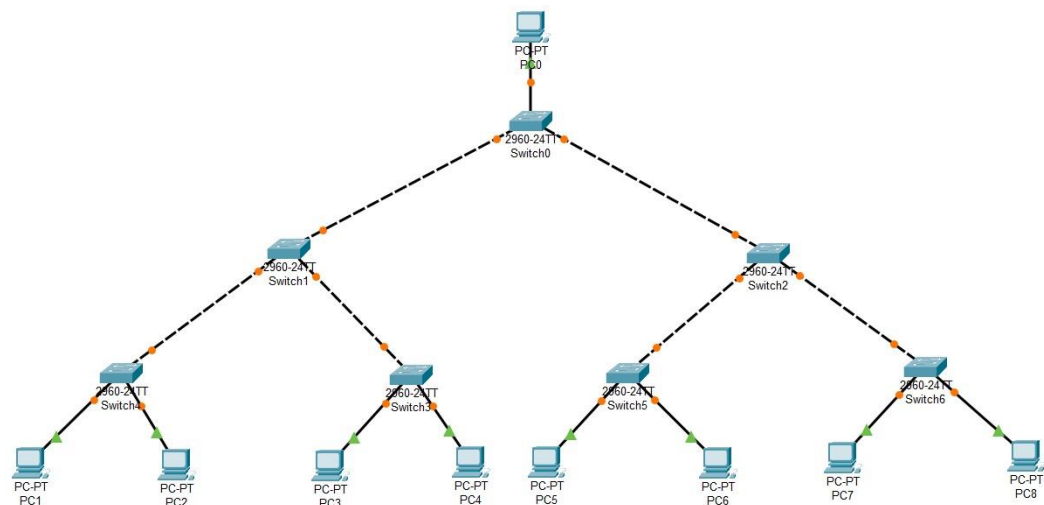
Fig 3.2.6.1 - Tree Topology

4. Drag 9 pc's from end-devices and 7 switches from network devices.

5. Establish a straight-through connection between hub and pc and cross-over connection between switch and switch.

6. Resolve all issues

7. Now configure   pc's Ip as 10.0.0.1 , 10.0.0.2,....10.0.0.9 respectively
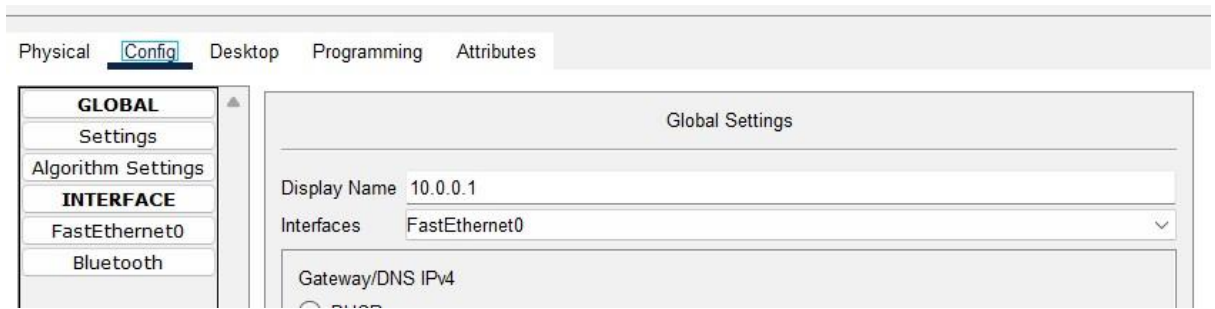
Fig 3.2.6.2 - IP Config

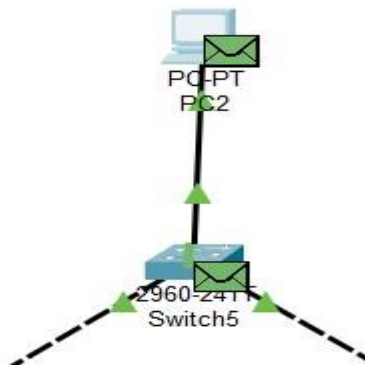8. Open cmd in a device and make a ping request to another device in stimulation mode.

Fig 3.2.6.3 - Ping Req

Observation:

1. A message is being sent in a   hierarchy from one level to other level.

2. If message reaches wrong ip address , red cross mark flashes.

PC-PT
10.0.0.4
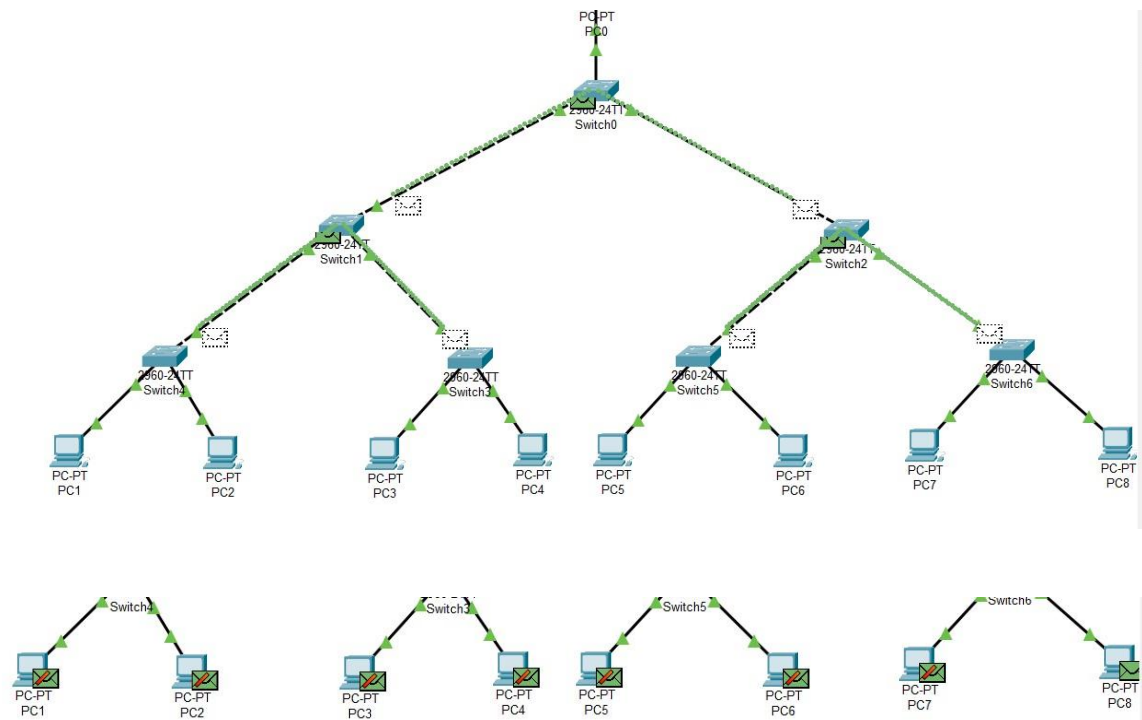
3. If the message reaches the correct ip address, the pc sends back an acknowledgement which once again repeats the process above until it reaches the sender computer and then a green tick flashes.

PC-PT
10.0.0.1

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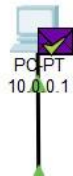
4. Internet Protocol Address (IP Address)

Internet Protocol Address is a Logical Address given to every device in a network so that they can communicate with each other.

4.1. Understanding IP Address

- IPv4 Address is a 32 bit address divided into 4 octals split by colons.

IPv4 Address Example

17.172.224.47

| 8 bits (1 byte) | 8 bits (1 byte) | 8 bits (1 byte) | 8 bits (1 byte) |

32 bits = 4 bytes
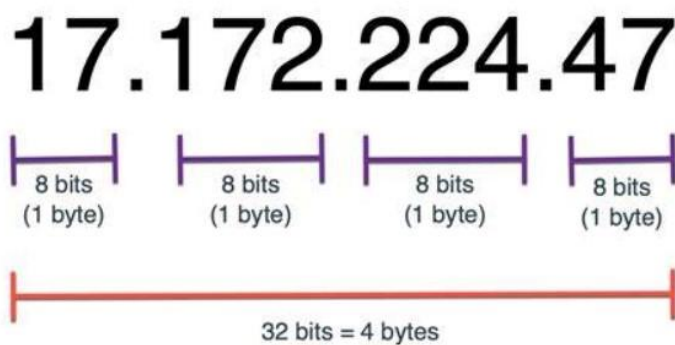
- Min value of a octal is 0 and max value of a octal is 255.
- IP Address is split into Network and host bits.

- The splitting is done by subnetting mask , 1 indicates network bit and 0 indicates the host bit.

Binary Notation of IP Address and Subnet

Network Portion   **Host Portion**

IP Address   **192.168.100.10**

8 bits   8 bits   8 bits   8 bits

11000000   10101000   01100100   00001010

Subnet Mask   **255.255.255.0**

8 bits   8 bits   8 bits   8 bits

11111111   11111111   11111111   00000000
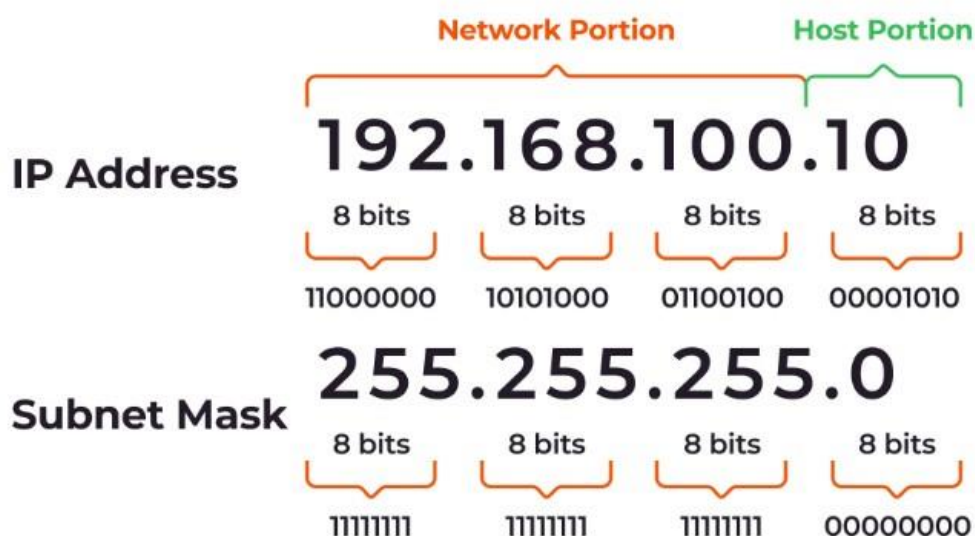
4.2. Classification of IP Address

IP addresses are classified as two types - Classful and Classless.

1. Classful IP Address :

- It is a type of Addressing Schema where the IP Address is split into different classes where each class has different subnetting. The different classes present in this schema are Class A , Class B , Class C , Class D , Class E.

Classes	Purpose
A , B , C	General Purpose
D	Multicasting
E	Research

Class	1st octet of IP address	Default Subnet Mask	Network / Host	Number of networks	Maximum nodes in a network
A	1 - 126	255.0.0.0	N.H.H.H	126	16,777,214
B	128 - 191	255.255.0.0	N.N.H.H	16,384	65,534
C	192 - 223	255.255.255.0	N.N.N.H	2,097,152	254
D	224 - 239				
E	240 - 254				

Fig 4.2.1 - Classes IP Range

- Each class has its own private ip ranges.

Class	RFC 1918		CIDR prefix
A	10.0.0.0	– 10.255.255.255	10.0.0.0/8
B	172.16.0.0	– 172.16.255.255	172.16.0.0/12
C	192.168.0.0	– 192.168.255.255	192.168.0.0/16

Fig 4.2.2 - Private IP Range

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5. Ethernet Cables

5.1. CAT 5 vs CAT 6
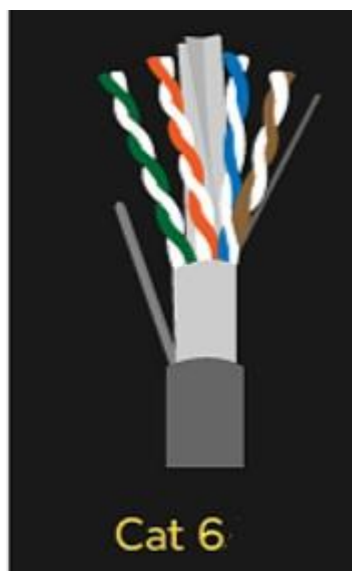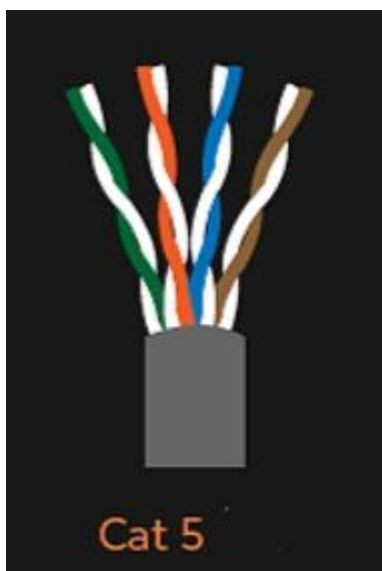
Cat 5

Cat 6

Fig 5.1.1 - CAT 5 vs CAT 6

Property	CAT 5	CAT 6
Plastic Separator	Absent	Present
Speed	2.5Gbps	10Gbps
Max Length	100m	55m
Bandwidth	100MHz	250MHz

Note : The plastic separator prevents interference

5.2. RJ45 Color Coding

Though there is no electrical difference between both wires they are used as per technical standards.

T568 A

T568 B
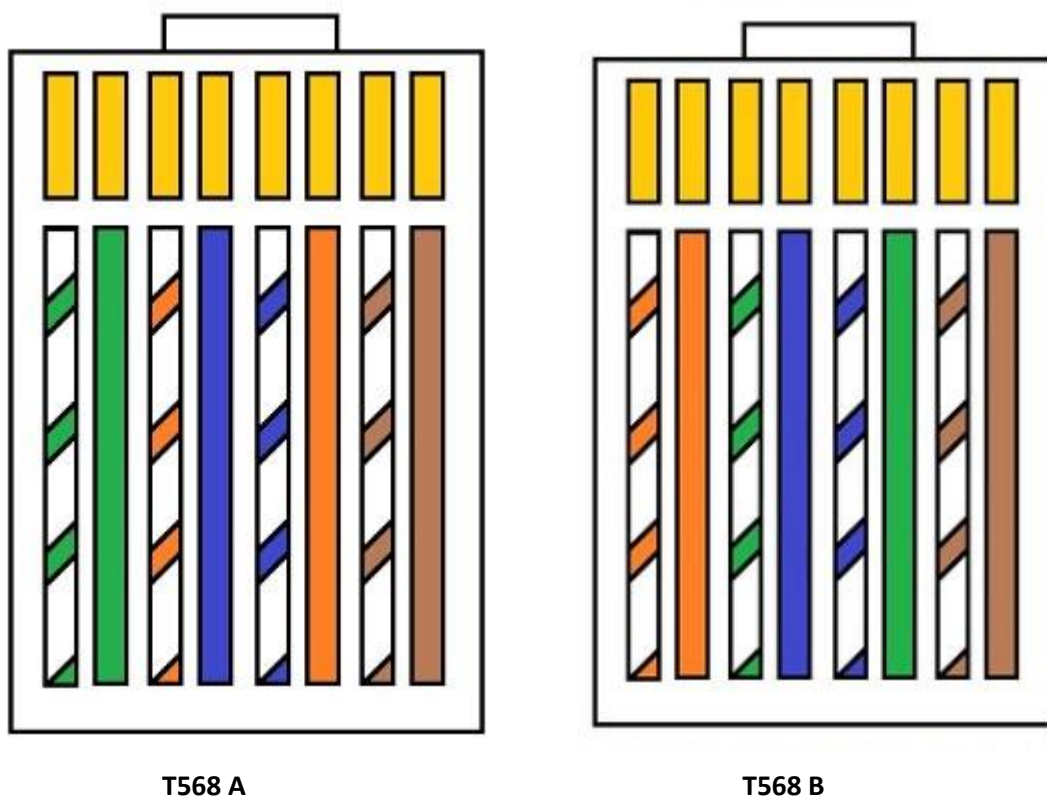
Based on the color coding on edges of wires , the wires are split into two kinds:

1. **Straight Through Wire:**
   - Same color code on both sides ● Used to connect two different devices

2. **Cross Over Wire:**

- Different color code on both sides
- Used to connect two same devices

1	White and Orange	1
2	Orange	2
3	White and Green	3
4	Blue	4
5	White and Blue	5
6	Green	6
7	White and Brown	7
8	Brown	8

5.3. Crimping a Ethernet Cable

Crimping an ethernet cable is the process of attaching connectors onto the ends of ethernet cables. Lets see how we crimp a RJ45 ethernet cable.

Aim : To Crimp a RJ45 cable **Apparatus :**

1. **RJ45 Crimping Tool**

It is the primary tool used for doing crimping, i.e compressing golden pins of connecter to wires of ethernet.

2. **Cable Stripper**

It is used to strip off the protecting layer of ethernet cable

3. **RJ45 Connecter**

These are connected to the ends of the cables

4. **RJ45 Boots**

Placed at edges for protection to RJ45 connector and wire connection.

5. **RJ45 Cable Tester**

Used to test if the RJ45 connector is properly connected or not.

Procedure:

1. Strip the ends of the cable using a cable stripper and remove the foil over it.

2. Untwist the wires.
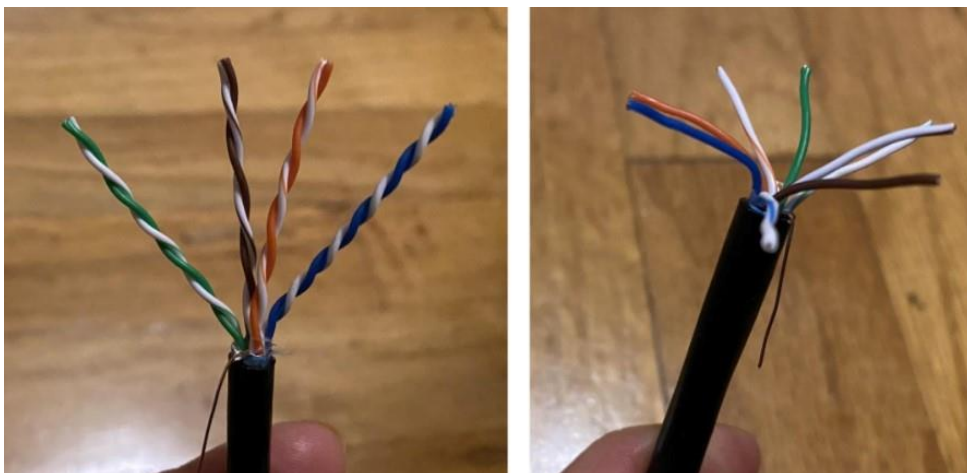
3. Straighten the wires and lay them in a order based on color code you choose.
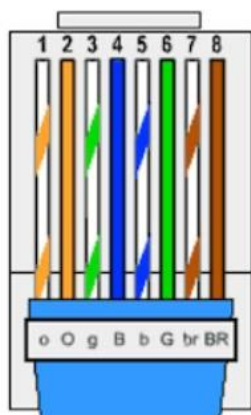
RJ-45 Plug
Pin 1
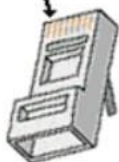
Clip is pointed
away from you.

4. Trim the wires

5. Slide down the RJ45 connector into the wires

clip side down

Make sure you can see the shiny copper tips of all 8 small wires, or they might not be in far enough.

Look through the sides to make sure they're all the way in. Make sure wire color order is maintained.

6. Now crimp using RJ45 crimper
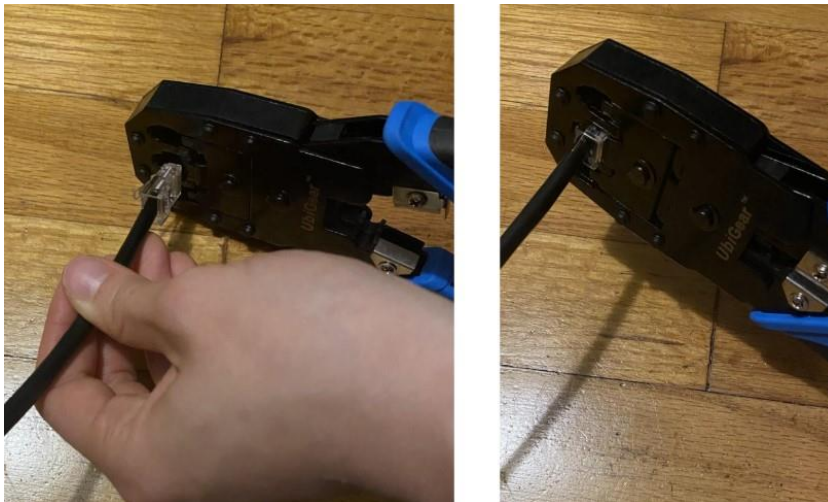
7. Test it.

6. Switches

Switches are points of connectivities in an ethernet network. Switch receives data from multiple devices and transfers data to specific devices .

There are two type of Switches : ●

    Layer 2 Switches

  ●   Layer 3 Switches (Routers)

6.1. Layer 2 Switches

Switches which work on Data Layer are called Layer 2 switches. These switches have a mapping of MAC Address along with their ports , which makes the transfer of data quick and efficient.

Aim : To Understand working of a switch and how it updates MAC Table.

Apparatus : A pc with CPT software.

Procedure 1:

- Create a star topology using CPT using a switch.
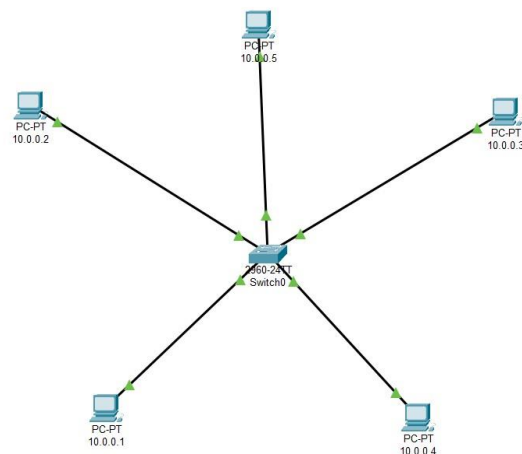
Fig 6.1.1 - Star Topology with switch

- Open CLI in switch and use command ' show mac-address-table ' , you will observe a empty table

```
Switch>show mac-address-table
          Mac Address Table
-------------------------------------------------

Vlan     Mac Address        Type        Ports
----     -----------        --------    -----
```

Fig 6.1.2 - Empty Mac Table

● Make a ping request from one device to any other device , which helps in switch building its own mac table.

```
Cisco Packet Tracer PC Command Line 1.0
C:\>ping 10.0.0.3

Pinging 10.0.0.3 with 32 bytes of data:

Reply from 10.0.0.3: bytes=32 time=1ms TTL=128
Reply from 10.0.0.3: bytes=32 time<1ms TTL=128
Reply from 10.0.0.3: bytes=32 time<1ms TTL=128
Reply from 10.0.0.3: bytes=32 time<1ms TTL=128
```

Fig 6.1.3 - Ping Request

● The mac table get updated , now run the previous command again.
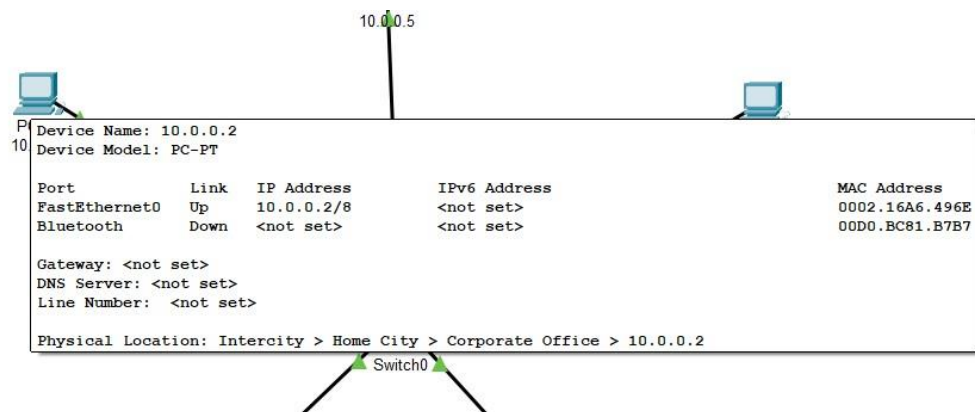
Fig 6.1.4 . MAC Address of particular PC
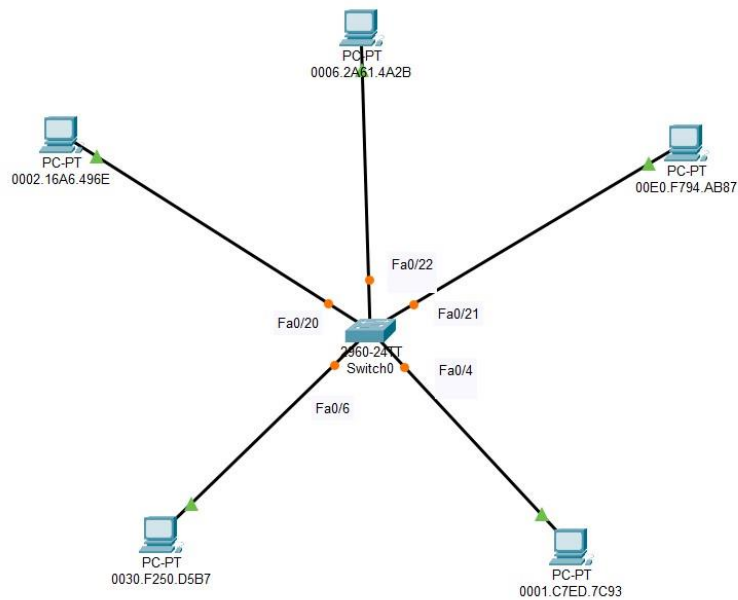
Fig 6.1.5 - PC labelled with their mac address

```
            Mac Address Table
--------------------------------------------

Vlan    Mac Address        Type       Ports
----    -----------        --------   -----

  1     0001.c7ed.7c93     DYNAMIC    Fa0/7
  1     0002.16a6.496e     DYNAMIC    Fa0/20
  1     0006.2a61.4a2b     DYNAMIC    Fa0/22
  1     00e0.f794.ab87     DYNAMIC    Fa0/21
```

Fig 6.1.6 - The Updated MAC Table

● This mac table is used by the switch for the next service .

Procedure 2:

● Create a ring topology using CPT using switches and   label them with their IP address , Mac Address and Ports.

● Send ping requests from one pc to all other pcs.

● Notice how the mac table of a switch changes every time you make a ping.

Fig 6.1.7 - Ring Topology

Fig 6.1.8 - Ping Req from PC1

Fig 6.1.9 - Switch 5 Mac Table

```
Vlan      Mac Address        Type        Ports
----      -----------        --------    -----

   1      0002.16d6.1801     DYNAMIC     Fa0/19
   1      00e0.a3ed.6818     DYNAMIC     Fa0/21
Switch>show mac-address-table
          Mac Address Table
-------------------------------------------------

Vlan      Mac Address        Type        Ports
----      -----------        --------    -----

   1      0002.16a7.9c4a     DYNAMIC     Fa0/19
   1      0002.16d6.1801     DYNAMIC     Fa0/19
   1      0004.9ad5.8729     DYNAMIC     Fa0/24
   1      00e0.a3ed.6818     DYNAMIC     Fa0/21
Switch>show mac-address-table
          Mac Address Table
-------------------------------------------------

Vlan      Mac Address        Type        Ports
----      -----------        --------    -----

   1      0002.16a7.9c4a     DYNAMIC     Fa0/19
   1      0002.16d6.1801     DYNAMIC     Fa0/19
   1      0002.4a37.cd06     DYNAMIC     Fa0/21
   1      0004.9ad5.8729     DYNAMIC     Fa0/24
   1      00e0.a3ed.6818     DYNAMIC     Fa0/21
Switch>show mac-address-table
          Mac Address Table
-------------------------------------------------

Vlan      Mac Address        Type        Ports
----      -----------        --------    -----

   1      0002.16a7.9c4a     DYNAMIC     Fa0/19
   1      0002.16d6.1801     DYNAMIC     Fa0/19
   1      0002.1731.7331     DYNAMIC     Fa0/21
   1      0002.4a37.cd06     DYNAMIC     Fa0/21
   1      0004.9ad5.8729     DYNAMIC     Fa0/24
   1      00e0.a3ed.6818     DYNAMIC     Fa0/21
Switch>
```
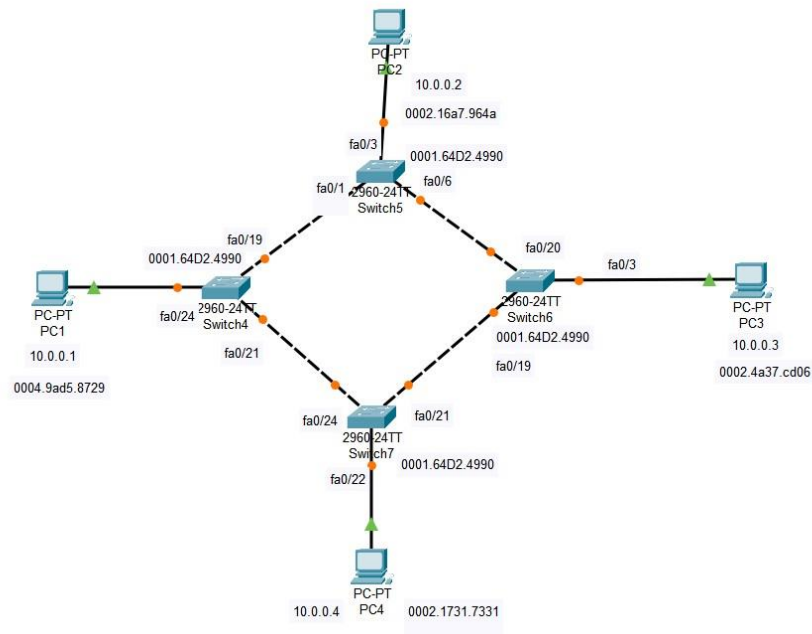
Fig 6.1.9 - Switch 4 Mac Address Table Updation after every ping

Note : Everytime we make a ping request the switch updates its mac table with a nearby port using some algorithms.
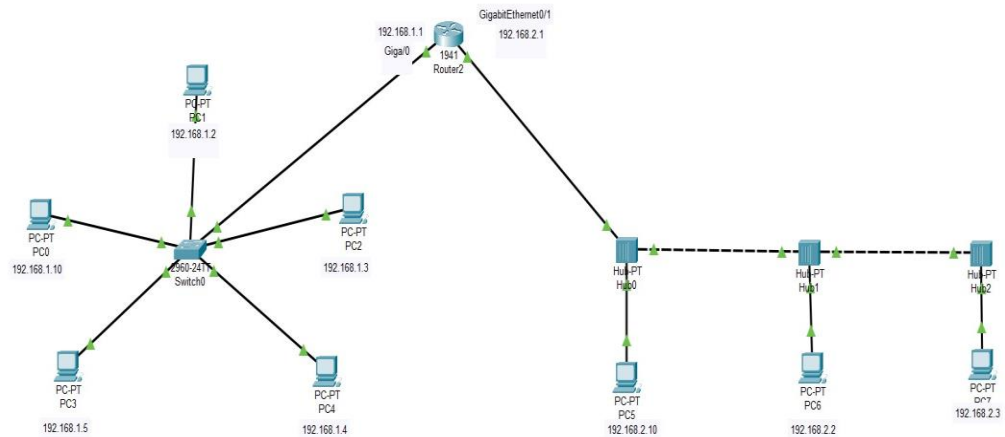
7. Routers

7.1. SINGLE ROUTER

Aim : To Setup Single Router

Apparatus : A pc with CPT software.

Procedure:

1. Create a setup as shown in the figure.

2. Connect the router in between the two topologies.
3. FIrst topology belongs to 192.168.1.0 and other 192.168.2.0
4. Now connect the endpoints of both topologies to the router and now its time to set-up router interfaces.
5. Enter the below commands.

```
My-Router(config)# interface GigabitEthernet 0/0
My-Router(config-if)# ip address 100.100.100.1 255.255.255.252
My-Router(config-if)# no shutdown
My-Router(config-if)# exit

My-Router(config)# interface GigabitEthernet 0/1
My-Router(config-if)# ip address 192.168.10.1 255.255.255.0
My-Router(config-if)# no shutdown
My-Router(config-if)# exit
```

6. You can even set it up at configure inside the router.
7. Now send a message from one topology to other side.

Observation:

1.   The message was successful at 2nd attempt.

●	Failed	PC4	PC5	ICMP ■
●	Successful	PC4	PC5	ICMP ■

7.2 TWO ROUTERS

Aim : To Setup Two Routers using Static Routing.

Apparatus : A pc with CPT software.

Procedure:

1. Create a setup as shown in the figure.
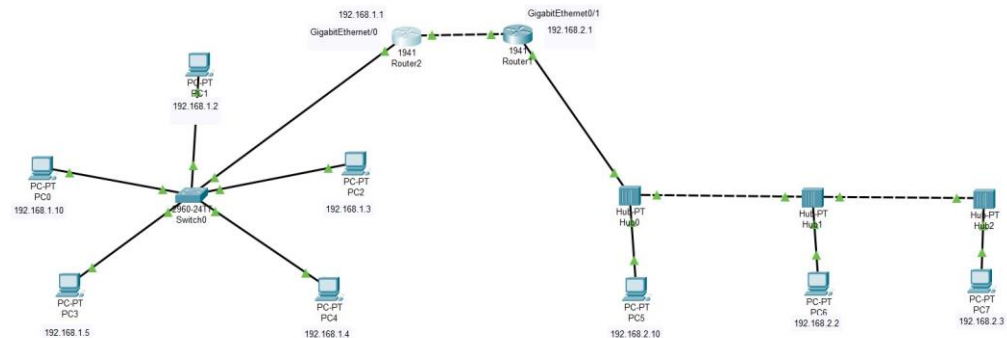
2. Same setup as the above one but add an extra router.
3. At the terminals of router and topologies setup the gateways and ports as shown above.
4. Now in between two routers setup one port as 192.168.3.1 and other port gateway as 192.168.3.2
5. Now you need to setup static routes in config of router.

6. You can also set up using command prompt also.

```
Router(config)#ip route 192.168.2.0 255.255.255.0 192.168.3.2
```

7. Ping a message.

Observation:

1.   Successful after 2 failures.

7.3. THREE ROUTERS

Aim : To Setup 3 Routers using RIP.

Apparatus : A pc with CPT software.

Procedure:

1. Setup the apparatus as shown in the figure below.
2. Use router pt and connect all the routers with serials and give two connecting serials the ip of same network , i gave 10.0.0.0 and 11.0.0.0 series and for pcs 192.168.10.0 , 20.0 , 30.0.

3. Now Setup RIP using RIP config inside the router.

RIP Routing

Network

Add

Network Address
10.0.0.0
11.0.0.0
192.168.20.0

4. Add all the networks which are connected to the router.

5. You can also use router rip command.

6. Activate all

7. Send a ping message.

Observation:

1.   Message successfully set after the 2 failures.
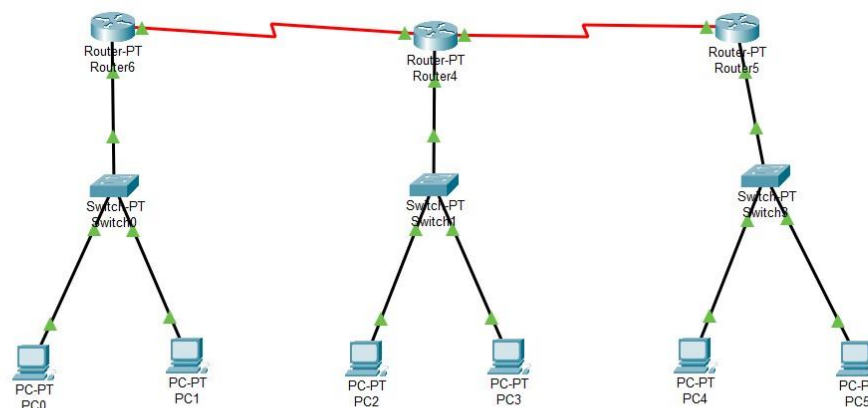

7.4. FOUR ROUTERS

Aim : To Setup 4 Routers using OSPF.

Apparatus : A pc with CPT software.

Procedure:

1. Setup the apparatus as shown in the figure.
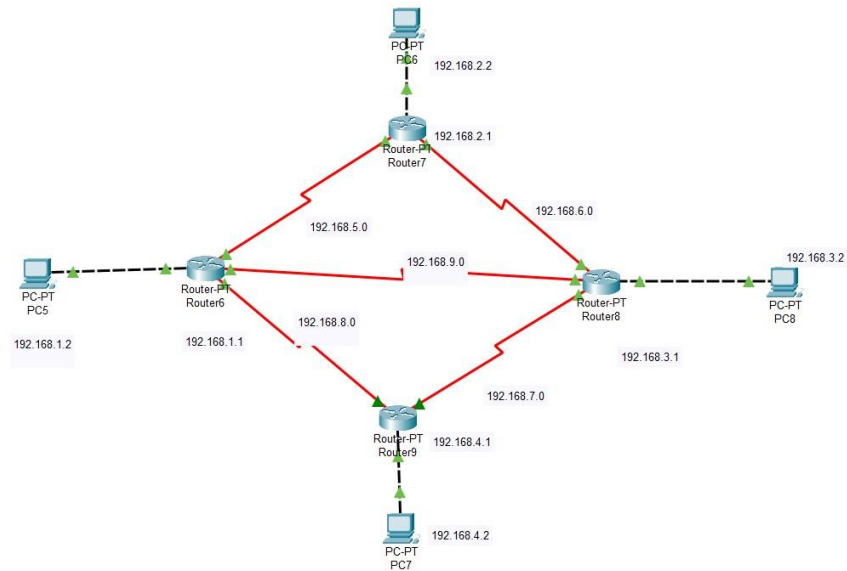
2. Setup all the gateways at the routers and as well as the connections between them.

3. Use the below commmand in cli of each router and add all the networks connected to it and note that the subnet is reversed.

```
Router(config)#router ospf 1
Router(config-router)#network 192.168.3.0 0.255.255.255 area 0
Router(config-router)#network 20.0.0.0 0.0.0.255 area 0
Router(config-router)#exit
```

4. Send a ping request.

Observation:

1.   Successful message in the first attempt.

---

8. Telent and SSH Setup

Aim : Setup the Telenet Remote access and SSH.

Apparatus : A pc with CPT software.

Procedure:

1. Connect a pc to switch/router.

2. Now inside the switch configure this.

```
Switch(config)#
Switch(config)#
Switch(config)#
Switch(config)#int vlan 1
Switch(config-if)#no shut

Switch(config-if)#
%LINK-5-CHANGED: Interface Vlan1, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan1, changed state to up

Switch(config-if)#
Switch(config-if)#
Switch(config-if)#
Switch(config-if)#
Switch(config-if)#
Switch(config-if)#ip add 10.0.0.10 255.0.0.0
Switch(config-if)#
Switch(config-if)#exit
Switch(config)#line vty 0 4
Switch(config-line)#password cisco
Switch(config-line)#login
Switch(config-line)#exit
Switch(config)#enable secret cisco12
Switch(config)#
```

3. Inside the pc command prompt enter these.

```
C:\>
C:\>
C:\>
C:\>telnet 10.0.0.10
Trying 10.0.0.10 ...Open


User Access Verification

Password:
Switch>en
Password:
Switch#
Switch#
Switch#
Switch#show mac-address-table
          Mac Address Table
---------------------------------------------

Vlan    Mac Address       Type        Ports
----    -----------       --------    -----

  1     000b.bela.8072    DYNAMIC     Fa0/1
Switch#
```

Obervation:

1. The Telent i.e remote control is successful.

Procedure:

1. Connect a pc to switch/router.
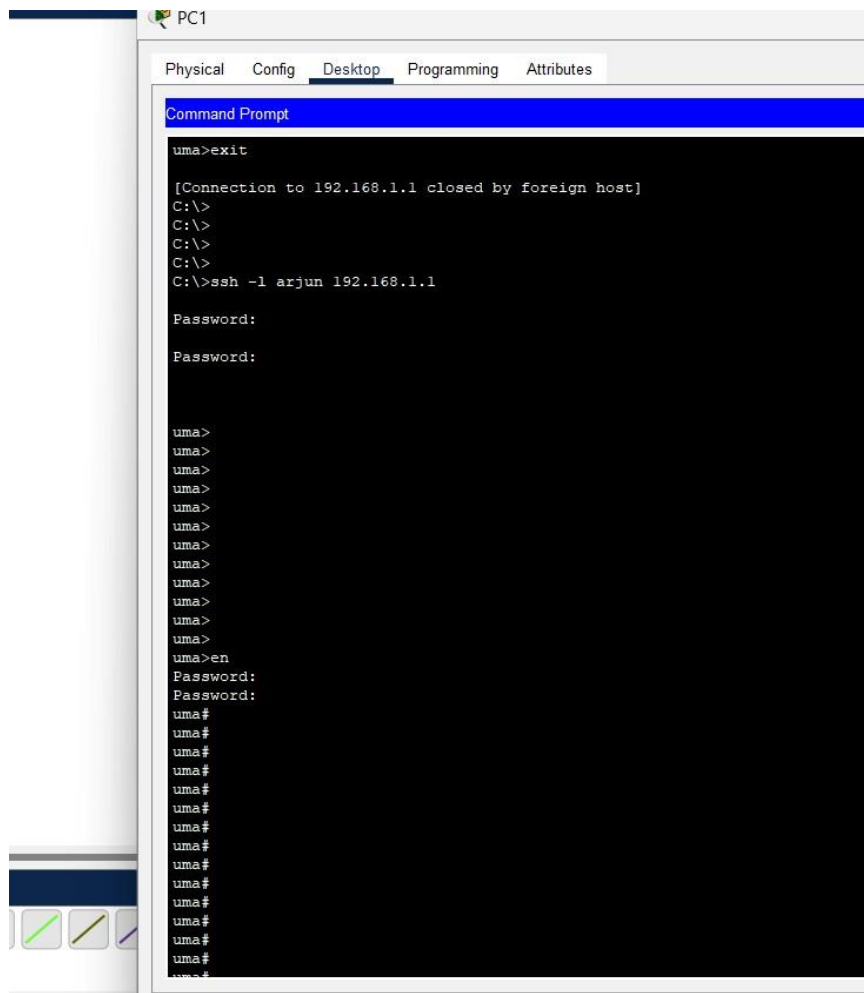2. Configure the following commands.

```
Router(config)#ip domain-name GeeksforGeeks.com
Router(config)#hostname Router1
Router1(config)#line vty 0 4
Router1(config-line)#transport input ssh
Router1(config-line)password GeeksforGeeks
Router1(config-line)#login
```

```
Router1(config)#line vty 0 4
Router1(config-line)#crypto key generate rsa
```

3. Open the cmd in pc and type the below command.

```
Router2#ssh -l Cisco 192.168.1.1
```

4. Remote access is granted.

PC1

Physical   Config   Desktop   Programming   Attributes

Command Prompt

```
uma>exit

[Connection to 192.168.1.1 closed by foreign host]
C:\>
C:\>
C:\>
C:\>
C:\>ssh -l arjun 192.168.1.1

Password:

Password:


uma>
uma>
uma>
uma>
uma>
uma>
uma>
uma>
uma>
uma>
uma>
uma>
uma>en
Password:
Password:
uma#
uma#
uma#
uma#
uma#
uma#
uma#
uma#
uma#
uma#
uma#
uma#
uma#
uma#
```

---

9. DHCP Setup

Aim : To Setup DHCP

Apparatus : A pc with CPT software.

Procedure:

1. Create the setup as show below.
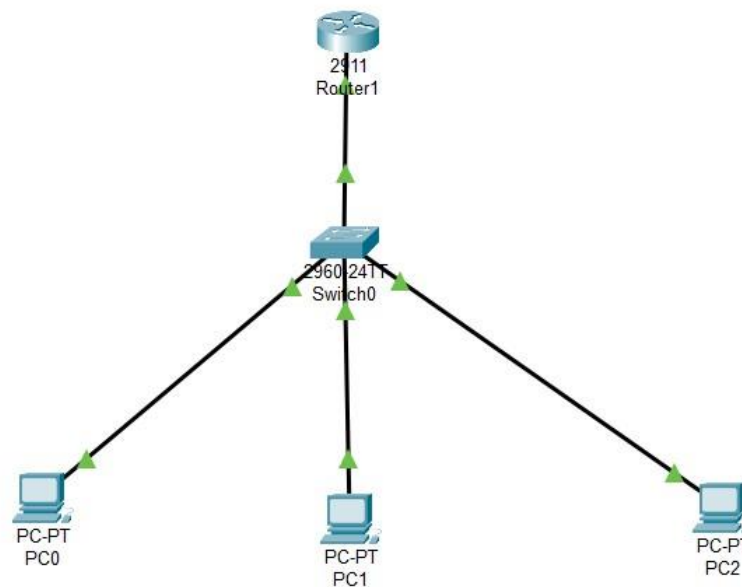
2. Dont configure ip address of the pcs.
3. Now enter the following commands.

4. Setup the gateway.

5. Turn on dhcp on pc.

| Physical | Config | Desktop | Programming | Attributes |

IP Configuration   X

Interface   FastEthernet0

IP Configuration

⦿ DHCP   ○ Static   DHCP request successful.

IP Address   192.168.10.7

Subnet Mask   255.255.255.0

Default Gateway   192.168.10.1

6. Ip address is successfully assigned.

—---

| Physical | Config | Desktop | Programming | Attributes |

IP Configuration

Interface   FastEthernet0

⦿ DHCP   ○ Static