Operating Systems and Networks

TA Finance Network Design

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Introduction

This report will explain and evaluate how Virtual LANs (VLAN)s can be used in this network topology. Moreover, this report will explain the benefits of using DHCP to allocate IP address. This report will also include screenshots of my configuration and the connectivity test.

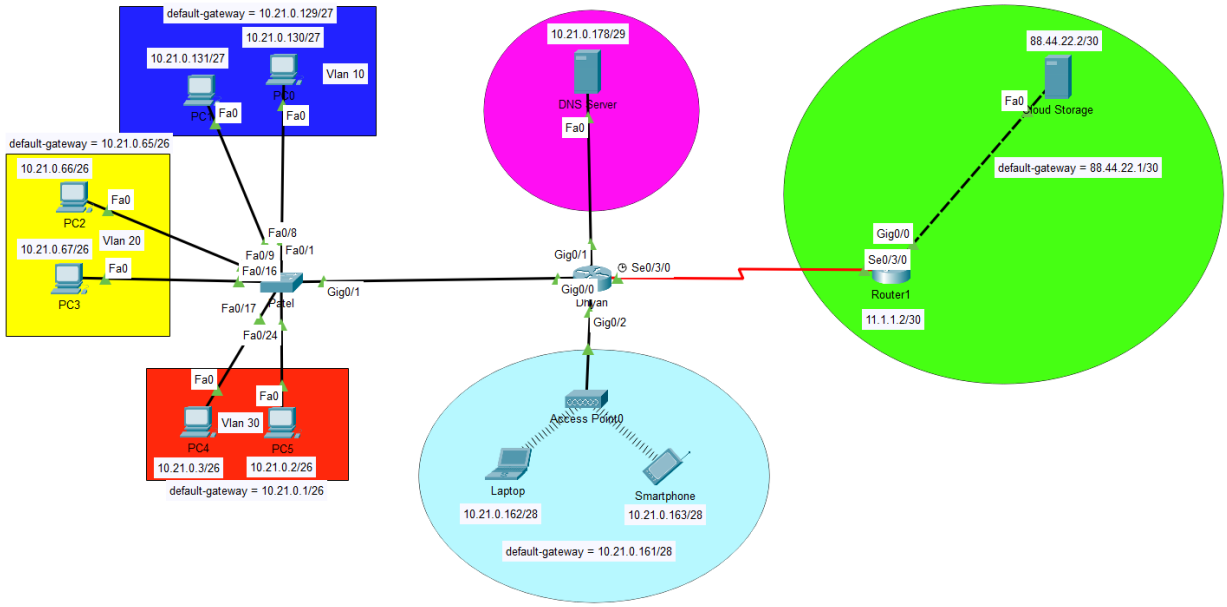


FIGURE 1

1. List the cables used in a table with their specifications.

Source	Destination	Cable used
Router (Dhyan)	Switch	Copper Straight-Through
Switch	All the PCs	Copper Straight-Through
Router (Dhyan)	DNS Server	Copper Straight-Through
Router (Dhyan)	ISP Router	Serial DTE
ISP Router	Cloud Storage	Copper Cross-Over

Table 1

2. Subnetting calculations

Given Ip address: 10.21.0.0/16.

There are Four Networks.
2^n = 4
n = 2, so we need to borrow 2 host bits from the host portion.

128 + 64 = 192

1 1 1 1 1 1 1 1 . 1 1 1 1 1 1 1 1 . 1 1 0 0 0 0 0 0 . 0 0 0 0 0 0 0 0

255 . 255 . 192 . 0

Total number of 1s = 18, so the subnet mask is 18.
Number of hosts = 2^14 -2 = 16,382.
The Magic Number is 64.

Range	Network address	First address	Last address	Broadcast address
1	10.21.0.0	10.21.0.1	10.21.63.254	10.21.63.255
2	10.21.64.0	10.21.64.1	10.21.127.254	10.21.127.255
3	10.21.128.0	10.21.128.1	10.21.191.254	10.21.191.255
4	10.21.192.0	10.21.192.1	10.21.255.254	10.21.255.255

Table 2

- **We are using range 1 and performing further subnetting in order not to waste any IP address.**

LAN 1

For Sales = 60 hosts:

2^n – 2 = 60
2^n = 62
n = 6, so we leave 6 host bits

1 1 1 1 1 1 1 1 . 1 1 1 1 1 1 1 1 . 1 1 1 1 1 1 1 1 . 1 1 0 0 0 0 0 0

255 . 255 . 255 . 192

Total number of 1s = 26, so the subnet mask is 26.
Number of hosts = 2^6 – 2 = 62 hosts (Usable IP address).
The Magic Number is 64.

Range	Network address	First address	Last address	Broadcast address
1	10.21.0.0	10.21.0.1	10.21.0.62	10.21.0.63

For Accounting = 35 hosts:

2^n – 2 = 35
2^n = 37
n = 6, so we leave 6 host bits.

1 1 1 1 1 1 1 1 . 1 1 1 1 1 1 1 1 . 1 1 1 1 1 1 1 1 . 1 1 0 0 0 0 0 0
255 . 255 . 255 . 192

Total number of 1s = 26, so the subnet mask is 26.
Number of hosts = 2^6 – 2 = 62 hosts (Usable IP address).
The Magic Number is 64.

Range	Network address	First address	Last address	Broadcast address
1	10.21.0.64	10.21.0.65	10.21.0.126	10.21.0.127

For Admin = 20 hosts:

2^n – 2 = 20
2^n = 22
n = 5, so we leave 5 host bits.

1 1 1 1 1 1 1 1 . 1 1 1 1 1 1 1 1 . 1 1 1 1 1 1 1 1 . 1 1 1 0 0 0 0 0
255 . 255 . 255 . 224

Total number of 1s = 27, so the subnet mask is 27.
Number of hosts = 2^5 – 2 = 30 hosts (Usable IP address).
The Magic Number is 32.

Range	Network address	First address	Last address	Broadcast address
1	10.21.0.128	10.21.0.129	10.21.0.158	10.21.0.159

LAN 2

Assuming 14 host can join:

2^n – 2 = 14
2^n = 16
n = 4, so we leave 4 host bits.

1 1 1 1 1 1 1 1 . 1 1 1 1 1 1 1 1 . 1 1 1 1 1 1 1 1 . 1 1 1 1 0 0 0 0
255 . 255 . 255 . 240

Total number of 1s = 28, so the subnet mask is 28.
Number of hosts = 2^4 – 2 = 14 hosts (Usable IP address).
The Magic Number is 16.

Range	Network address	First address	Last address	Broadcast address
1	10.21.0.160	10.21.0.161	10.21.0.174	10.21.0.175

LAN3

Assuming 6 host can join:

2^n – 2 = 6
2^n = 8
n = 3, so we leave 3 host bits.

1 1 1 1 1 1 1 1 . 1 1 1 1 1 1 1 1 . 1 1 1 1 1 1 1 1 . 1 1 1 1 1 0 0 0
255 . 255 . 255 . 248

Total number of 1s = 29, so the subnet mask is 29.
Number of hosts = 2^3 – 2 = 6 hosts (Usable IP address).
The Magic Number is 8.

Range	Network address	First address	Last address	Broadcast address
1	10.21.0.176	10.21.0.177	10.21.0.182	10.21.0.183

LAN4

Given IP address 11.1.1.0/30.

Assuming 2 host can join:

2^n - 2 = 2
2^n = 4
n = 2, so we leave 2 host bits.
1 1 1 1 1 1 1 1 . 1 1 1 1 1 1 1 1 . 1 1 1 1 1 1 1 1 . 1 1 1 1 1 1 0 0
255 . 255 . 255 . 252

Total number of 1s = 30, so the subnet mask is 30.
Number of hosts = 2^2 – 2 = 2 hosts (Usable IP address).
The Magic Number is 4.

Range	Network address	First address	Last address	Broadcast address
1	11.1.1.0	11.1.1.1	11.1.1.2	11.1.1.3

LAN5

- Cloud Storage has been given an IP address of 88.44.22.2/30.
- ISP Router has an IP address of 88.44.22.1/30.

3. A Table with the IP addresses assigned to each device after subnetting.

Name of device	IP address	Subnet mask	Default Gateway
PC0 (Admin)	10.21.0.130	255.255.255.224	10.21.0.129
PC1 (Admin)	10.21.0.131	255.255.255.224	10.21.0.129
PC2 (Accounting)	10.21.0.66	255.255.255.192	10.21.0.65
PC3 (Accounting)	10.21.0.67	255.255.255.192	10.21.0.65
PC4 (Sales)	10.21.0.3	255.255.255.192	10.21.0.1
PC5 (Sales)	10.21.0.2	255.255.255.192	10.21.0.1
Interfaces of the Router (Dhyan):			
Router (Dhyan) (Gig0/1)	10.21.0.177	255.255.255.248	
Router (Dhyan) (Gig0/2)	10.21.0.161	255.255.255.240	
Router (Dhyan) (Se0/3/0)	11.1.1.1	255.255.255.252	
Router (Dhyan) (Gig0/0.1)	10.21.0.129	255.255.255.224	
Router (Dhyan) (Gig0/0.2)	10.21.0.65	255.255.255.192	
Router (Dhyan) (Gig0/0.3)	10.21.0.1	255.255.255.192	
Switch (Patel)			
DNS Server	10.21.0.178	255.255.255.248	10.21.0.177
Interfaces of the ISP Router:			
ISP Router (Se0/3/1)	11.1.1.2	255.255.255.252	
ISP Router (Gig0/0)	88.44.22.1	255.255.255.252	
Cloud Storage	88.44.22.2	255.255.255.252	88.44.22.1
Laptop	10.21.0.162	255.255.255.240	10.21.0.161
Smartphone	10.21.0.163	255.255.255.240	10.21.0.161

4. Screenshots of all my connectivity

- Figure 2 is pinging from PC0 (Admin) to DNS Server, Laptop and Cloud Storage

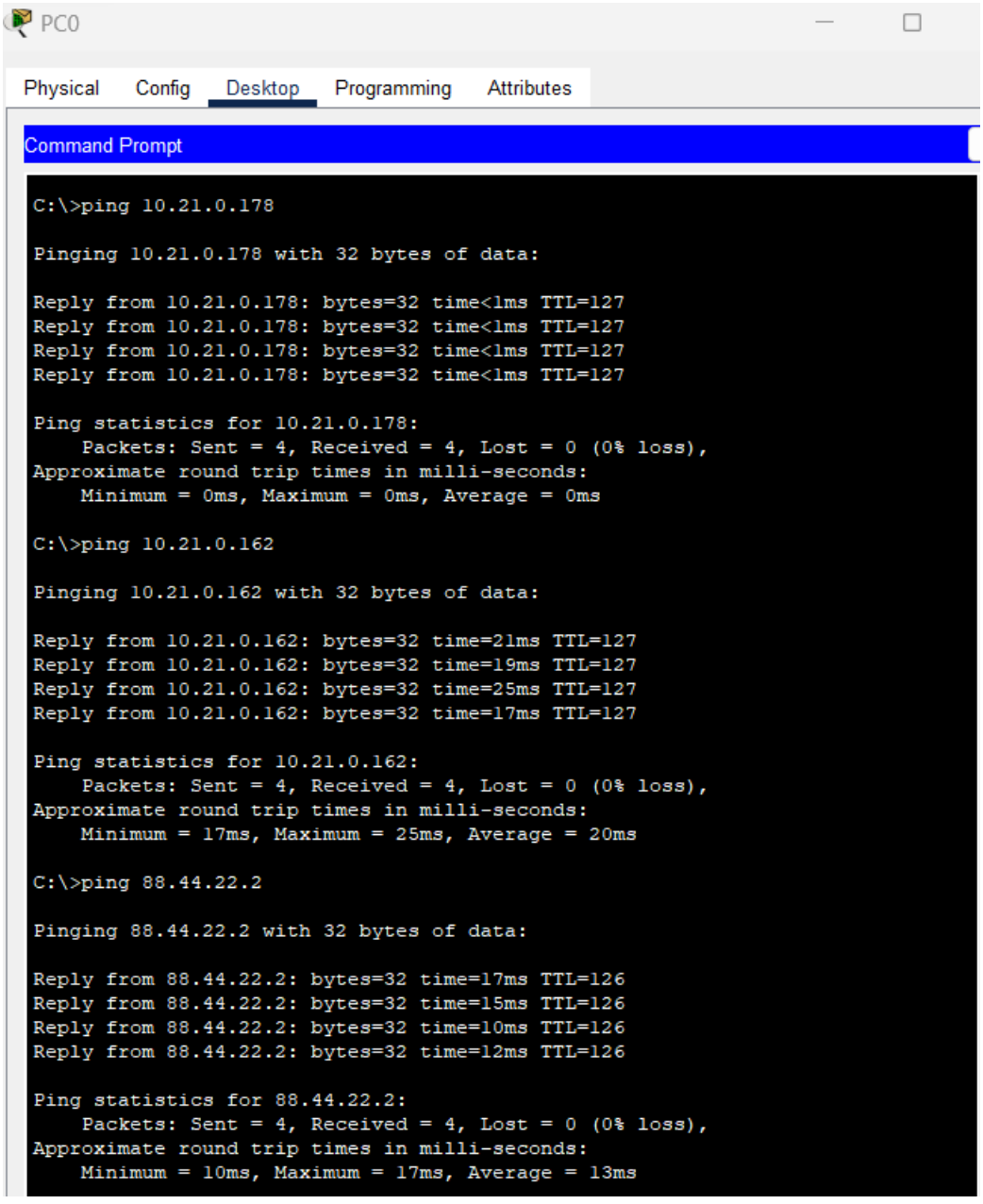


FIGURE 2

- Figure 3 is pinging from PC3 (Accounting) to DNS Server, Laptop and Cloud Storage

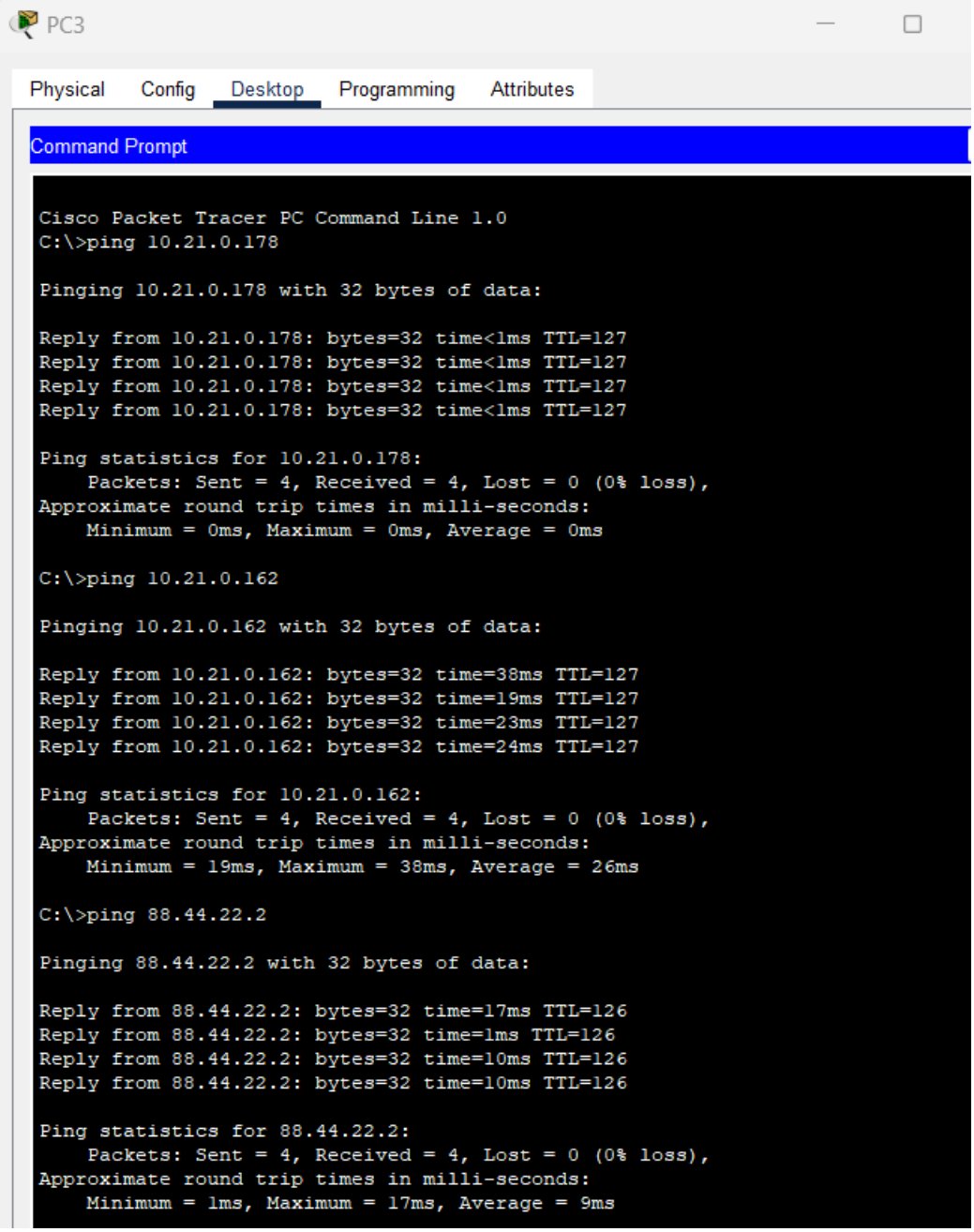


FIGURE 3

- Figure 4 is pinging from PC5 to DNS Server, Smartphone and Cloud Storage

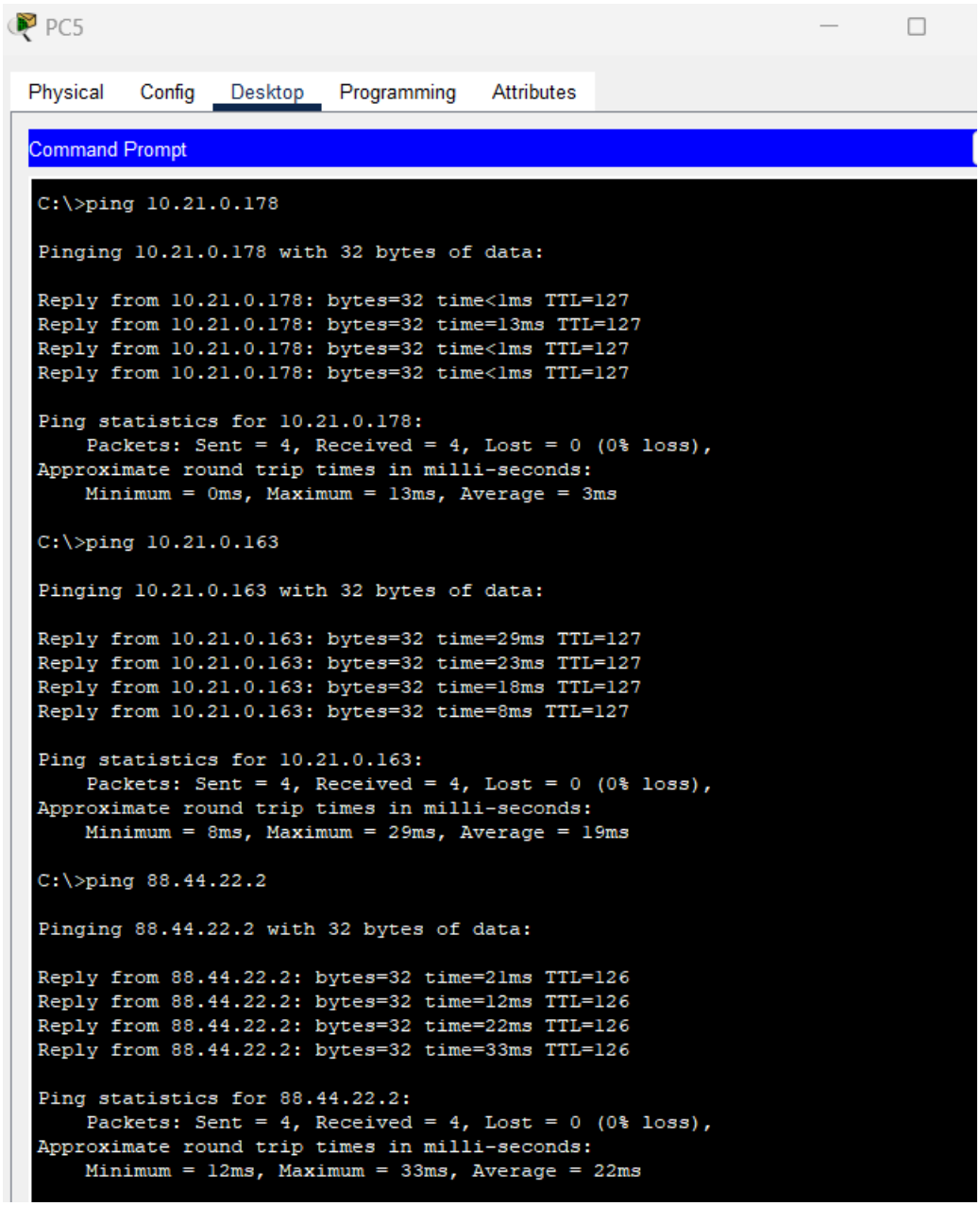


FIGURE 4

- Figure 5 is pinging from Cloud Storage to Laptop, PC2(Accounting) and DNS Server

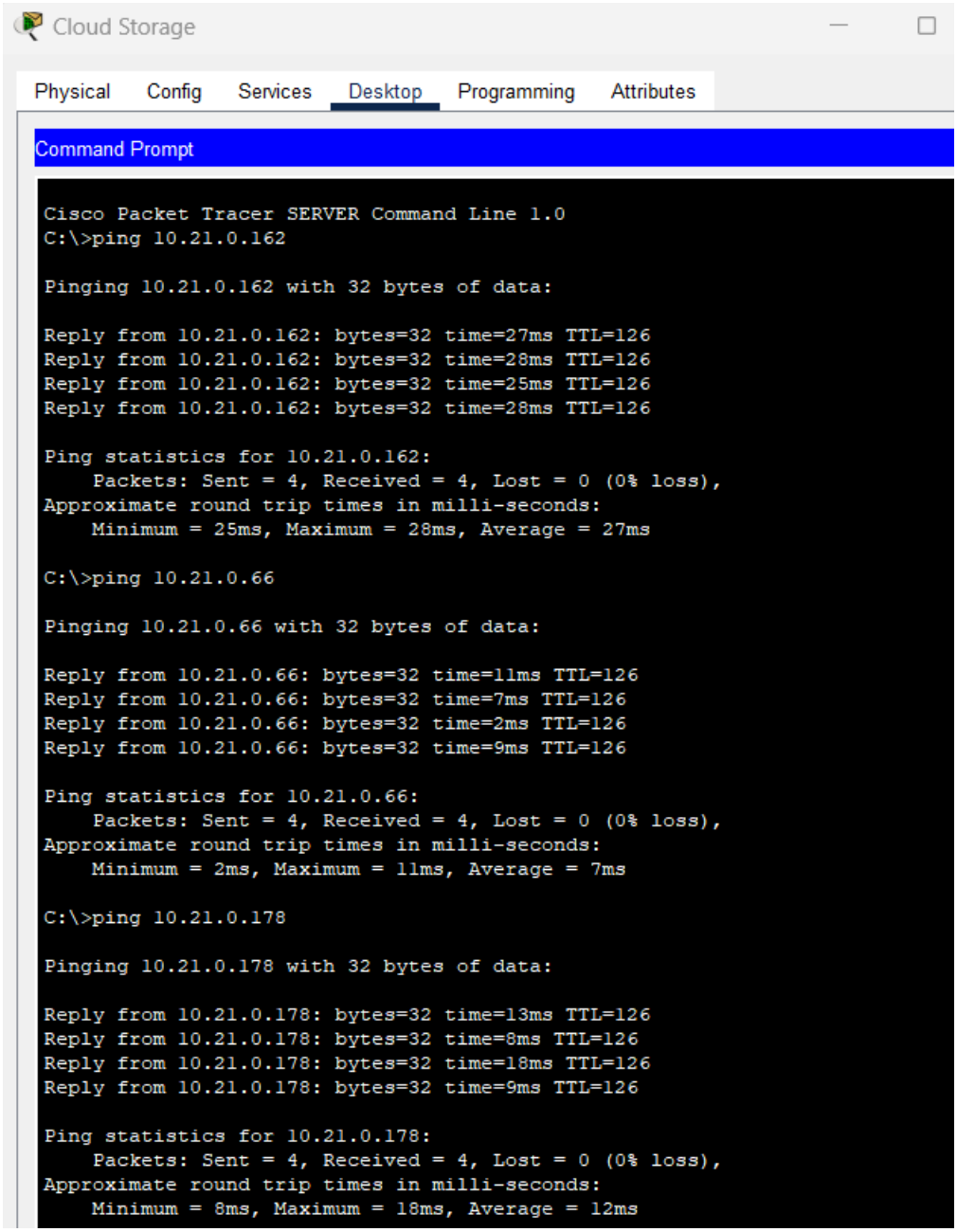


FIGURE 5

- Figure 6 is pinging from ISP Router to Laptop, PC2(Accounting) and DNS Server

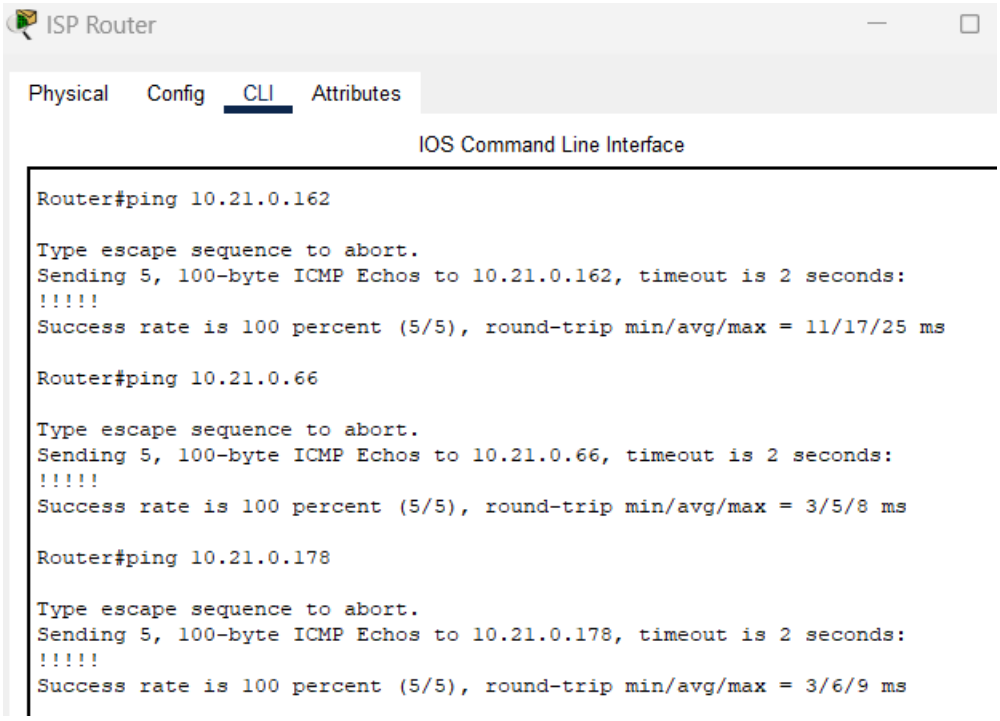


FIGURE 6

5. Routing Protocols and Ip Interface

- Figure 7 shows Ip interface for Router(Dhyan)

```
Dhyan#show ip interface brief
Interface              IP-Address      OK? Method Status
Protocol
GigabitEthernet0/0     unassigned      YES unset  up                    up
GigabitEthernet0/0.1   10.21.0.129     YES manual up                    up
GigabitEthernet0/0.2   10.21.0.65      YES manual up                    up
GigabitEthernet0/0.3   10.21.0.1       YES manual up                    up
GigabitEthernet0/1     10.21.0.177     YES manual up                    up
GigabitEthernet0/2     10.21.0.161     YES manual up                    up
Serial0/3/0            11.1.1.1        YES manual up                    up
Serial0/3/1            unassigned      YES unset  administratively down down
Vlan1                  unassigned      YES unset  administratively down down
```

FIGURE 7

- Figure 8 shows the routing protocol for Router(Dhyan)

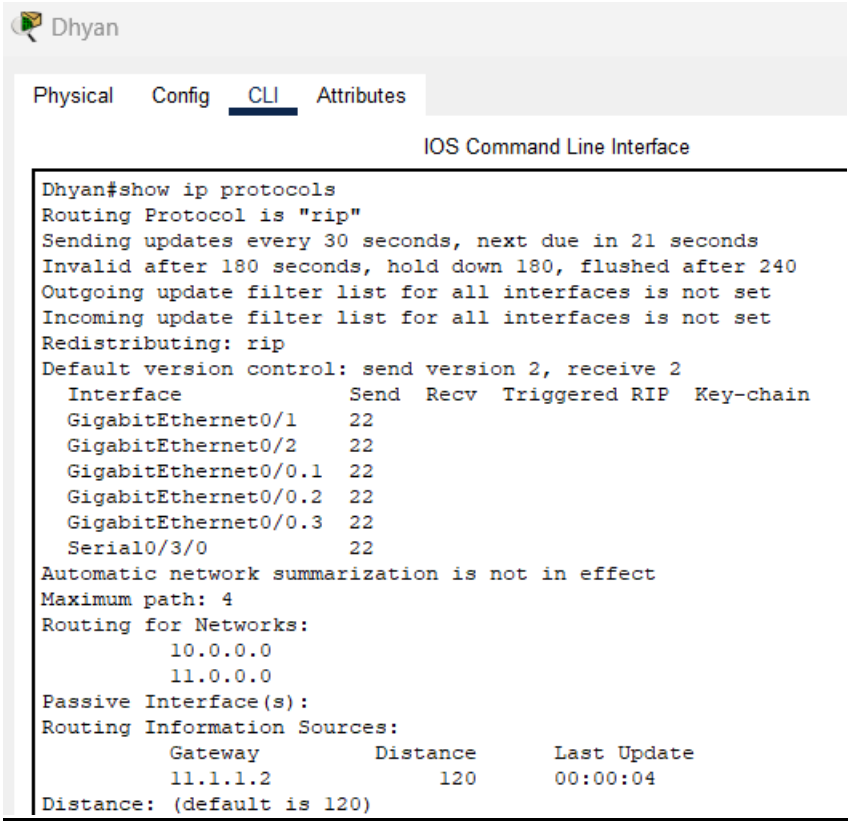


FIGURE 8

This paragraph explains how the RIP routing protocol works:

- In Figure 8, the routing protocols that is being used is RIP that allows routers in a network to exchange information about the best routes to reach different destinations. It works by periodically sending updates to neighboring routers, which contain information about the network topology and the number of hops needed to reach different destinations. Routers use this information to update their own routing tables and choose the most efficient path to send packets to their destinations.

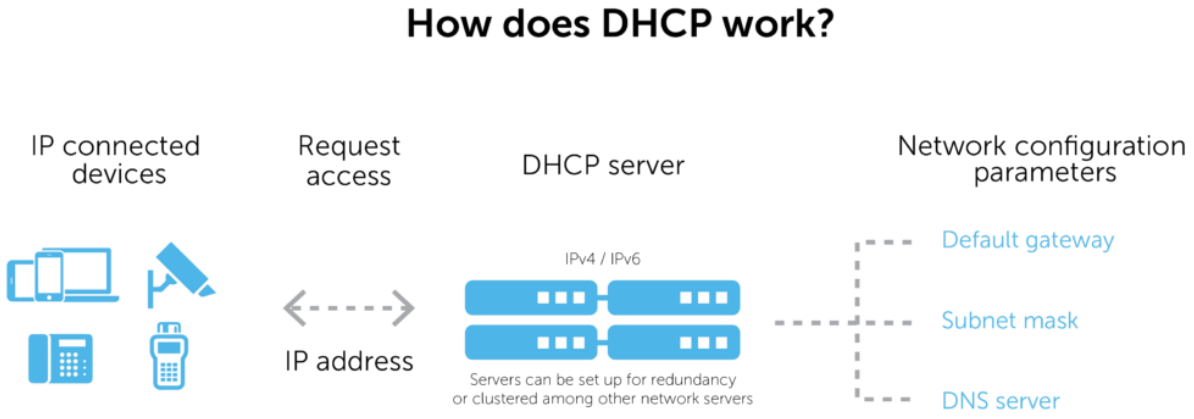
6. DHCP (Dynamic Host Configuration Protocol)

What is DHCP (Dynamic Host Configuration Protocol)?

- Dynamic Host Configuration Protocol (DHCP) is a network protocol that allows automatic configuration of IP addresses and other network settings for devices on a network. The protocol enables devices to obtain IP addresses and other network configuration information dynamically, without the need for manual configuration.

How does DHCP works in this network?

- DHCP is a network management protocol. A laptop, for example, enters a network and gets an IP address from a client device (or DHCP client). A DHCP server is contacted with the request.



- A quick and automatic IP address assignment process is performed by the server, along with some associated network setup factors. The gadget can interact with both the internal network and the public internet once it has accepted the request.

Why is the use of DHCP beneficial in the network IP address allocation?

- DHCP makes it easy to configure new devices on a network. When a device is added to the network, it can instantly acquire an IP address and other required configuration settings from the DHCP server without the need for human intervention. This lessens the burden for network administrators and facilitates the management of vast networks.
- DHCP ensures that IP addresses are assigned to devices only when they are needed. DHCP can immediately release an IP address when a device no longer needs it, making it accessible for use by other devices. This guarantees effective IP address utilization and helps avoid IP address waste.
- DHCP reduces the likelihood of configuration errors because devices are automatically assigned the correct IP address and network configuration settings. This removes the need for manual setup, which can be laborious and error prone.

I've used DHCP to setup my network. I've included some images of my configuration below.

- In Figure 9, I have used DHCP pool to configure a range of IP addresses that can be automatically assigned to devices on a network.

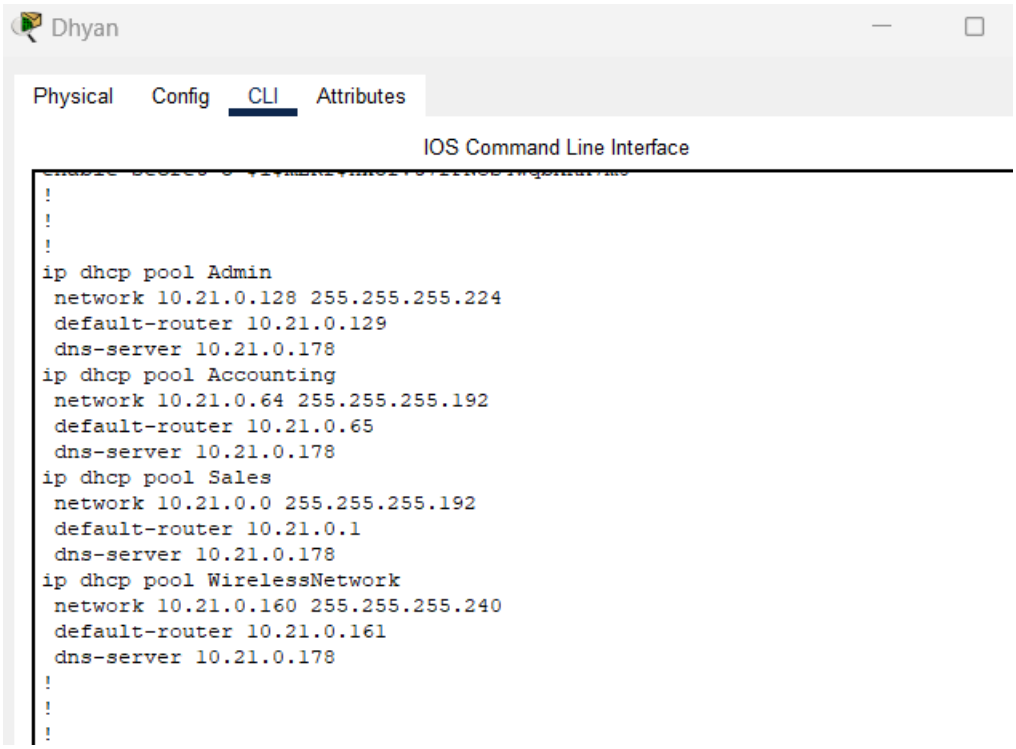


FIGURE 9

- The screenshot below is verifying the DHCP client configuration:

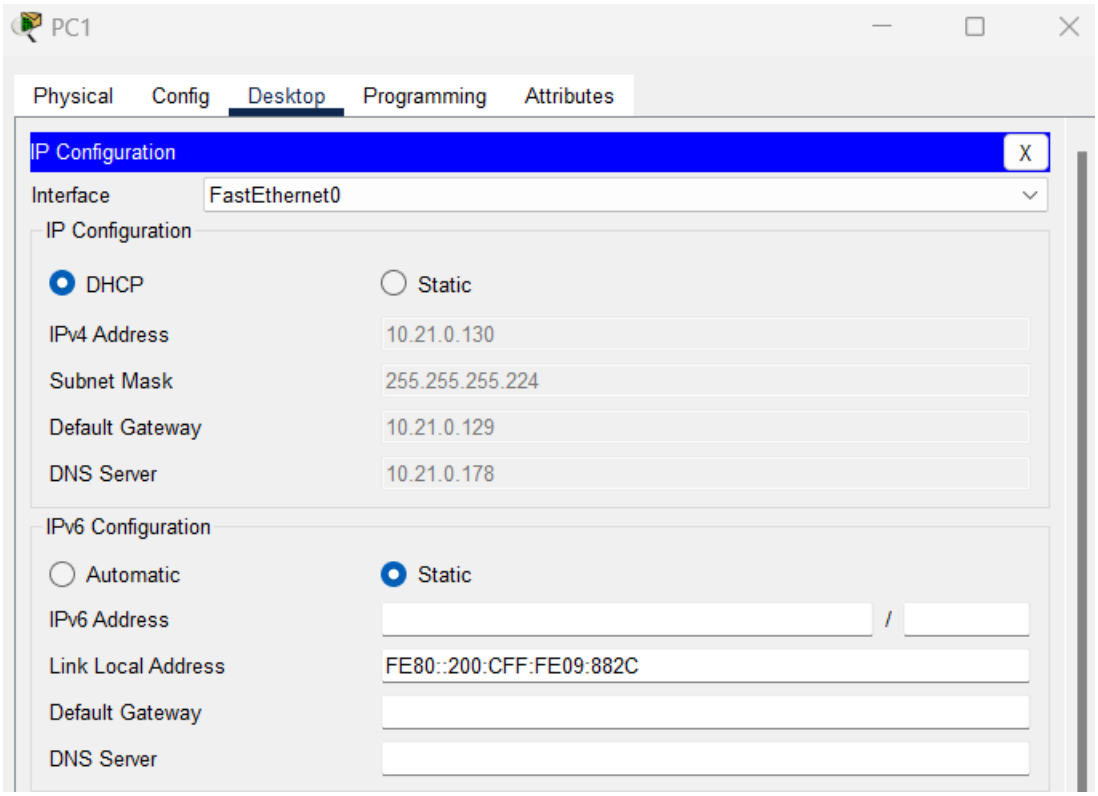


FIGURE 10

7. VLANs (Virtual Local Area Networks)

What are VLANs (Virtual Local Area Networks)?

- VLAN is a custom network which is created from one or more local area networks. It makes it possible to join a collection of devices that are spread across several virtual networks.

Explain how Virtual LANs can improve this network?

- Network administrators can implement security rules based on device or user function and create secure zones by grouping devices into various VLANs. VLANs can add an extra layer of security, decreasing the possibility of unapproved entry and lowering the scope of security breaches.
- VLANs give administrators the ability to group devices based on their purposes or geographic locations, making it simpler to control network resources. VLANs can facilitate the implementation of network rules and modifications as well as the investigation of network problems by organizing devices into logical segments.

What are the limitations of VLANs?

- VLANs can become complex to manage as the number of users and devices increases. The configuration and maintenance of VLANs become more challenging as their number increases.

- VLANs' utility in some circumstances may be constrained by interoperability problems they may have with other networking systems.

What are the benefits of VLANs?

- VLANs cut down on broadcast traffic by restricting the scope of broadcast packets to devices on the same VLAN. This contributes to a decrease in network overcrowding and improved network efficiency.
- Network administrators can organize users and devices based on their functional requirements using VLANs, regardless of where they are physical location. This makes network architecture more flexible and makes it simpler to handle network resources.

I've used VLANs to setup my network. I've included some images of my configuration below.

- In Figure 11, I have used encapsulation dot1Q to tag the VLAN ID to the data packet, enabling the switch to differentiate between packets belonging to different VLANs.

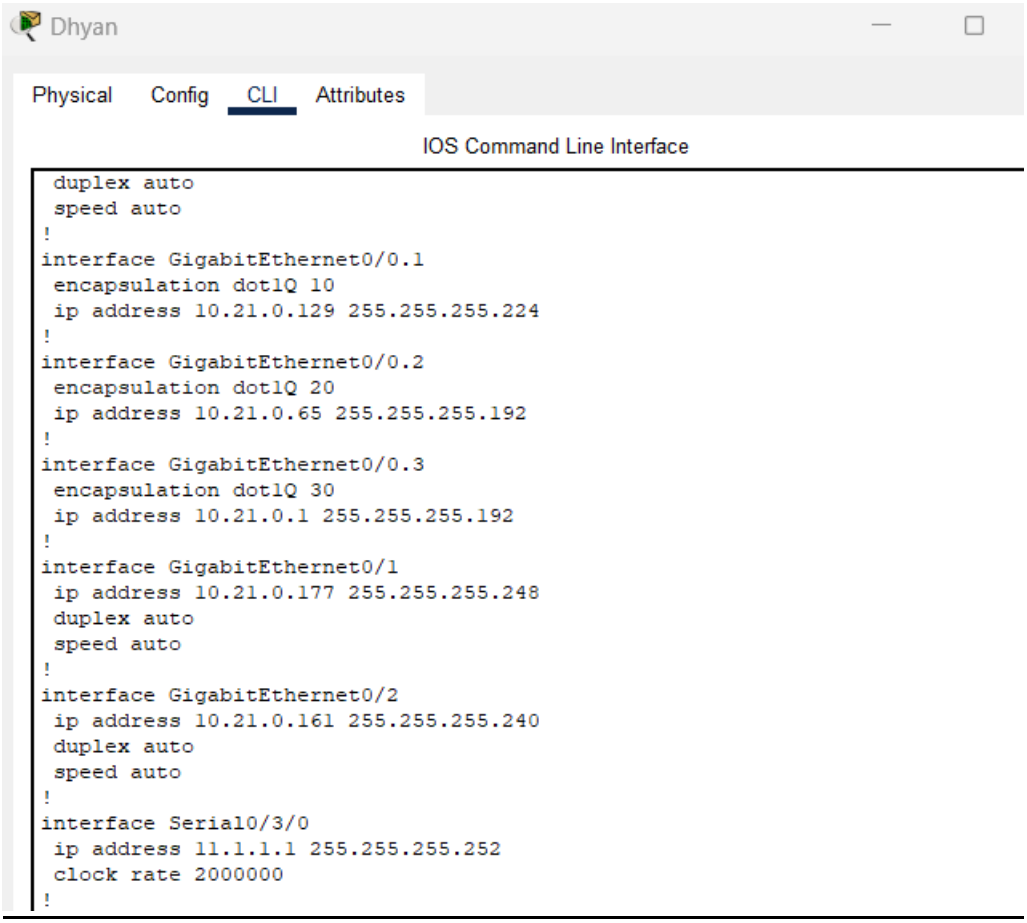


FIGURE 11

- In Figure 12, I have used ‘ show vlan brief ’ command to show the VLANs ID, VLANs Name and the Ports that they are using.

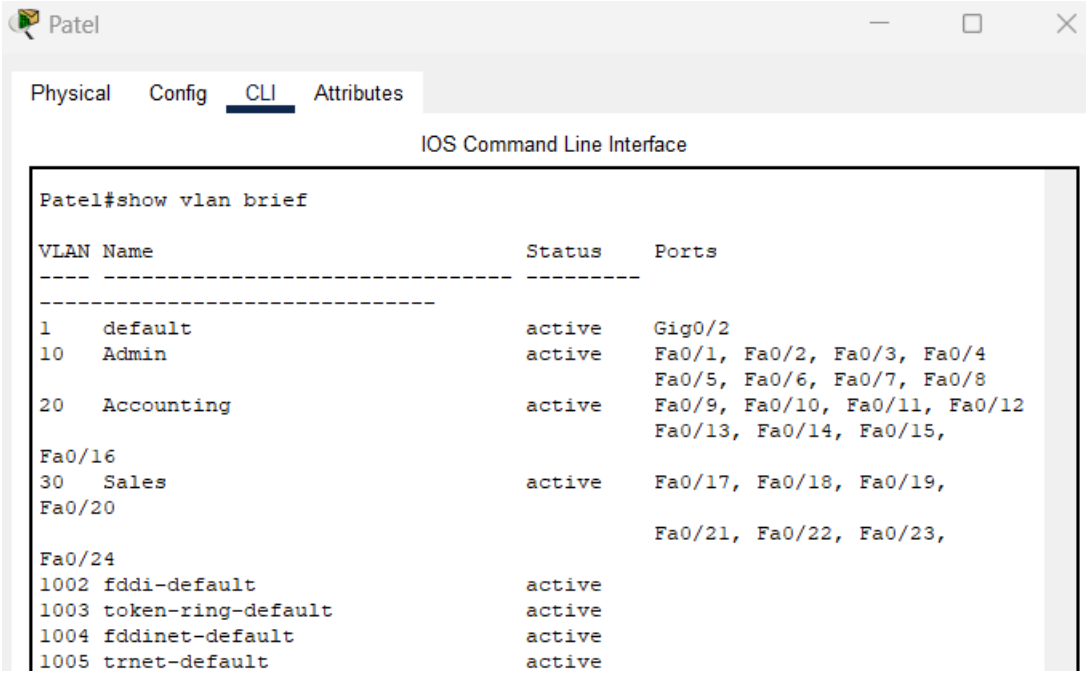


FIGURE 12

- In Figure 13, I have used ‘show run’ command in Switch(Patel).

```
User Access Verification

Password:

Patel>en
Password:
Patel#sh run
Building configuration...

Current configuration : 2588 bytes
!
version 15.0
no service timestamps log datetime msec
no service timestamps debug datetime msec
service password-encryption
!
hostname Patel
!
enable secret 5 $1$mERr$hx5rVt7rPNoS4wqbXKX7m0
!
!
!
!
!
!
spanning-tree mode pvst
spanning-tree extend system-id
!
interface FastEthernet0/1
 switchport access vlan 10
 switchport mode access
!
interface FastEthernet0/2
 switchport access vlan 10
 switchport mode access
!
interface FastEthernet0/3
 switchport access vlan 10
 switchport mode access
!
interface FastEthernet0/4
 switchport access vlan 10
 switchport mode access
!
interface FastEthernet0/5
 switchport access vlan 10
 switchport mode access
!
interface FastEthernet0/6
 switchport access vlan 10
 switchport mode access
!
interface FastEthernet0/7
 switchport access vlan 10
 switchport mode access
!
interface FastEthernet0/8
 switchport access vlan 10
 switchport mode access
!
interface FastEthernet0/9
 switchport access vlan 20
 switchport mode access
!
interface FastEthernet0/10
 switchport access vlan 20
 switchport mode access
!
interface FastEthernet0/11
 switchport access vlan 20
 switchport mode access
!
interface FastEthernet0/12
 switchport access vlan 20
 switchport mode access
!
interface FastEthernet0/13
 switchport access vlan 20
 switchport mode access
!
interface FastEthernet0/14
 switchport access vlan 20
 switchport mode access
!
interface FastEthernet0/15
 switchport access vlan 20
 switchport mode access
!
interface FastEthernet0/16
 switchport access vlan 20
 switchport mode access
!
interface FastEthernet0/17
 switchport access vlan 30
 switchport mode access
!
interface FastEthernet0/18
 switchport access vlan 30
 switchport mode access
!
interface FastEthernet0/19
 switchport access vlan 30
 switchport mode access
!
interface FastEthernet0/20
 switchport access vlan 30
 switchport mode access
!
interface FastEthernet0/21
 switchport access vlan 30
 switchport mode access
!
interface FastEthernet0/22
 switchport access vlan 30
 switchport mode access
!
interface FastEthernet0/23
 switchport access vlan 30
 switchport mode access
!
interface FastEthernet0/24
 switchport access vlan 30
 switchport mode access
!
interface GigabitEthernet0/1
 switchport mode trunk
!
interface GigabitEthernet0/2
!
interface Vlan1
 no ip address
!
banner motd ^C Authorized access only.Violaters will be prosecuted the the full extent of the law. ^C
!
!
!
line con 0
 password 7 08314D5D1A0E0A0516
 login
!
line vty 0 4
 password 7 08701E1D5D
 login
 transport input ssh
line vty 5 15
 password 7 08701E1D5D
 login
 transport input ssh
!
!
!
!
end
```

FIGURE 13

8. Final Test Screenshots

- In Figure 13, I have used ‘ Ipconfig ’ command in PC0(Admin).

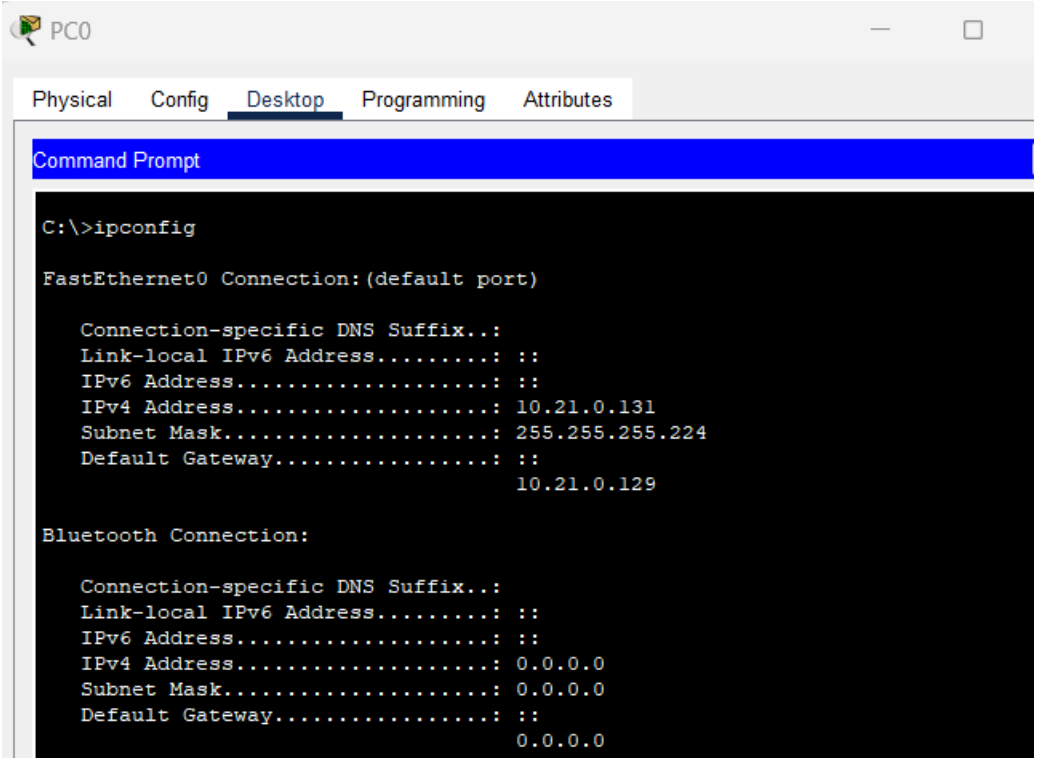


FIGURE 14

- In Figure 14, I have used ‘ Ipconfig ’ command in PC3(Accounting).

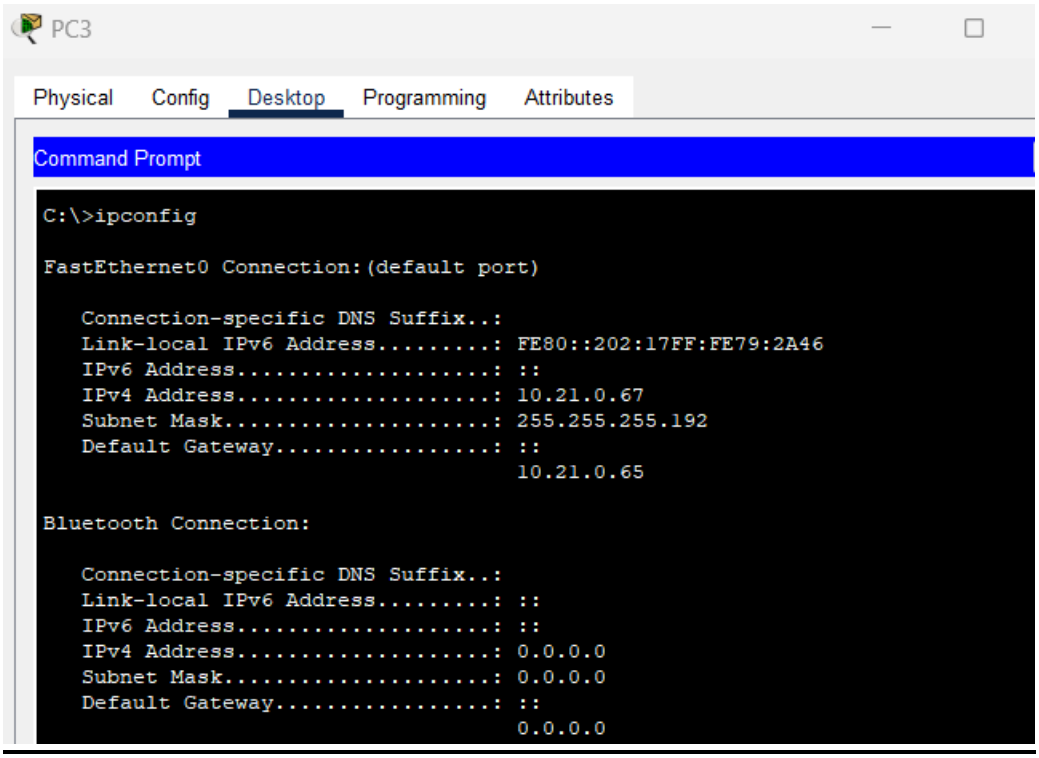


FIGURE 15

- In Figure 15, I have used ‘ Ipconfig ’ command in PC5(Sales).

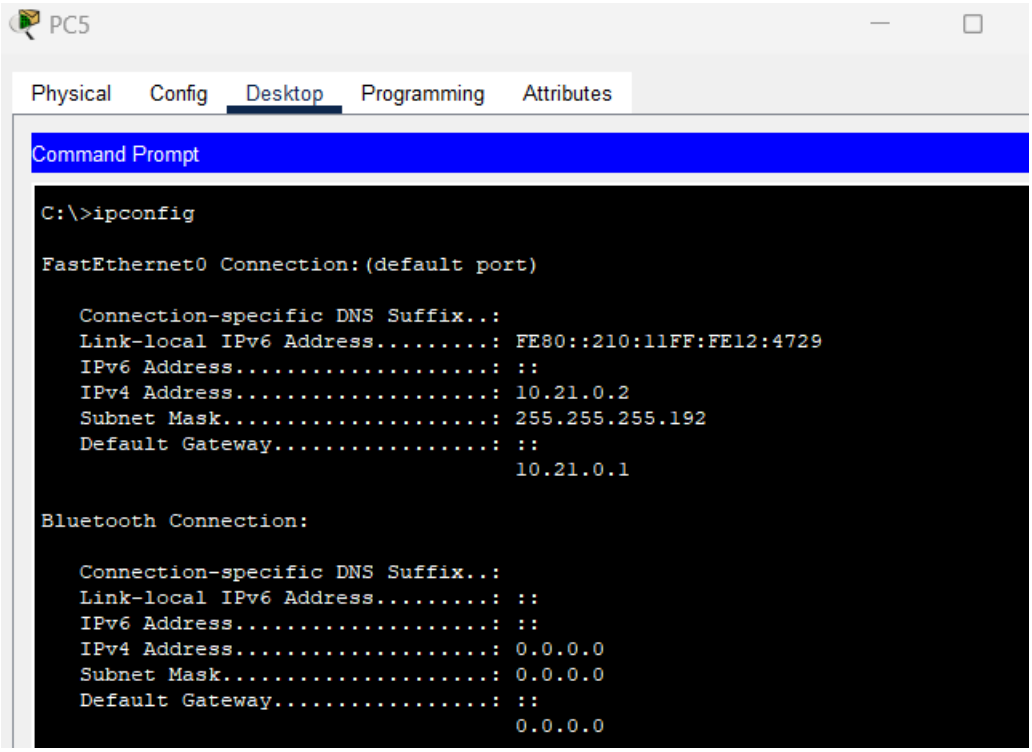


FIGURE 16

- In Figure 16, I have used ‘ show run ’ command in Router(Dhyan).

```
User Access Verification

Password:

Dhyan>en
Password:
Dhyan#sh run
Building configuration...

Current configuration : 2088 bytes
!
version 15.1
no service timestamps log datetime msec
no service timestamps debug datetime msec
service password-encryption
!
hostname Dhyan
!
!
!
enable secret 5 $1$mERr$hx5rVt7rPNoS4wqbXKX7m0
!
!
!
ip dhcp pool Admin
 network 10.21.0.128 255.255.255.224
 default-router 10.21.0.129
 dns-server 10.21.0.178
ip dhcp pool Accounting
 network 10.21.0.64 255.255.255.192
 default-router 10.21.0.65
 dns-server 10.21.0.178
ip dhcp pool Sales
 network 10.21.0.0 255.255.255.192
 default-router 10.21.0.1
 dns-server 10.21.0.178
ip dhcp pool WirelessNetwork
 network 10.21.0.160 255.255.255.240
 default-router 10.21.0.161
 dns-server 10.21.0.178
!
!
!
no ip cef
no ipv6 cef
!
!
!
username admin privilege 15 secret 5 $1$mERr$9cTjUIEqNGurQiFU.ZeCi1
!
!
license udi pid CISCO2911/K9 sn FTX1524YDVO-
!
!
!
!
!
!
!
!
!
ip domain-name BigNetwork
!
!
spanning-tree mode pvst
!
!
!
!
!
!
interface GigabitEthernet0/0
 no ip address
 duplex auto
 speed auto
!
interface GigabitEthernet0/0.1
 encapsulation dot1Q 10
 ip address 10.21.0.129 255.255.255.224
!
interface GigabitEthernet0/0.2
 encapsulation dot1Q 20
 ip address 10.21.0.65 255.255.255.192
!
interface GigabitEthernet0/0.3
 encapsulation dot1Q 30
 ip address 10.21.0.1 255.255.255.192
!
interface GigabitEthernet0/1
 ip address 10.21.0.177 255.255.255.248
 duplex auto
 speed auto
!
interface GigabitEthernet0/2
 ip address 10.21.0.161 255.255.255.240
 duplex auto
 speed auto
!
interface Serial0/3/0
 ip address 11.1.1.1 255.255.255.252
 clock rate 2000000
!
interface Serial0/3/1
 no ip address
 clock rate 2000000
 shutdown
!
interface Vlan1
 no ip address
 shutdown
!
router rip
 version 2
 network 10.0.0.0
 network 11.0.0.0
 no auto-summary
!
ip classless
!
ip flow-export version 9
!
!
!
banner motd ^C Authorized access only.Violaters will be prosecuted the the full extent of the law. ^C
!
!
!
!
line con 0
 password 7 08314D5D1A0E0A0516
 login
!
line aux 0
!
line vty 0 4
 password 7 08701E1D5D
 login local
 transport input ssh
line vty 5 15
 password 7 08701E1D5D
 login local
 transport input ssh
!
!
!
end
```

FIGURE 17

- In Figure 17, I have used ‘ tracert ’ command from DNS Server to PC3, Laptop and Cloud Storage.

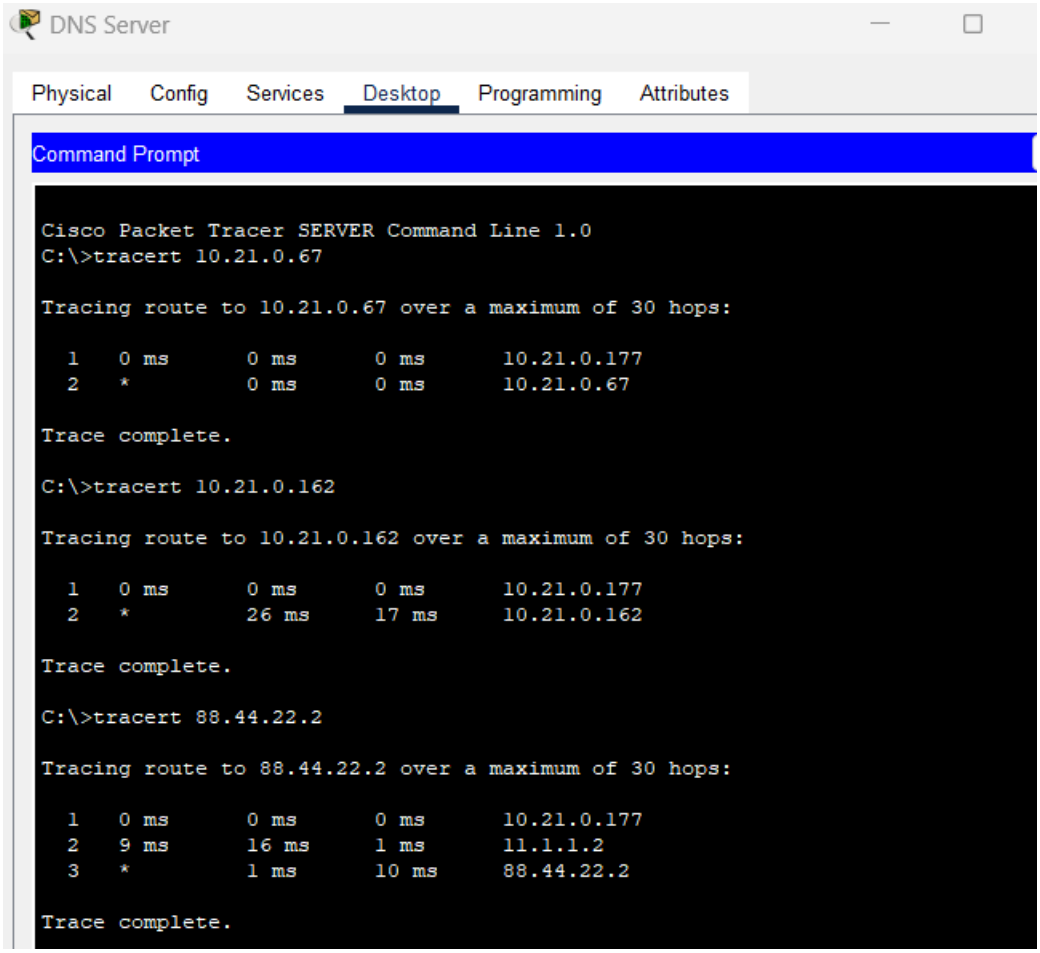


FIGURE 18

REFERENCES

1. Gillis, A.S. (2023) *What is DHCP (dynamic host configuration protocol)?*, *Networking*. TechTarget. Available at: https://www.techtarget.com/searchnetworking/definition/DHCP

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