Marwadi University Marwadi Chandarana Group	**Marwadi University** **Faculty of Engineering and Technology** **Department of Information and Communication Technology**	
Subject: Computer Networks (01CT0503)	**Aim:** Campus network design (Guided project).	
Experiment No: 14	**Date: 18/11/2024**	**Enrolment No: 92200133029**

Campus Network Design and Implementation

Objective :

This project focuses on designing and implementing a secure and efficient network for a university campus using **Cisco Packet Tracer**. The primary goal is to ensure seamless connectivity across multiple buildings, with an emphasis on scalability, performance, and security. The network will integrate components like **VLANs**, **routers**, **switches**, **firewalls**, and **servers** to manage data traffic, facilitate communication, and protect sensitive information.

Steps for the Project:

1. Understand Requirements

- Identify the network's core purpose: providing internet access, supporting internal communications, and enabling resource sharing.
- Determine the number of departments, devices, and users that need to be connected.

2. Design the Network Topology

- Use **Cisco Packet Tracer** to design a visual network layout.
- Include routers, switches, access points, and end devices such as PCs and printers.
- Plan IP address allocation using **IPv4 subnetting** to ensure efficient management.

3. Subnet the Network

- Divide the network into smaller subnets, allocating one subnet per department or building.
- Apply subnetting techniques to allocate IP addresses efficiently and ensure that each subnet supports the required number of devices.

4. Configure Routers and Switches

- **Routers**: Set up router interfaces and configure routing protocols like **OSPF** or **RIP** for inter-VLAN communication.
- **Switches**: Implement VLANs to logically separate network traffic by department or function.

5. Implement DHCP

- Set up a **DHCP server** to automatically assign IP addresses to devices in each subnet.
- Configure a unique DHCP scope for each subnet to streamline address assignment.

6. Set Up Servers

- **DNS Server**: Configure to resolve domain names for smooth communication.
- **Web Server**: Set up to provide internal/external access to campus web applications.

- **Email Server**: Enable email communication within the campus network.

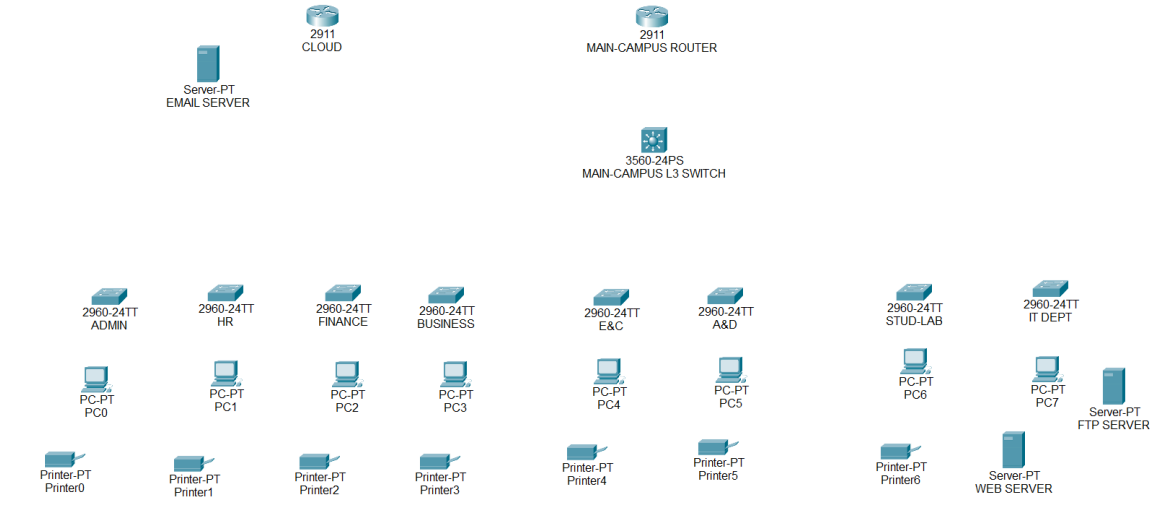
7. *Testing*

- Test the network by checking device connectivity within and between VLANs.
- Verify that **DHCP** is assigning IP addresses correctly.
- Ensure **DNS** resolves domain names, and check the proper functioning of **web** and **email servers**.

What Happens in the Network:

- **Device Communication**: Devices within the same VLAN can communicate directly, while devices in different VLANs require routing through a router.
- **Inter-VLAN Routing**: Routers facilitate communication between different VLANs to ensure network-wide connectivity.
- **Centralized Management**: With DHCP and DNS servers, devices can be configured automatically, reducing manual setup.
- **Security**: Firewalls and VLANs help protect sensitive data by restricting access and blocking unauthorized traffic.

Take all the devices that you need for the implementation.



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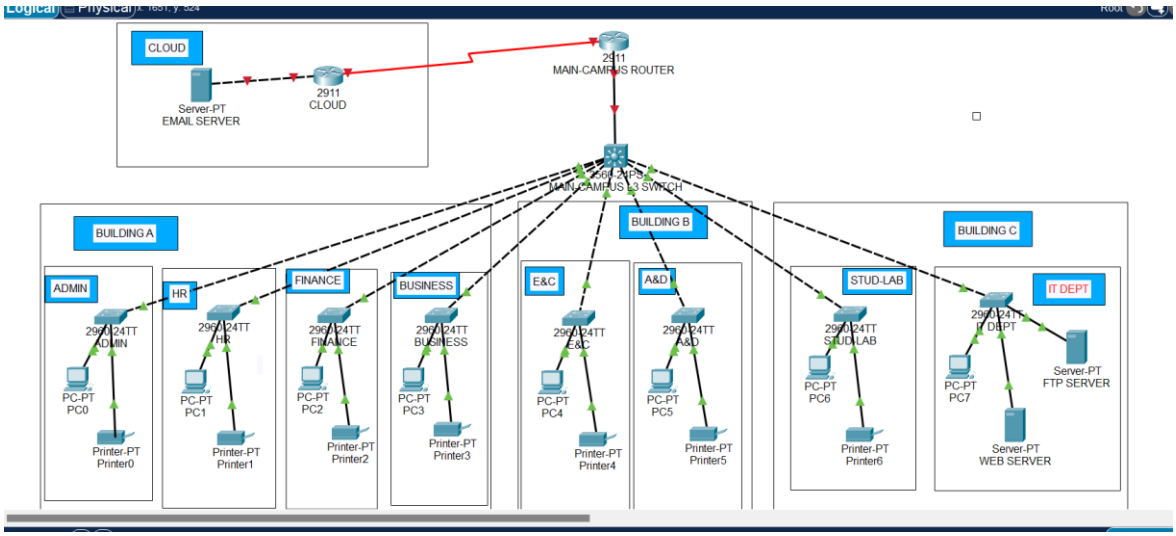
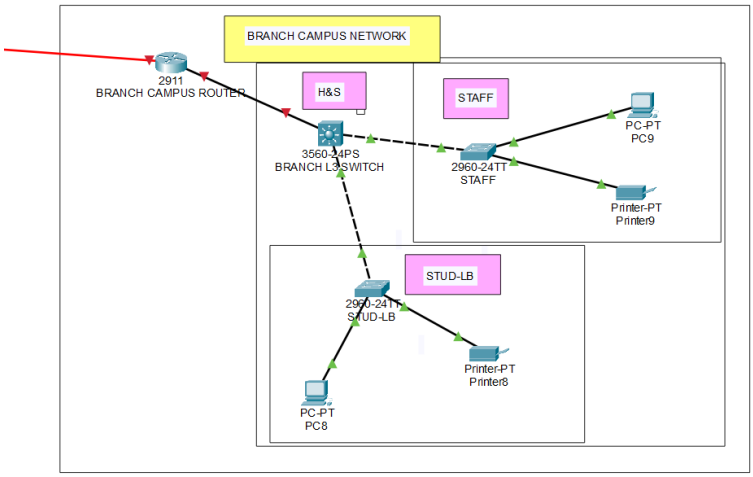
Connect all the devices with suitable wires. This is a main campus network.



This is a brach campus network



Connect main campus network with the branch campus network.

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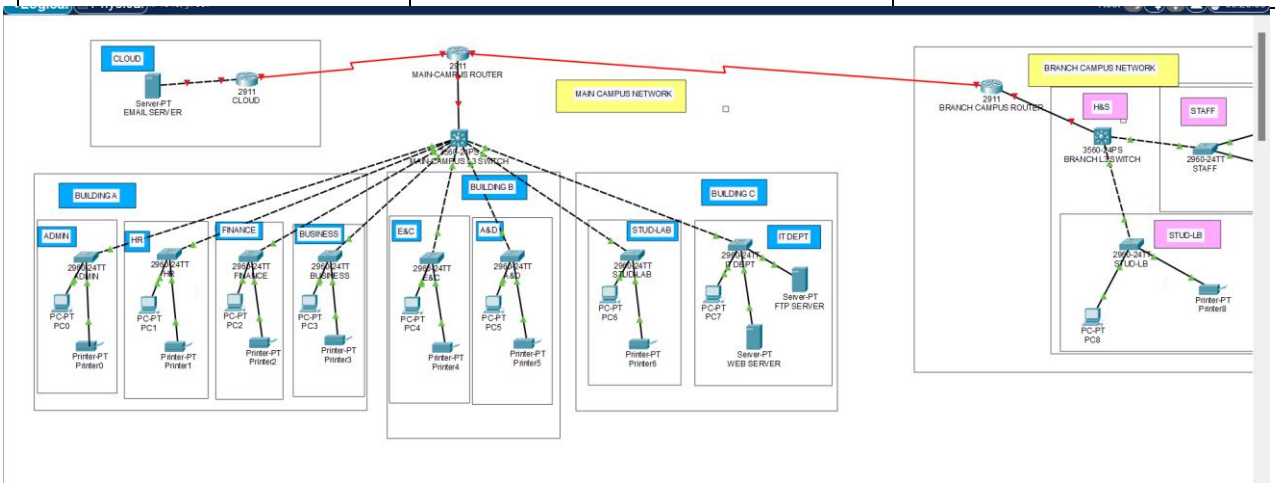
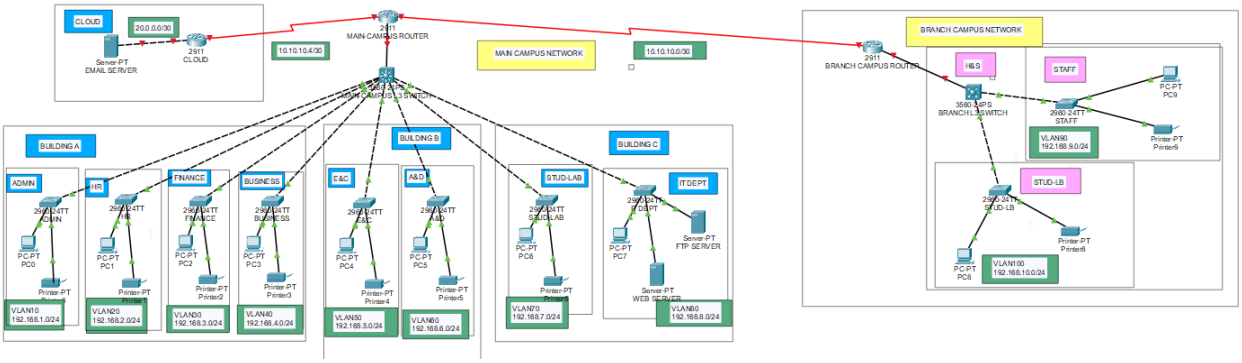


This is the entire campus network.



Make all the ports up for the configuration.

```
Router>
Router>en
Router#config t
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#
Router(config)#int gig0/0
Router(config-if)#no sh

Router(config-if)#
%LINK-5-CHANGED: Interface GigabitEthernet0/0, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet0/0, changed state to up

Router(config-if)#int se0/1/0
Router(config-if)#no sh

%LINK-5-CHANGED: Interface Serial0/1/0, changed state to down
Router(config-if)#
Router(config-if)#int se0/1/1
Router(config-if)#no sh

%LINK-5-CHANGED: Interface Serial0/1/1, changed state to down
Router(config-if)#
Router(config-if)#do wr
Building configuration...
[OK]
Router(config-if)#
Router(config-if)#
```

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```
Router>
Router>en
Router#
Router#config t
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#int gig0/0
Router(config-if)#no sh

Router(config-if)#
%LINK-5-CHANGED: Interface GigabitEthernet0/0, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet0/0, changed state to up

Router(config-if)#int se0/1/0
Router(config-if)#no sh

Router(config-if)#
%LINK-5-CHANGED: Interface Serial0/1/0, changed state to up

Router(config-if)#
Router(config-if)#do wr
%LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/1/0, changed state to up

Building configuration...
[OK]
Router(config-if)#
```

```
Router>en
Router#config t
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#
Router(config)#int gig0/0
Router(config-if)#no sh

Router(config-if)#
%LINK-5-CHANGED: Interface GigabitEthernet0/0, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet0/0, changed state to up

Router(config-if)#int se0/1/0
Router(config-if)#no sh

Router(config-if)#
%LINK-5-CHANGED: Interface Serial0/1/0, changed state to up

Router(config-if)#do wr
Building configuration...
[OK]
Router(config-if)#
```

Configure the clock rate for serial interfaces to 64000 using global configuration mode to enable proper serial communication.

```
Router>
Router>en
Router#sonfig t
              ^
% Invalid input detected at '^' marker.

Router#
Router#config t
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#
Router(config)#in se0/1/1
Router(config-if)#clock rate 64000
Router(config-if)#
Router(config-if)#in se0/1/0
Router(config-if)#clock rate 64000
Router(config-if)#do wr
Building configuration...
[OK]
Router(config-if)#
Router(config-if)#ex
Router(config)#
```

Configured VLAN 10 on the switch and assigned ports (fa0/1 to fa0/24) to VLAN 10 as access ports, enabling communication within the same VLAN. Do the same for all the VLANs.

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```
Switch>
Switch>en
Switch#config t
Enter configuration commands, one per line.  End with CNTL/Z.
Switch(config)#
Switch(config)#int range fa0/1-24
Switch(config-if-range)#switchport mode access
Switch(config-if-range)#switchport access vlan 10
% Access VLAN does not exist. Creating vlan 10
Switch(config-if-range)#do wr
Building configuration...
[OK]
Switch(config-if-range)#
Switch(config-if-range)#
```

```
Switch>
Switch>en
Switch#config t
Enter configuration commands, one per line.  End with CNTL/Z.
Switch(config)#
Switch(config)#int range fa0/1-24
Switch(config-if-range)#switchport mode access
Switch(config-if-range)#switchport access vlan 20
% Access VLAN does not exist. Creating vlan 20
Switch(config-if-range)#
Switch(config-if-range)#do wr
Building configuration...
[OK]
Switch(config-if-range)#
```

```
Switch>
Switch>en
Switch#config t
Enter configuration commands, one per line.  End with CNTL/Z.
Switch(config)#int range fa0/1-24
Switch(config-if-range)#switchport mode access
Switch(config-if-range)#switchport access vlan 30
% Access VLAN does not exist. Creating vlan 30
Switch(config-if-range)#do wr
Building configuration...
[OK]
Switch(config-if-range)#
```

Give IP add to all the ports. So the same for all the routers.

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```
Router>
Router>
Router>en
Router#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#
Router(config)#
Router(config)#int se0/1/1
Router(config-if)#ip add
Router(config-if)#ip address 10.10.10.1 255.255.255.252
Router(config-if)#
Router(config-if)#
Router(config-if)#ex
Router(config)#
Router(config)#
Router(config)#int se0/1/0
Router(config-if)#ip address 10.10.10.5 255.255.255.252
Router(config-if)#
Router(config-if)#
Router(config-if)#ex
Router(config)#
Router(config)#
Router(config)#do wr
Building configuration...
[OK]
Router(config)#
```

```
Router>
Router>
Router>en
Router#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#
Router(config)#
Router(config)#int se0/2/0
Router(config-if)#ip add
Router(config-if)#ip address 10.10.10.2 255.255.255.252
Router(config-if)#ex
Router(config)#
Router(config)#
Router(config)#do wr
Building configuration...
[OK]
Router(config)#
```

```
Router(config)#int gig0/0.90
Router(config-subif)#
%LINK-5-CHANGED: Interface GigabitEthernet0/0.90, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet0/0.90, changed state to
up

Router(config-subif)#
Router(config-subif)#enc
Router(config-subif)#encapsulation d
Router(config-subif)#encapsulation dot1Q 90
Router(config-subif)#ip add
Router(config-subif)#ip address 192.168.9.1 255.255.255.0
Router(config-subif)#ex
Router(config)#
Router(config)#
Router(config)#
Router(config)#int gig0/0.100
Router(config-subif)#
%LINK-5-CHANGED: Interface GigabitEthernet0/0.100, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet0/0.100, changed state to
up
```

Configure the DHCP service on the router, create a DHCP pool for "Staff-pool," and assign network details like the network address and default gateway. Do the same for all the VLANs.

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```
Router(config)#
Router(config)#
Router(config)#serv
Router(config)#service dh
Router(config)#service dhcp
Router(config)#
Router(config)#
Router(config)#
Router(config)#ip dhc
Router(config)#ip dhcp p
Router(config)#ip dhcp pool Staf-pool
Router(dhcp-config)#net
Router(dhcp-config)#network 192.168.9.0 255.255.255.0
Router(dhcp-config)#def
Router(dhcp-config)#default-router 192.168.9.1
Router(dhcp-config)#dn
Router(dhcp-config)#dns-server 192.168.9.1
Router(dhcp-config)#ex
Router(config)#
Router(config)#
Router(config)#do wr
Building configuration...
[OK]
```

Now check the connectivity between different vlans using the pink command.

```
Packet Tracer PC Command Line 1.0
C:\>ping 192.168.9.2

Pinging 192.168.9.2 with 32 bytes of data:

Request timed out.
Reply from 192.168.9.2: bytes=32 time<1ms TTL=127
Reply from 192.168.9.2: bytes=32 time<1ms TTL=127
Reply from 192.168.9.2: bytes=32 time=4ms TTL=127

Ping statistics for 192.168.9.2:
    Packets: Sent = 4, Received = 3, Lost = 1 (25% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 4ms, Average = 1ms

C:\>
```

The command **encapsulation dot1Q 10** is used in Cisco networking to configure **802.1Q encapsulation** on a subinterface of a router. Specifically, the number "10" refers to the **VLAN ID**. Here's a breakdown:

- **dot1Q**: This is the IEEE 802.1Q protocol used for **VLAN tagging** on Ethernet frames. It allows multiple VLANs to traverse the same physical network link, with each frame tagged to indicate the VLAN it belongs to.
- **10**: This number specifies the **VLAN ID** for which the subinterface will handle traffic. Each VLAN is assigned a unique identifier (ID), and in this case, VLAN 10 is being used for this particular subinterface.

This command is typically issued on a **router subinterface** that is configured for **trunking** on a switch port, allowing the router to handle multiple VLANs through a single interface.

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```
Router(config)#
Router(config)#int gig0/0.10
Router(config-subif)#
%LINK-5-CHANGED: Interface GigabitEthernet0/0.10, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet0/0.10, changed state to
up

Router(config-subif)#
Router(config-subif)#enc
Router(config-subif)#encapsulation d
Router(config-subif)#encapsulation dot1Q 10
Router(config-subif)#ip add
Router(config-subif)#ip address 192.168.1.1 255.255.255.0
Router(config-subif)#ex
Router(config)#
Router(config)#
Router(config)#
Router(config)#int gig0/0.20
Router(config-subif)#
%LINK-5-CHANGED: Interface GigabitEthernet0/0.20, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet0/0.20, changed state to
up

Router(config-subif)#encapsulation dot1Q 20
Router(config-subif)#ip address 192.168.2.1 255.255.255.0
Router(config-subif)#ex
Router(config)#
```

Again create dhcp pool for remaining routers.

```
Router(config)#
Router(config)#serv
Router(config)#service dh
Router(config)#service dhcp
Router(config)#
Router(config)#
Router(config)#ip dh
Router(config)#ip dhcp p
Router(config)#ip dhcp pool admin-pool
Router(dhcp-config)#net
Router(dhcp-config)#network 192.168.1.0 255.255.255.0
Router(dhcp-config)#def
Router(dhcp-config)#default-router 192.168.1.1
Router(dhcp-config)#dn
Router(dhcp-config)#dns-server 192.168.1.1
Router(dhcp-config)#ex
Router(config)#
```

```
Router(dhcp-config)#ex
Router(config)#
Router(config)#
Router(config)#ip dhcp pool hr-pool
Router(dhcp-config)#network 192.168.2.0 255.255.255.0
Router(dhcp-config)#default-router 192.168.2.1
Router(dhcp-config)#dns-server 192.168.2.1
Router(dhcp-config)#
Router(dhcp-config)#ex
Router(config)#
Router(config)#
```

Again check the connectivity between different vlan using ping command.

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```
Packet Tracer PC Command Line 1.0
C:\>ping 192.168.8.2

Pinging 192.168.8.2 with 32 bytes of data:

Request timed out.
Reply from 192.168.8.2: bytes=32 time<1ms TTL=127
Reply from 192.168.8.2: bytes=32 time<1ms TTL=127
Reply from 192.168.8.2: bytes=32 time<1ms TTL=127

Ping statistics for 192.168.8.2:
    Packets: Sent = 4, Received = 3, Lost = 1 (25% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 0ms, Average = 0ms

C:\>
```

```
C:\>ping 192.168.10.2

Pinging 192.168.10.2 with 32 bytes of data:

Reply from 192.168.1.1: Destination host unreachable.
Reply from 192.168.1.1: Destination host unreachable.
Reply from 192.168.1.1: Destination host unreachable.
Reply from 192.168.1.1: Destination host unreachable.

Ping statistics for 192.168.10.2:
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),

C:\>ping 192.168.9.2

Pinging 192.168.9.2 with 32 bytes of data:

Reply from 192.168.1.1: Destination host unreachable.
Reply from 192.168.1.1: Destination host unreachable.
```

Now configure the rip protocol to the main campus network and give all the neighbor network id.

```
Router>
Router>en
Router#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#
Router(config)#
Router(config)#
Router(config)#route
Router(config)#router rip
Router(config)#router rip
Router(config-router)#ver
Router(config-router)#version 2
Router(config-router)#netw
Router(config-router)#network 192.168.9.0
Router(config-router)#network 192.168.10.0
Router(config-router)#network 10.10.10.0
Router(config-router)#ex
```

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```
Router(config)#rout
Router(config)#router r
Router(config)#router rip
Router(config-router)#v
Router(config-router)#version 2
Router(config-router)#networ
Router(config-router)#network 10.10.10.0
Router(config-router)#network 10.10.10.4
Router(config-router)#network 192.168.1.0
Router(config-router)#network 192.168.2.0
Router(config-router)#network 192.168.3.0
Router(config-router)#network 192.168.4.0
Router(config-router)#network 192.168.5.0
Router(config-router)#network 192.168.6.0
Router(config-router)#network 192.168.7.0
Router(config-router)#network 192.168.8.0
Router(config-router)#ex
```

```
C:\>ping 192.168.9.2

Pinging 192.168.9.2 with 32 bytes of data:

Reply from 192.168.9.2: bytes=32 time=1ms TTL=126
Reply from 192.168.9.2: bytes=32 time=1ms TTL=126
Reply from 192.168.9.2: bytes=32 time=21ms TTL=126
Reply from 192.168.9.2: bytes=32 time=1ms TTL=126

Ping statistics for 192.168.9.2:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 1ms, Maximum = 21ms, Average = 6ms

C:\>ping 192.168.10.2

Pinging 192.168.10.2 with 32 bytes of data:

Reply from 192.168.10.2: bytes=32 time=24ms TTL=126
```

```
    Minimum = 0ms, Maximum = 4ms, Average = 1ms

C:\>ping 192.168.4.2

Pinging 192.168.4.2 with 32 bytes of data:

Request timed out.
Reply from 192.168.4.2: bytes=32 time=24ms TTL=126
Reply from 192.168.4.2: bytes=32 time=1ms TTL=126
Reply from 192.168.4.2: bytes=32 time=23ms TTL=126

Ping statistics for 192.168.4.2:
    Packets: Sent = 4, Received = 3, Lost = 1 (25% loss),
Approximate round trip times in milli-seconds:
    Minimum = 1ms, Maximum = 24ms, Average = 16ms
```

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Conclusion :

This **Campus Network Design and Implementation** project on Cisco Packet Tracer gives a clear understanding of how to design and implement a secure and scalable network for a university campus. By configuring routers, switches, DHCP, VLANs, and firewalls, you can simulate a real-world network setup. This project helps develop essential networking skills, such as subnetting, inter-VLAN routing, and IP addressing, while also focusing on network security and performance. It's a comprehensive experience that provides hands-on practice with various network components and configurations.