

UNIVERSITY/CAMPUS NETWORK

Coursework Brief

Albion University is a large university which has two campuses situated 20 miles apart. The university's students and staff are distributed in 4 faculties; these include the faculties of Health and Sciences; Business; Engineering/Computing and Art/Design. Each member of staff has a PC and students have access to PCs in the labs.

Requirements:

- a. Create a network topology with the main components to support the following:
 - Main campus:
 - **Building A:** Administrative staff in the departments of management, HR and finance. The admin staff PCs are distributed in the building offices and it is expected that they will share some networking equipment (**Hint: use of VLANs is expected here**). The Faculty of Business is also situated in this building
 - **Building B:** Faculty of Engineering and Computing and Faculty of Art and Design
 - **Building C:** Students' labs and IT department. The IT department hosts the University Web server and other servers
 - There is also an email server hosted externally on the cloud.
 - Smaller campus:
 - Faculty of Health and Sciences (staff and students' labs are situated on separate floors)
- b. You will be expected to configure the core devices and few end devices to provide end-to-end connectivity and access to the internal servers and the external server.
 - Each department/faculty is expected to be on its own separate IP network
 - The switches should be configured with appropriate VLANs and security settings
 - RIPv2 will be used to provide routing for the routers in the internal network and static routing for the external server.
 - The devices in building A will be expected to acquire dynamic IP addresses from a router-based DHCP server

Tasks:

Task 1: Your task is to plan, design, and prototype the network topology for Albion University's network using Cisco Packet Tracer. **Formative feedback will be given on this task in week 6.**

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Task 2: Configure in Packet Tracer the network with appropriate settings to achieve the connectivity and functionalities specified in the requirements.

Task 3: Produce a report (**max 1500 words**) including evaluation your proposed network design and critical appraisal on your work. Your evaluation should include performance, scalability, reliability and security of your proposed network.

This documentation will serve as my report for the above case study.

Plan and Design

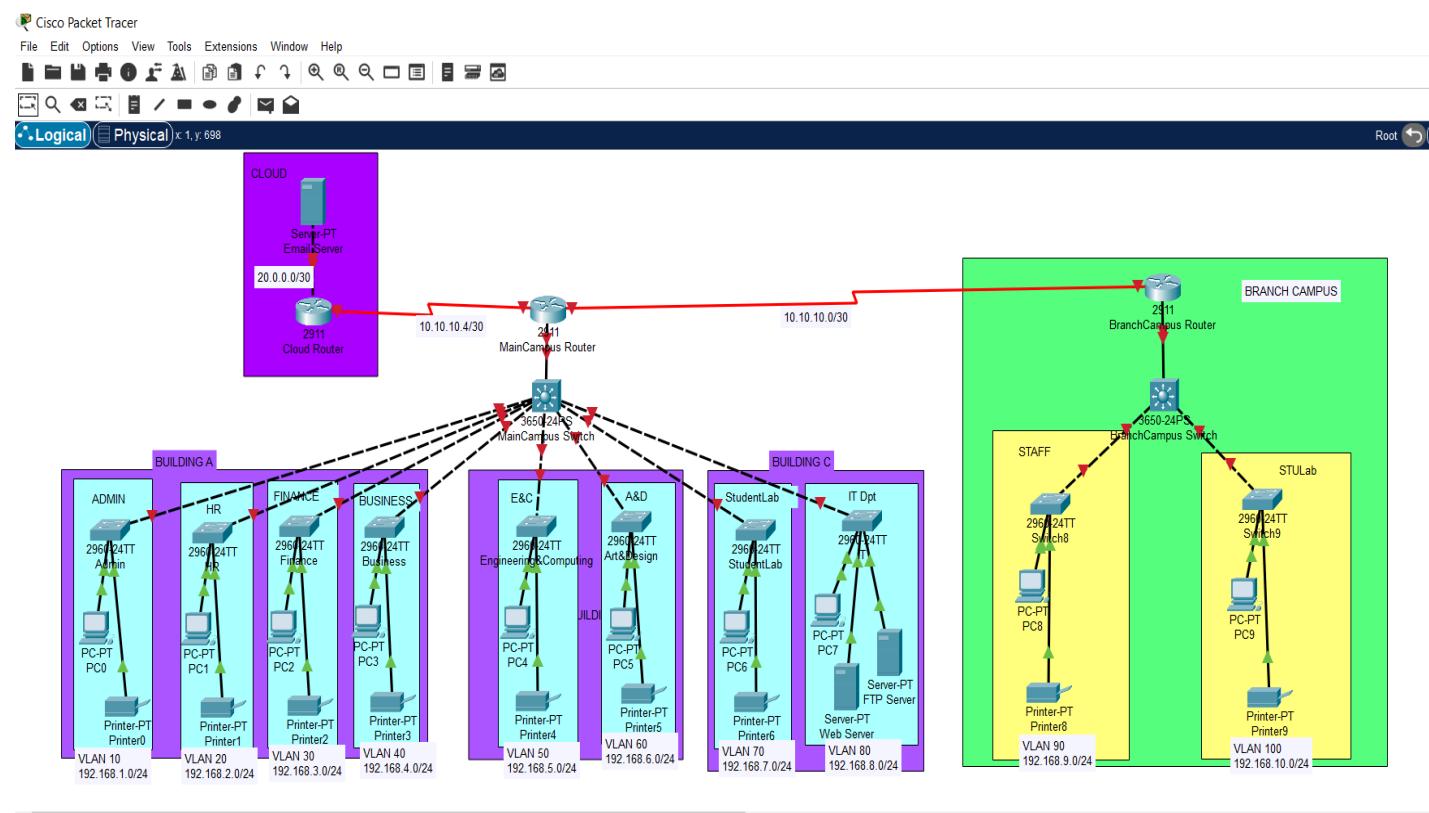
The network is set to service the main campus and a smaller campus for the university.

The hierarchical topology is most suitable for this as it will have 3 layers; the distribution layer, the access layer, and the core layer. For the core layer, there is a router, and both the access and distribution layers have switches.

The main campus network has 3 buildings; building A has 4 departments, building B has 2 departments, lastly Building C has 2 departments.

The server is hosted externally in the cloud which means it is not hosted anywhere on site.

The serial connection for the router requires you to replace one of the modules with a serial port since it needs it to use a serial DCE cable.



We also need to make a network for the branch campus which is just one building with 2 departments.

Each department should have its own VLAN network. Include the networks between the routers while assigning networks.

Configuration

The first thing is to remove the routers from shutdown state. On the MainCampus router CLI:

En

Conf t

Int gig0/0

No shutdown

Int se0/2/0

No shutdown

Int se0/2/1

No shutdown

Do wr

On the Cloud Router CLI:

En

Conf t

Int gig0/0

No shutdown

Int se0/1/0

No shutdown

Do wr

On the BranchCampus Router CLI:

En

Conft

Int gig0/0

No shutdown

Int se0/1/0

No shutdown

Do wr

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

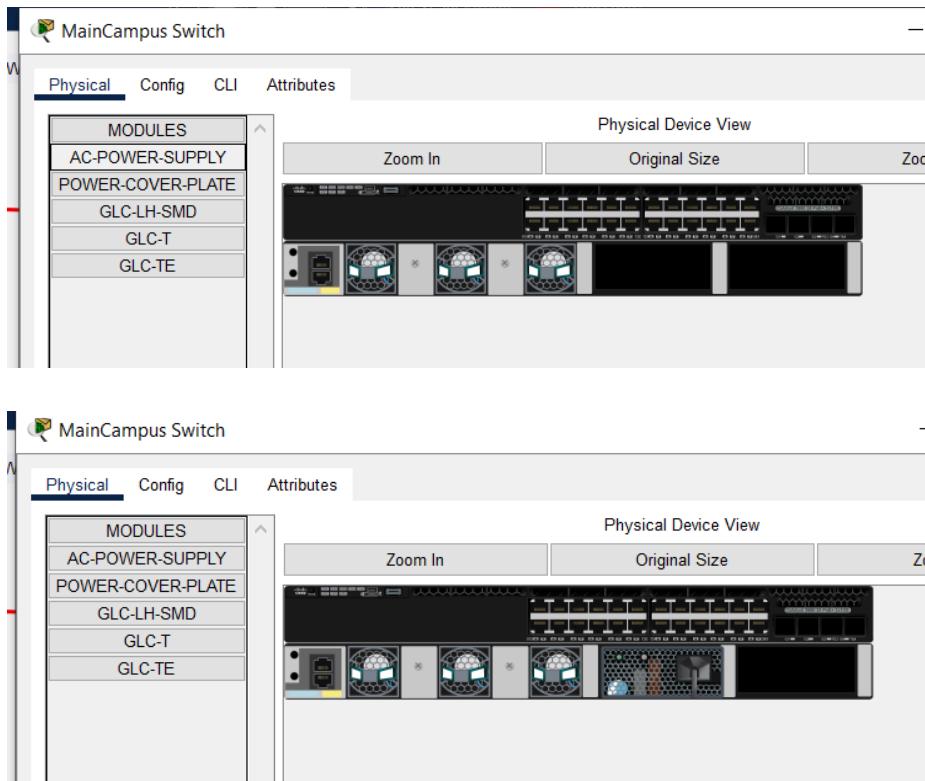
Router(config-if)#
%LINK-5-CHANGED: Interface GigabitEthernet0/0, changed state to up

Router(config-if)#int se0/2/0
%Invalid interface type and number
Router(config)#int se0/1/0
Router(config-if)#no shutdown

Router(config-if)#
%LINK-5-CHANGED: Interface Serial0/1/0, changed state to up
do wr
Building configuration...
[OK]
Router(config-if)#
%LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/1/0, changed state to up
```

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Now let's turn on the layer 3 switch. This means plugging in an AC switch to turn it on. This is for both switches on the network.



Since the routers are using serial DCE cables, this means we should configure a clock rate to enable traffic to flow through those cables. To determine which router is the interface hover above it and the clock icon should show you.

On the MainCampus Router CLI:

Exit

Int se0/2/1

Clock rate 64000

Int se0/2/0

Clock rate 64000

Do wr

Exit

```
%LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/2/0, changed state to up
Router(config)#int se0/1/1
%Invalid interface type and number
Router(config)#int se0/2/1
Router(config-if)#clock rate 64000
Router(config-if)#int se0/2/0
Router(config-if)#clock rate 64000
Router(config-if)#do wr
Building configuration...
[OK]
Router(config-if)#exit
Router(config)#+
```

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Configuring VLANs

This next step is to configure all the switches for every department.

Start with the Admin switch CLI:

EN

Conf t

Int range fa0/1-24

Switchport mode access

Switchport access vlan 10

Do wr

exit

Do this for all switches changing only the vlan number

```
Switch>
Switch>en
Switch#conf 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 10
% Access VLAN does not exist. Creating vlan 10
Switch(config-if-range)#do wr
Building configuration...
[OK]
Switch(config-if-range)#exit
Switch(config)#[
```

The connecting port on the layer 3 switch should be in access mode having the same vlan as the corresponding layer 2 switch. So on the MainCampus switch CLI:

En

Conf t

Int gig1/0/2

Switchport mode access

Switchport access vlan 10

Exit

Int gig1/0/3

Switchport mode access

Switchport access vlan 20

Exit

Int gig1/0/4

Switchport mode access

Switchport access vlan 30

Exit

Int gig1/0/5

Switchport mode access

Switchport access vlan 40

Exit

Int gig1/0/6

Switchport mode access

Switchport access vlan 50

Exit

Int gig1/0/7

Switchport mode access

Switchport access vlan 60

Exit

Int gig1/0/8

Switchport mode access

Switchport access vlan 70

Exit

Int gig1/0/9

Switchport mode access

Switchport access vlan 80

Exit

Do wr

```

MainCampus Switch
Physical Config CLI Attributes
IOS Command Line Interface

Switch(config-if)#Switchport mode access
Switch(config-if)#Switchport access vlan 40
Switch(config-if)#Exit
Switch(config)#
%CDP-4-NATIVE_VLAN_MISMATCH: Native VLAN mismatch discovered on GigabitEthernet1/0/2 (10), with
Switch FastEthernet0/1 (50).

%CDP-4-NATIVE_VLAN_MISMATCH: Native VLAN mismatch discovered on GigabitEthernet1/0/5 (40), with
Switch FastEthernet0/1 (30).

%CDP-4-NATIVE_VLAN_MISMATCH: Native VLAN mismatch discovered on GigabitEthernet1/0/7 (60), with
Switch FastEthernet0/1 (10).

%CDP-4-NATIVE_VLAN_MISMATCH: Native VLAN mismatch discovered on GigabitEthernet1/0/3 (20), with
Switch FastEthernet0/1 (60).

%CDP-4-NATIVE_VLAN_MISMATCH: Native VLAN mismatch discovered on GigabitEthernet1/0/6 (50), with
Switch FastEthernet0/1 (20).
Int gig1/0/6
Switch(config-if)#Switchport mode access
Switch(config-if)#Switchport access vlan 50
Switch(config-if)#Exit
Switch(config)#
%CDP-4-NATIVE_VLAN_MISMATCH: Native VLAN mismatch discovered on GigabitEthernet1/0/4 (30), with
Switch FastEthernet0/1 (40).
Int gig1/0/7
Switch(config-if)#Switchport mode access
Switch(config-if)#Switchport access vlan 60
Switch(config-if)#Exit
Switch(config)#!Int gig1/0/8
Switch(config-if)#Switchport mode access
Switch(config-if)#Switchport access vlan 70
Switch(config-if)#Exit
Switch(config)#!Int gig1/0/9
Switch(config-if)#Switchport mode access
Switch(config-if)#Switchport access vlan 80
Switch(config-if)#Exit
Switch(config)#do wr
Building configuration...
Compressed configuration from 7383 bytes to 3601 bytes[OK]
[OK]
Switch(config)#

```

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On the branch campus network let's configure the access layer. On the StudentLab switch CLI:

En

conf t

Int range fa0/1-24

Switchport mode access

Switchport access vlan 100

Do wr

Exit

On the Staff switch CLI:

En

conf t

Int range fa0/1-24

Switchport mode access

Switchport access vlan 90

Do wr

Exit

```
Switch>en
Switch#conf 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 90
% Access VLAN does not exist. Creating vlan 90
Switch(config-if-range)#Do wr
Building configuration...
[OK]
Switch(config-if-range)#exit
Switch(config)#Int range fa0/1-24
Switch(config-if-range)#Switchport mode access
Switch(config-if-range)#Switchport access vlan 90
Switch(config-if-range)#Do wr
Building configuration...
[OK]
Switch(config-if-range)#Exit
Switch(config)#
1
```

To configure the layer 2 distribution layer, go to the Branch Switch CLI:

EN

Conf t

int gig1/0/2

Switchport mode access

Switchport access vlan 90

Exit

Int gig1/0/3

Switchport mode access

Switchport access vlan 100

Exit

Do wr

The devices on this network also need to communicate with those on the main campus network and since an access port cannot connect with more than one VLAN we have to make the layer 2 switch on the branch campus a trunk port such that all vlan communication can be transported to the router. So on the BranchCampus switch CLI:

Int gig1/0/1

Switchport trunk encapsulation dot1q

Switchport mode trunk

Exit

Do wr

```
Switch#Conf t
Enter configuration commands, one per line.  End with CNTL/Z.
Switch(config)#int gig1/0/2
Switch(config-if)#Switchport mode access
Switch(config-if)#Switchport access vlan 90
% Access VLAN does not exist. Creating vlan 90
Switch(config-if)#Exit
Switch(config)#Int gig1/0/3
Switch(config-if)#Switchport mode access
Switch(config-if)#Switchport access vlan 100
% Access VLAN does not exist. Creating vlan 100
Switch(config-if)#Exit
Switch(config)#do wr
Building configuration...
Compressed configuration from 7383 bytes to 3601 bytes[OK]
[OK]
Switch(config)#Int gig1/0/1
Switch(config-if)#Switchport trunk encapsulation dot1q
^
% Invalid input detected at '^' marker.

Switch(config-if)#Switchport mode trunk

Switch(config-if)#Exit
Switch(config)#Do wr
Building configuration...
Compressed configuration from 7383 bytes to 3601 bytes[OK]
[OK]
Switch(config)#
%LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet1/0/1, changed state to down
%LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet1/0/1, changed state to up
%CDP-4-NATIVE_VLAN_MISMATCH: Native VLAN mismatch discovered on GigabitEthernet1/0/1 (1), with
Switch FastEthernet0/1 (90).
```

We also need to configure the MainCampus switch to be a trunk interface:

Int gig1/0/1

Switchport trunk encapsulation dot1q

Switchport mode trunk

Exit

Do wr

If the above doesn't work try:

Int gig1/0/1

Switchport trunk allowed vlan 10-100

Switchport mode trunk

Exit

Do wr

```
Switch(config)#
Switch(config)#
Switch(config)#
Switch(config)#
Switch(config)#
Switch(config)#Int gig1/0/1
Switch(config-if)#Switchport trunk encapsulation dot1q
                           ^
% Invalid input detected at '^' marker.

Switch(config-if)#Switchport mode trunk

Switch(config-if)#Exit
Switch(config)#Do wr
Building configuration...
Compressed configuration from 7383 bytes to 3601 bytes[OK]
[OK]
Switch(config)#
%LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet1/0/1, changed state to down

%LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet1/0/1, changed state to up
```

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We have configured both the access and distribution layer. All that is left is the core layer.

To allow inter-VLAN communication we must set up inter-VLAN routing. We also need to configure IP addresses and create sub-interfaces to assign IP addresses to the departments on the network.

Assigning IP Addresses

Note that for each of the routers, an IP address is left while assigning the addresses for inter-VLAN routing which we will see later.

On the MainCampus Router:

En

Conf t

Int se0/2/1

Ip address 10.10.10.1 255.255.255.252

Exit

Int se0/2/0

Ip address 10.10.10.5 255.255.255.252

Exit

Do wr

On the BranchCampus router:

En

Conf t

Int se0/1/0

Ip address 10.10.10.2 255.255.255.252

Exit

Do wr

On the cloud router:

En

Conf t

Int se0/1/0

Ip address 10.10.10.6 255.255.255.252

Exit

Int gig0/0

Ip address 20.0.0.1 255.255.255.252

Exit

Do wr

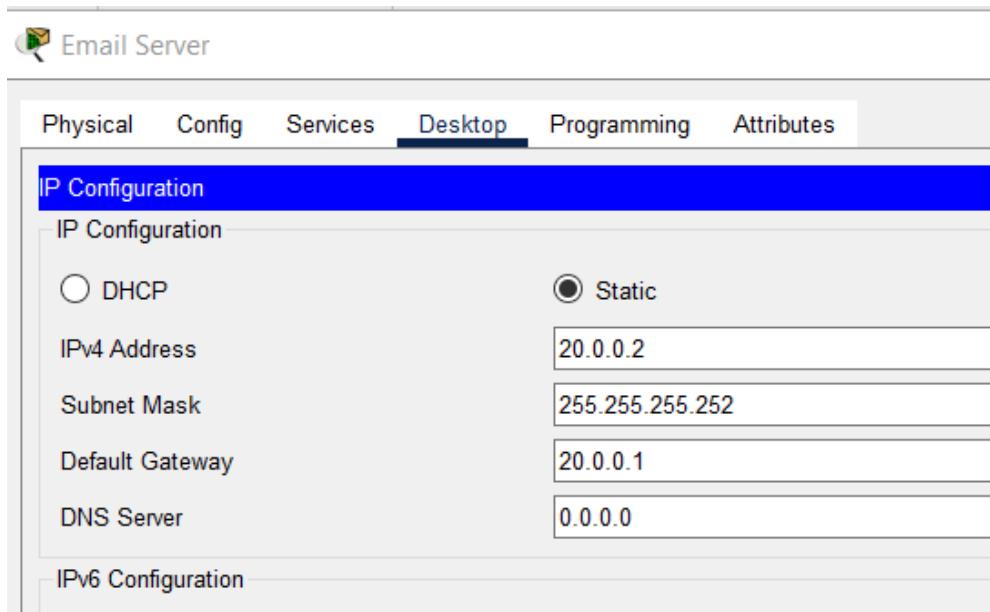
```
Router>
Router>
Router>
Router>En
Router#Conf t
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#Int se0/2/1
Router(config-if)#Ip address 10.10.10.1 255.255.255.252
Router(config-if)#Exit
Router(config)#Int se0/2/0
Router(config-if)#Ip address 10.10.10.5 255.255.255.252
Router(config-if)#Exit
Router(config)#Do wr
Building configuration...
[OK]
Router(config)#

```

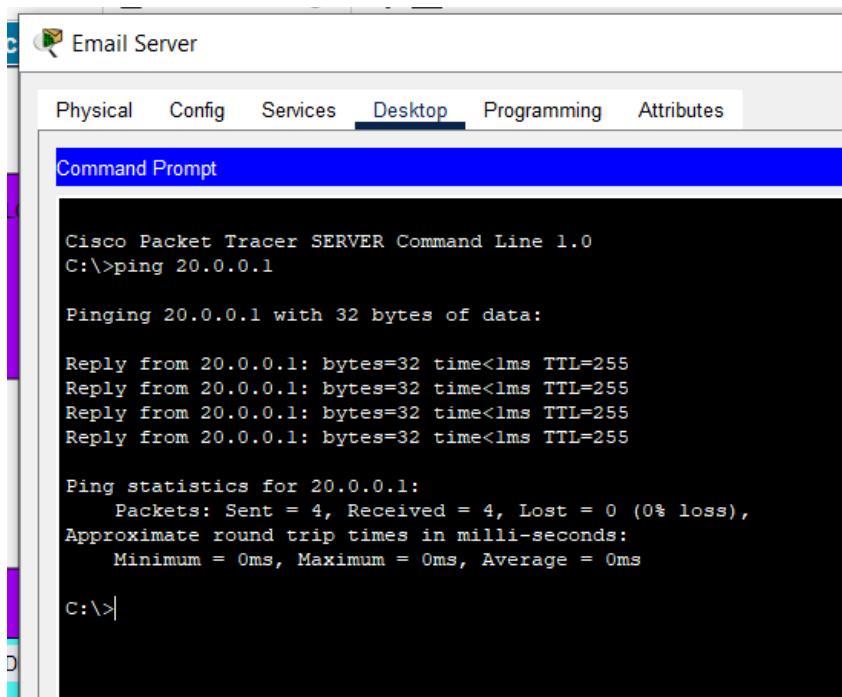
Now we have to assign an IP address to the server statically.

Click on the server> Desktop>static> ipv4 address 20.0.0.2> subnet mask 255.255.255.252 >

Default gateway 20.0.0.1



Try to ping the default gateway from the command prompt



Configuring Inter-VLAN Routing and DHCP Server

On the BranchCampus Router:

Int gig0/0.90

Encapsulation dot1Q 90

Ip address 192.168.9.1 255.255.255.0

Exit

Int gig0/0.100

Encapsulation dot1Q 100

Ip address 192.168.10.1 255.255.255.0

Exit

Do wr

Service dhcp

Ip dhcp pool Staff-pool

Network 192.168.9.0 255.255.255.0

Default-router 192.168.9.1

Dns-server 192.168.9.1

Exit

Ip dhcp pool Lab-pool

Network 192.168.10.0 255.255.255.0

Default-router 192.168.10.1

Dns-server 192.168.10.1

Exit

Do wr

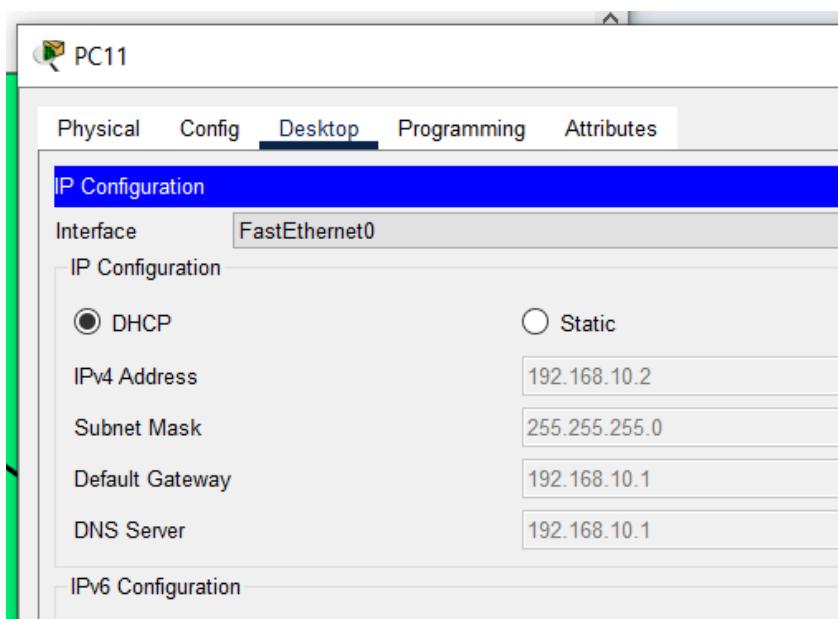
```

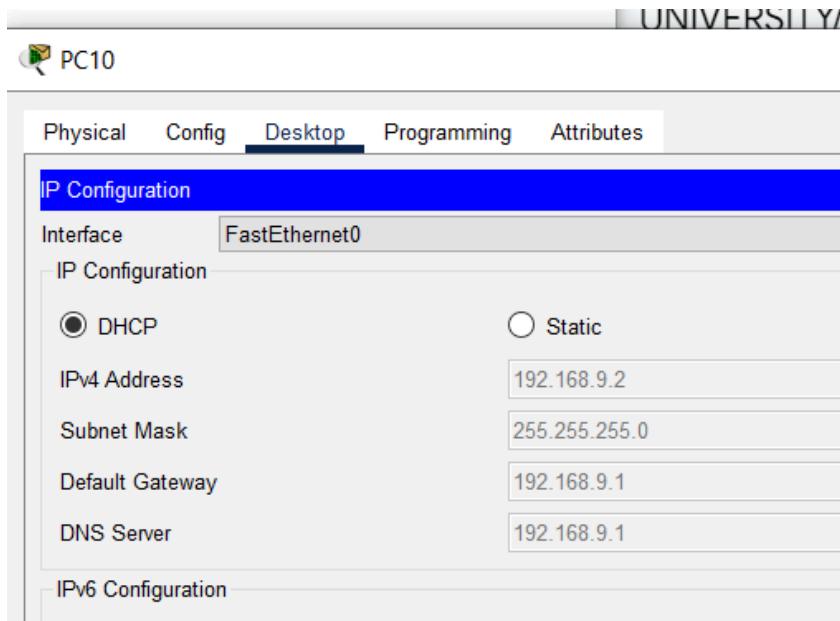
Router(config)#Int gig0/0.100
Router(config-subif)#Encapsulation dot1Q 100
Router(config-subif)#Ip address 192.168.10.1 255.255.255.0
Router(config-subif)#Exit
Router(config)#Do wr
Building configuration...
[OK]
Router(config)#
%LINK-5-CHANGED: Interface GigabitEthernet0/0.100, changed state to u
%LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet0/0.100
changed to up
Router(config)#Service dhcp
Router(config)#Ip dhcp pool Staff-pool
Router(dhcp-config)#Network 192.168.9.0 255.255.255.0
Router(dhcp-config)#Default router 192.168.9.1
^
% Invalid input detected at '^' marker.

Router(dhcp-config)#Dns-server 192.168.9.1
Router(dhcp-config)#Exit
Router(config)#Service dhcp
Router(config)#Ip dhcp pool Staff-pool
Router(dhcp-config)#Network 192.168.9.0 255.255.255.0
Router(dhcp-config)#Default-router 192.168.9.1
Router(dhcp-config)#Dns-server 192.168.9.1
Router(dhcp-config)#exit
Router(config)#Ip dhcp pool Lab-pool
Router(dhcp-config)#Network 192.168.10.0 255.255.255.0
Router(dhcp-config)#Default-router 192.168.10.1
Router(dhcp-config)#Dns-server 192.168.10.1
Router(dhcp-config)#Exit
Router(config)#Do wr
Building configuration...
[OK]
Router(config)#

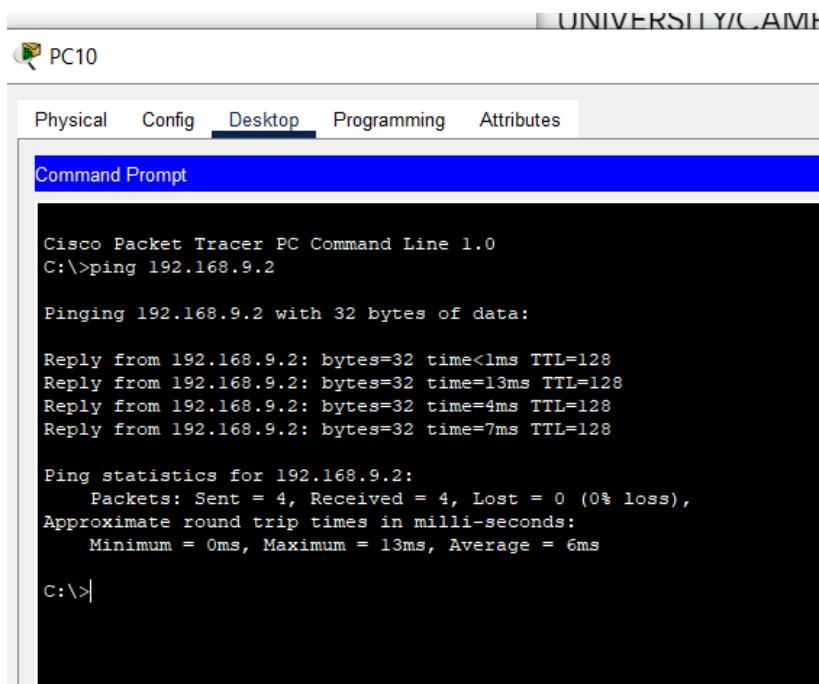
```

To test the configuration go to the PC> desktop> ip configuration> dhcp (do this on both PCs)





You can also test by pinging one PC from the other so ping 192.168.9.2



On the MainCampus Router:

En

Conf t

Int gig0/0.10

Encapsulation dot1Q 10

Ip address 192.168.1.1 255.255.255.0

Exit

Int gig0/0.20

Encapsulation dot1Q 20

Ip address 192.168.2.1 255.255.255.0

Exit

Int gig0/0.30

Encapsulation dot1Q 30

Ip address 192.168.3.1 255.255.255.0

Exit

Int gig0/0.40

Encapsulation dot1Q 40

Ip address 192.168.4.1 255.255.255.0

Exit

Int gig0/0.50

Encapsulation dot1Q 50

Ip address 192.168.5.1 255.255.255.0

Exit

Int gig0/0.60

Encapsulation dot1Q 60

Ip address 192.168.6.1 255.255.255.0

Exit

Int gig0/0.70

Encapsulation dot1Q 70

Ip address 192.168.7.1 255.255.255.0

Exit

Int gig0/0.80

Encapsulation dot1Q 80

Ip address 192.168.8.1 255.255.255.0

Exit

Service dhcp

Ip dhcp pool admin-pool

Network 192.168.1.0 255.255.255.0

Default-router 192.168.1.1

Dns-server 192.168.1.1

Exit

Ip dhcp pool hr-pool

Network 192.168.2.0 255.255.255.0

Default-router 192.168.2.1

Dns-server 192.168.2.1

Exit

Ip dhcp pool finance-pool

Network 192.168.3.0 255.255.255.0

Default-router 192.168.3.1

Dns-server 192.168.3.1

Exit

Ip dhcp pool business-pool

Network 192.168.4.0 255.255.255.0

Default-router 192.168.4.1

Dns-server 192.168.4.1

Exit

Ip dhcp pool EC-pool

Network 192.168.5.0 255.255.255.0

Default-router 192.168.5.1

Dns-server 192.168.5.1

Exit

Ip dhcp pool AD-pool

Network 192.168.6.0 255.255.255.0

Default-router 192.168.6.1

Dns-server 192.168.6.1

Exit

Ip dhcp pool student-pool

Network 192.168.7.0 255.255.255.0

Default-router 192.168.7.1

Dns-server 192.168.7.1

Exit

Ip dhcp pool IT-pool

Network 192.168.8.0 255.255.255.0

Default-router 192.168.8.1

Dns-server 192.168.8.1

Exit

Do wr

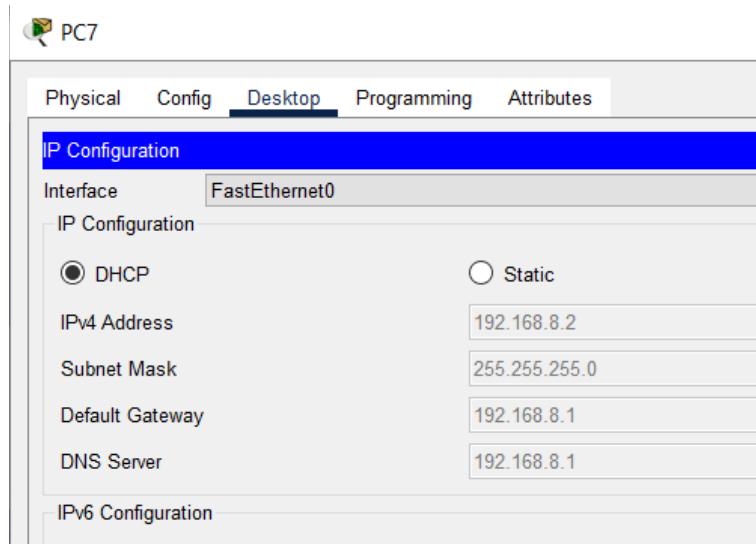
```

Router(dhcp-config)#Default-router 192.168.1.1
Router(dhcp-config)#Dns-server 192.168.1.1
Router(dhcp-config)#Exit
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)#Exit
Router(config)#Ip dhcp pool finance-pool
Router(dhcp-config)#Network 192.168.3.0 255.255.255.0
Router(dhcp-config)#Default-router 192.168.3.1
Router(dhcp-config)#Dns-server 192.168.3.1
Router(dhcp-config)#Exit
Router(config)#Ip dhcp pool business-pool
Router(dhcp-config)#Network 192.168.4.0 255.255.255.0
Router(dhcp-config)#Default-router 192.168.4.1
Router(dhcp-config)#Dns-server 192.168.4.1
Router(dhcp-config)#Exit
Router(config)#Ip dhcp pool EC-pool
Router(dhcp-config)#Network 192.168.5.0 255.255.255.0
Router(dhcp-config)#Default-router 192.168.5.1
Router(dhcp-config)#Dns-server 192.168.5.1
Router(dhcp-config)#Exit
Router(config)#Ip dhcp pool AD-pool
Router(dhcp-config)#Network 192.168.6.0 255.255.255.0
Router(dhcp-config)#Default-router 192.168.6.1
Router(dhcp-config)#Dns-server 192.168.6.1
Router(dhcp-config)#Exit
Router(config)#Ip dhcp pool student-pool
Router(dhcp-config)#Network 192.168.7.0 255.255.255.0
Router(dhcp-config)#Default-router 192.168.7.1
Router(dhcp-config)#Dns-server 192.168.7.1
Router(dhcp-config)#Exit
Router(config)#Ip dhcp pool IT-pool
Router(dhcp-config)#Network 192.168.8.0 255.255.255.0
Router(dhcp-config)#Default-router 192.168.8.1
Router(dhcp-config)#Dns-server 192.168.8.1
Router(config)#Do wr
Building configuration...
[OK]
Router(config)#

```

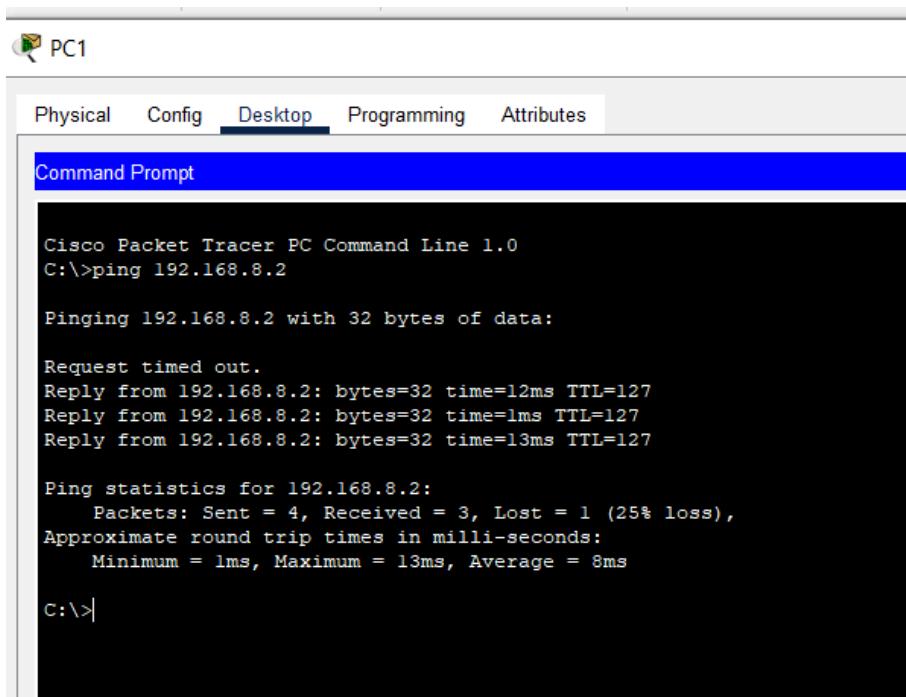
Copy Paste

Devices in the main campus network are now able to communicate with each other. To test the configuration go to the PC > desktop > ip configuration > dhcp (do this on all PCs)



Let's test inter-VLAN routing through ping on any PC.

Ping 192.168.8.2



```
Cisco 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=12ms TTL=127
Reply from 192.168.8.2: bytes=32 time=1ms TTL=127
Reply from 192.168.8.2: bytes=32 time=13ms 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 = 1ms, Maximum = 13ms, Average = 8ms

C:>|
```

Configure Routing Protocol

We have to use rip version 2 to enable inter-network communication to allow devices in the main campus network to communicate with those in the branch campus.

On the BranchCampus Router:

En

'Conf t

Router rip

Version 2

Network 192.168.9.0

Network 192.168.10.0

Network 10.10.10.0

Exit

Do wr

On the main campus router:

En

Conf t

Router rip

Version 2

Network 10.10.10.0

Network 10.10.10.4

Network 192.168.1.0

Network 192.168.2.0

Network 192.168.3.0

Network 192.168.4.0

Network 192.168.5.0

Network 192.168.6.0

Network 192.168.7.0

Network 192.168.8.0

Exit

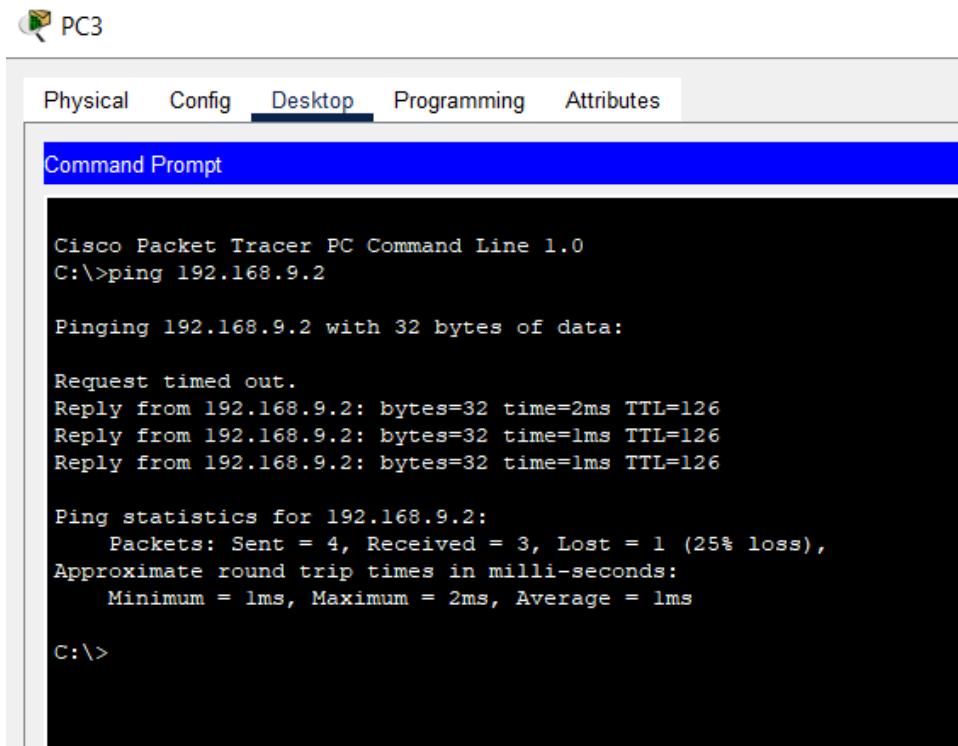
Do wr

```
Router(config)#
Router(config)#
Router(config)#
Router(config)#
Router(config)#
Router(config)#Router rip
Router(config-router)#Version 2
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)#Exit
Router(config)#Do wr
Building configuration...
[OK]
Router(config)#

```

'Test communication by pinging from any PC on the main campus to one on the branch campus.

Ping 192.168.9.2



On the cloud router:

En

Conft

Router rip

Version 2

Network 20.0.0.0

Network 10.10.10.4

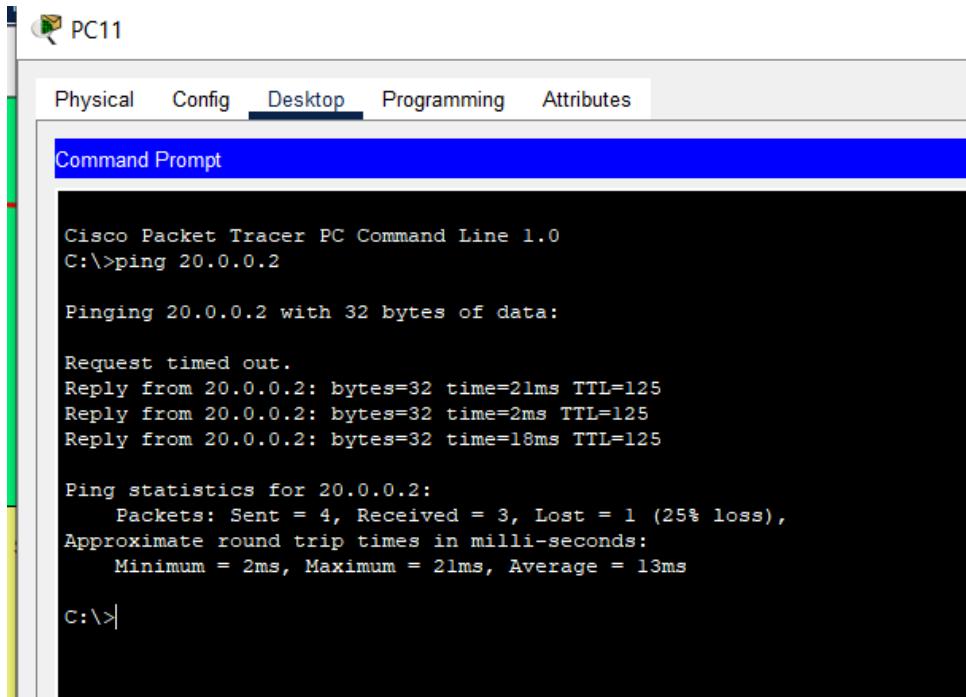
Exit

Do wr

```
Router>
Router>
Router>En
Router#Conf t
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#Router rip
Router(config-router)#Version 2
Router(config-router)#Network 20.0.0.0
Router(config-router)#Network 10.10.10.4
Router(config-router)#Exit
Router(config)#Do wr
Building configuration...
[OK]
Router(config)#[
```

Test by pinging the server from the branch campus network,

Ping 20.0.0.2



The screenshot shows the Cisco Packet Tracer PC Command Line interface. The title bar says "PC11". The menu bar includes "Physical", "Config", "Desktop" (which is selected), "Programming", and "Attributes". A blue header bar says "Command Prompt". The main window displays the following text:

```
Cisco Packet Tracer PC Command Line 1.0
C:\>ping 20.0.0.2

Pinging 20.0.0.2 with 32 bytes of data:

Request timed out.
Reply from 20.0.0.2: bytes=32 time=21ms TTL=125
Reply from 20.0.0.2: bytes=32 time=2ms TTL=125
Reply from 20.0.0.2: bytes=32 time=18ms TTL=125

Ping statistics for 20.0.0.2:
    Packets: Sent = 4, Received = 3, Lost = 1 (25% loss),
Approximate round trip times in milli-seconds:
    Minimum = 2ms, Maximum = 21ms, Average = 13ms

c:\>
```

That's it!!!

The major challenge I had was during encapsulation. That's why I have 2 codes there since i had to do a bit of research on the second which had my network working beautifully.

