Name: Wardha Khalid Class: BSCS-3B

Year: 2025 Fall Enrollment: 02-14242-096

BAHRIA UNIVERSITY KARACHI

DEPARTMENT OF COMPUTER SCIENCE

Computer Communication & Networks

(3 Credit Hours)

CEN-223

Name: Wardha Khalid **Class: BSCS-3B**

Year: 2025 Fall **Enrollment: 02-14242-096**

Computer Communication & Networks

(3 Credit Hours)

CEN-223

Student Name: *Wardha Khalid*

Registration Number: *94623*

Enrollment Number: *02-134242-096*

Class & Section: *BSCS-3B*

Semester: *3rd Semester*

Fall / spring: *Fall-2025*

Course Teacher: *Dr.Asif*

Assignmnet Submission: *7December'25*

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QUESTION # 01: **[CLO3, PLO2, C4]**

An international university (Int-Uni) plans to establish its campuses in three major cities of Pakistan—**Karachi, Lahore, and Islamabad**. To deploy the IT infrastructure for these newly proposed campuses, you have been appointed as the network engineer.

To ensure that the network aligns with operational needs, you conduct a meeting with the university's top management and IT personnel. During the discussion, the following requirements are outlined:

a. **User Groups:**
   Each branch campus will serve three distinct categories of users:
   a. Students
   b. Student Support Center (SSC) staff
   c. Marketing department staff

b. **Intra-Branch Access Control:**
   Due to differing responsibilities and privacy considerations, communication between these groups within the same branch must be restricted.
   a. Users from one group must not be allowed to interact with users from the other groups within the same campus network.

c. **Internet Access Policy:**
   For productivity and bandwidth management:
   a. Only the SSC and Marketing departments are permitted to access external sites such as Facebook.
   b. Students must be restricted from accessing Facebook to prevent misuse of network resources.

d. **Pilot Project Requirement:**
   Before implementing the complete network, management requires a pilot design that includes:
   a. One Student node
   b. One SSC node
   c. One Marketing node
   per branch.
   Once successful functionality is demonstrated, additional devices can be added as needed.

e. **Budget Constraints:**
   a. Due to the financial setbacks, the university emphasizes the need for a design that balances cost-effectiveness with acceptable network performance and reliability.
   You must therefore select a topology and devices that reduce expenses while maintaining reasonable uptime.

Expected Deliverables:

Using a suitable network simulation tool, you are required to present:
The complete network design and topology for all three branches
IP addressing schemes
Configuration details of all devices
Screenshots demonstrating the implemented setup and the verification of required functionalities

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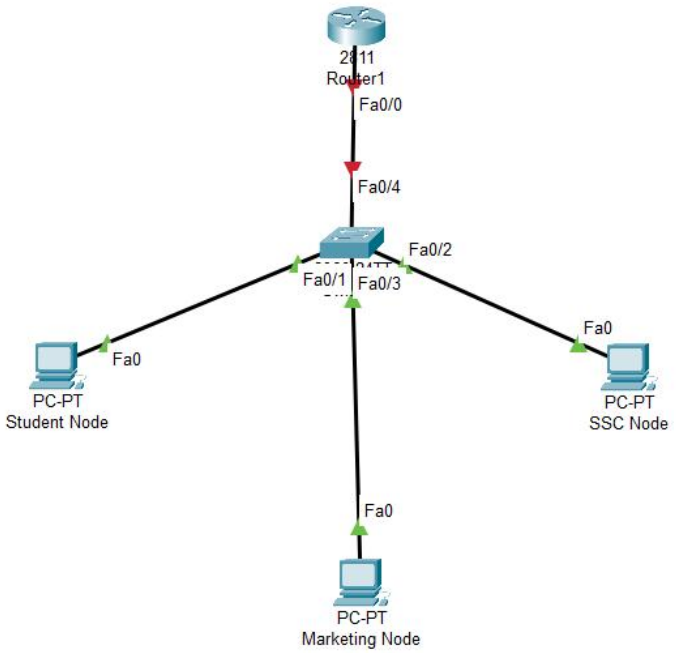
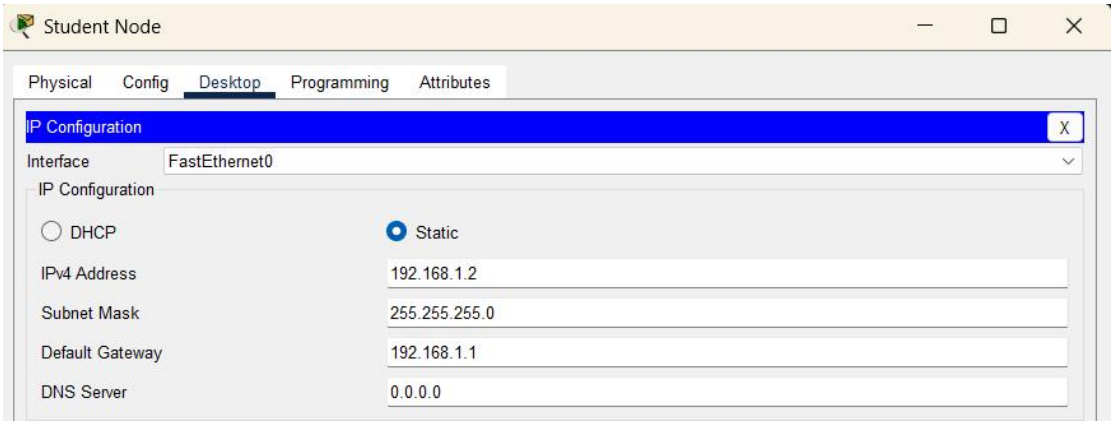
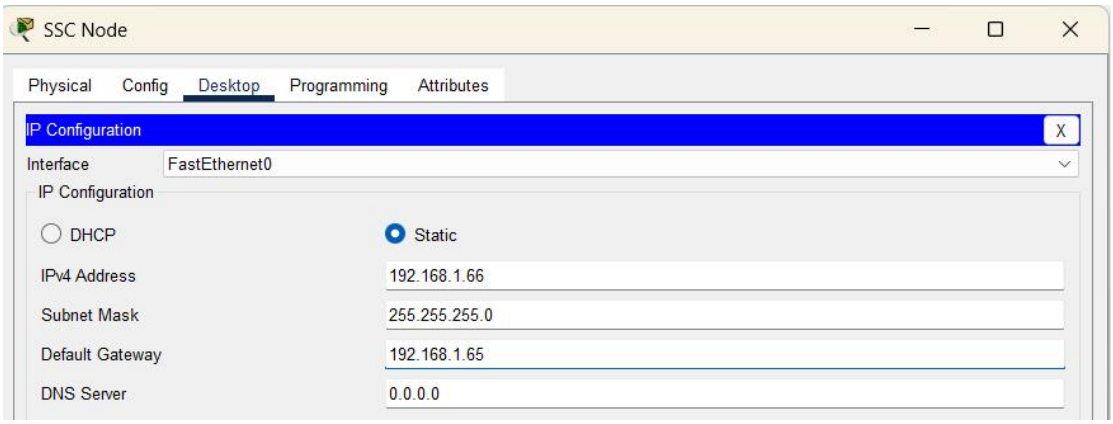


Step 1: PC IP Address Assignment

VLAN 10



VLAN 20



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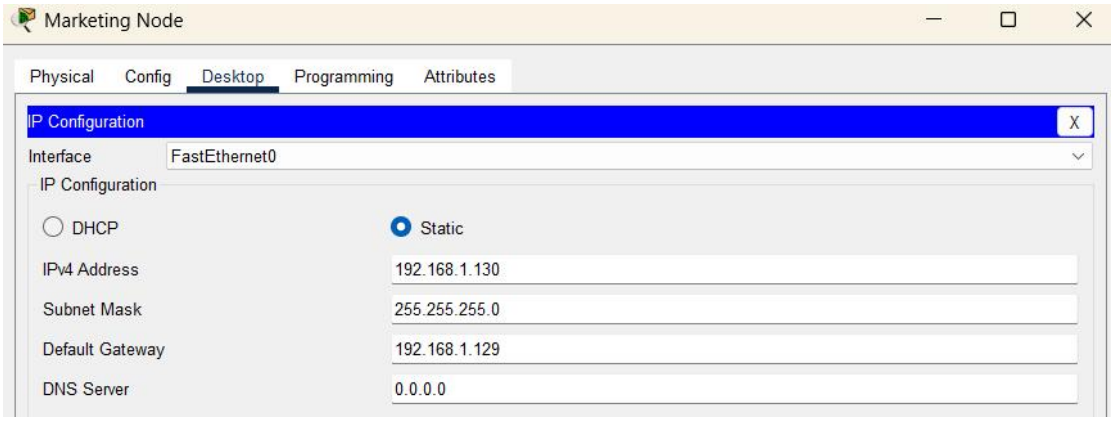
VLAN 30



Step 2: Switch Configuration (VLANs and Trunking)

```
Switch>en
Switch#config t
Enter configuration commands, one per line.  End with CNTL/Z.
Switch(config)#vlan 10
Switch(config-vlan)#name STUDENT_VLAN
Switch(config-vlan)#vlan 20
Switch(config-vlan)#name SSC_VLAN
Switch(config-vlan)#vlan 30
Switch(config-vlan)#name MARKETING_VLAN
Switch(config-vlan)#
```

```
Switch(config-vlan)#int FastEthernet0/1
Switch(config-if)#switchport mode access
Switch(config-if)#switchport access vlan 10
Switch(config-if)#^Z
Switch#
%SYS-5-CONFIG_I: Configured from console by console
```

```
Switch(config)#int FastEthernet0/2
Switch(config-if)#switchport mode access
Switch(config-if)#switchport access vlan 20
Switch(config-if)#^Z
Switch#
```

```
Switch(config)#int FastEthernet0/3
Switch(config-if)#switchport mode access
Switch(config-if)#switchport access vlan 30
Switch(config-if)#end
```

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```
Switch(config-if)#int FastEthernet0/4
Switch(config-if)#switchport mode trunk
Switch(config-if)#end
Switch#
%SYS-5-CONFIG_I: Configured from console by console
```

Step 3: Router Configuration (Sub-interfaces and ACLs)

(Router-on-a-Stick topology)

```
Router>en
Router#config t
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#int FastEthernet0/0
Router(config-if)#no ip address
Router(config-if)#no shutdown
```

```
Router(config)#int FastEthernet0/0.10
Router(config-subif)#
%LINK-5-CHANGED: Interface FastEthernet0/0.10, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0.10, changed state to up

Router(config-subif)#encapsulation dot1Q 10
Router(config-subif)#ip address 192.168.1.1 255.255.255.192
```

```
Router(config)#int FastEthernet0/0.20
Router(config-subif)#
%LINK-5-CHANGED: Interface FastEthernet0/0.20, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0.20, changed state to up

Router(config-subif)#encapsulation dot1Q 20
Router(config-subif)#ip address 192.168.1.65 255.255.255.192
Router(config-subif)#exit
```

```
Router(config)#int FastEthernet0/0.30
Router(config-subif)#
%LINK-5-CHANGED: Interface FastEthernet0/0.30, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0.30, changed state to up

Router(config-subif)#encapsulation dot1Q 30
Router(config-subif)#ip address 192.168.1.129 255.255.255.192
Router(config-subif)#exit
```

Step 4: Create New Extended ACLs (ACL 101, 102, 103)

```
Router(config)#access-list 101 deny ip 192.168.1.0 0.0.0.63 192.168.1.164 0.0.0.63
Router(config)#access-list 101 deny ip 192.168.1.0 0.0.0.63 192.168.1.128 0.0.0.63
Router(config)#access-list 101 permit ip any any
Router(config)#
```

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```
Router(config)#access-list 102 deny ip 192.168.1.64 0.0.0.63 192.168.1.0 0.0.0.63
Router(config)#access-list 102 deny ip 192.168.1.64 0.0.0.63 192.168.1.128 0.0.0.63
Router(config)#permit ip any any
              ^
% Invalid input detected at '^' marker.

Router(config)#access-list 102 permit ip any any
```

```
Router(config)#access-list 103 deny ip 192.168.1.128 0.0.0.63 192.168.1.0 0.0.0.63
Router(config)#access-list 103 deny ip 192.168.1.128 0.0.0.63 192.168.1.64 0.0.0.63
Router(config)#access-list 103 prmit ip any any
                               ^
% Invalid input detected at '^' marker.

Router(config)#access-list 103 permit ip any any
Router(config)#^Z
Router#
%SYS-5-CONFIG_I: Configured from console by console
```

Step 5: Apply New Extended ACLs

```
Router#en
Router#config t
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#int FastEthernet0/0.10
Router(config-subif)#ip access-group 101 in
Router(config-subif)#exit
Router(config)#
```

```
Router(config)#int FastEthernet0/0.20
Router(config-subif)#ip access-group 102 in
Router(config-subif)#exit
Router(config)#
```

```
Router(config)#int FastEthernet0/0.30
Router(config-subif)#ip access-group 103 in
Router(config-subif)#exit
Router(config)#
```

Step 6: Verification of Intra-Branch Access Control

Test from Student Node (IP: 192.168.1.2):-

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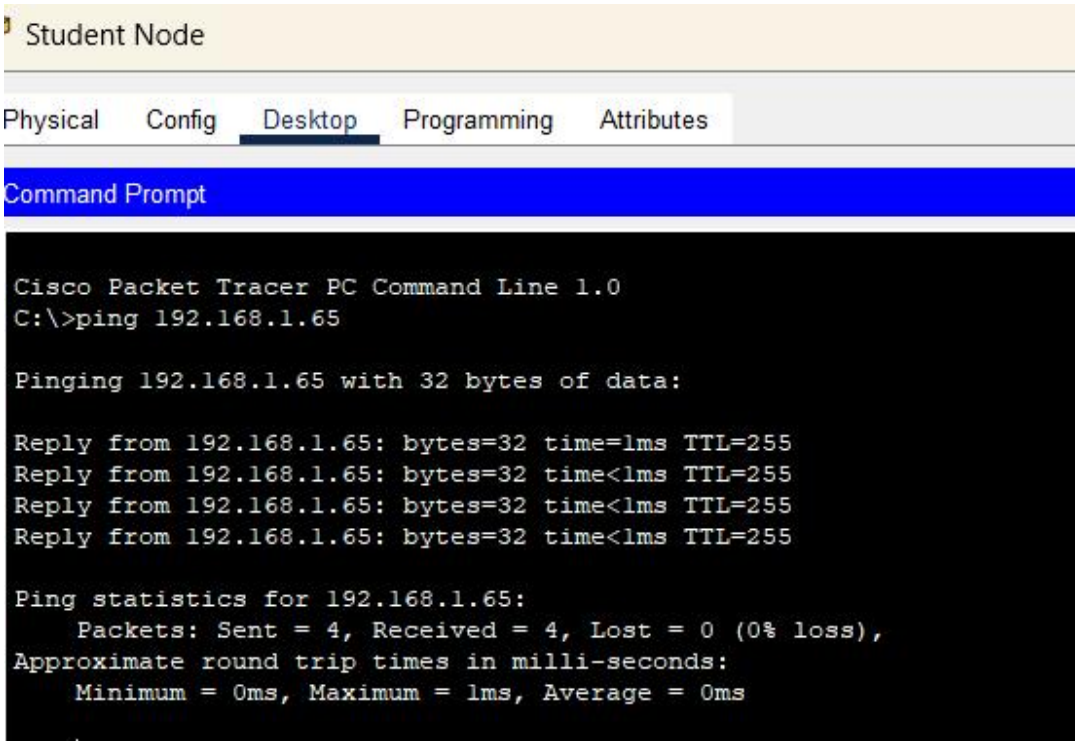
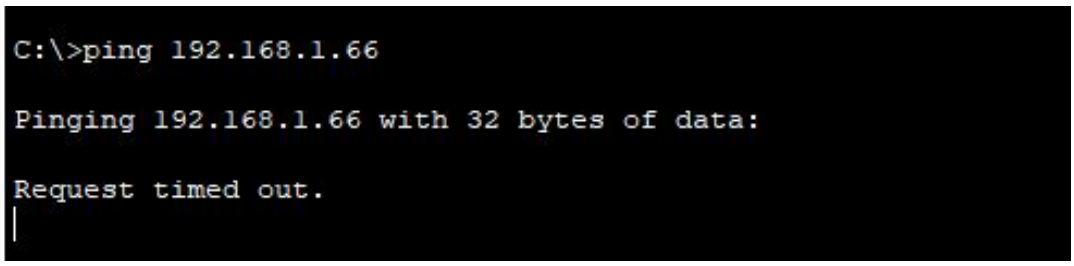
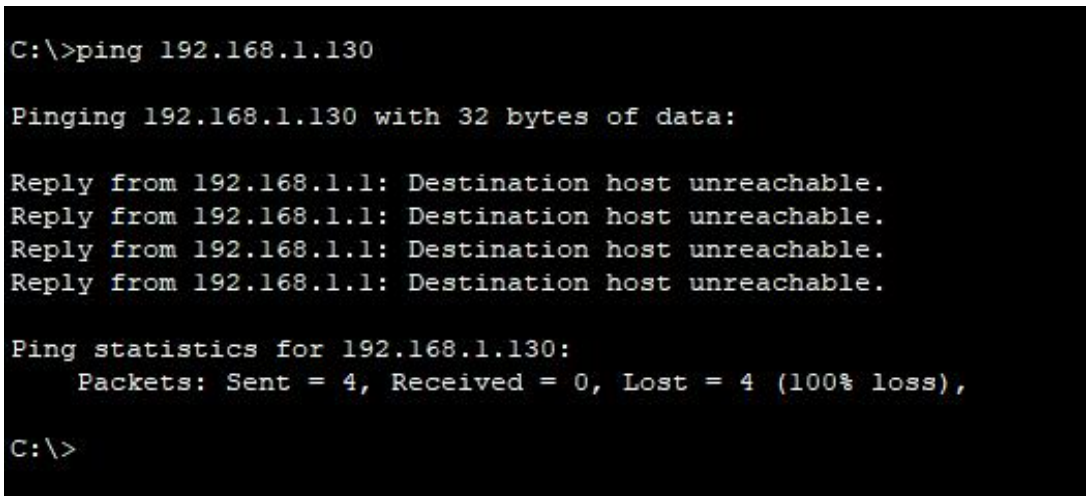


It succeeded to confirm the router's sub-interface is active.



It failed (Request Timed Out) because traffic is blocked by ACL 101 applied inbound on the Student sub-interface (Fa0/0.10).



It also failed (Request Timed Out or Destination Host Unreachable) because traffic is blocked by ACL.

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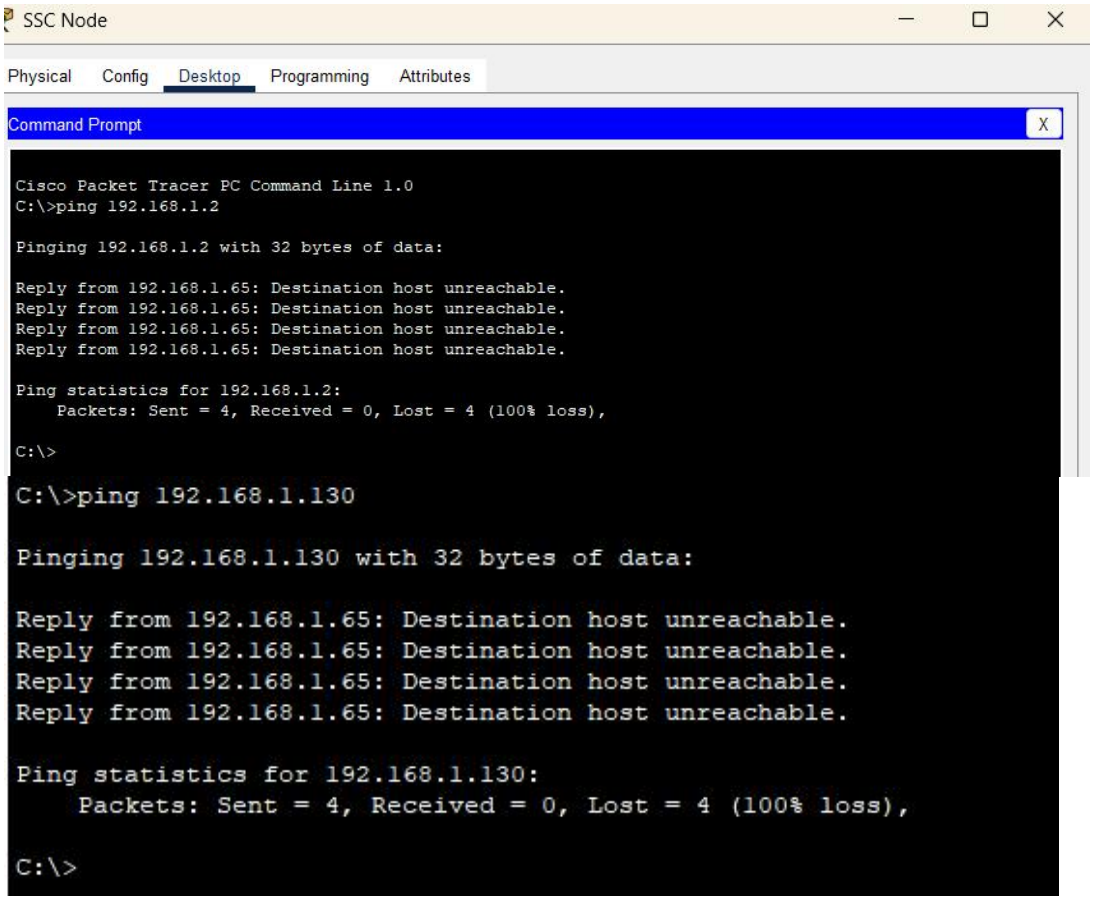
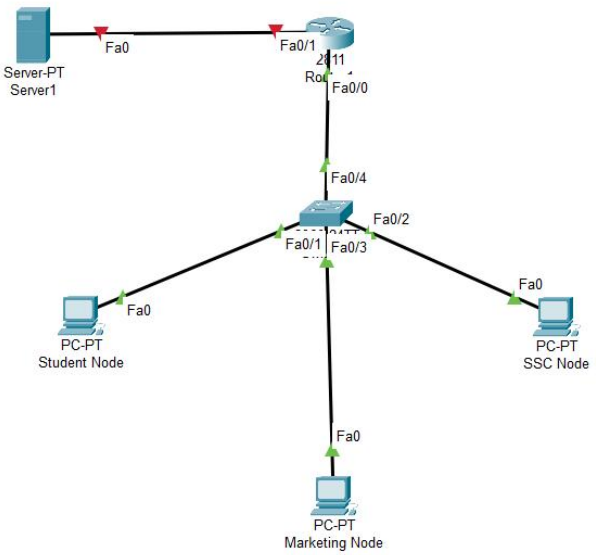
Test from SSC Node (IP: 192.168.1.66):-



Both failed because they are blocked by ACL 102.

Step 7:Implementing Final Security Policy: Facebook Restriction



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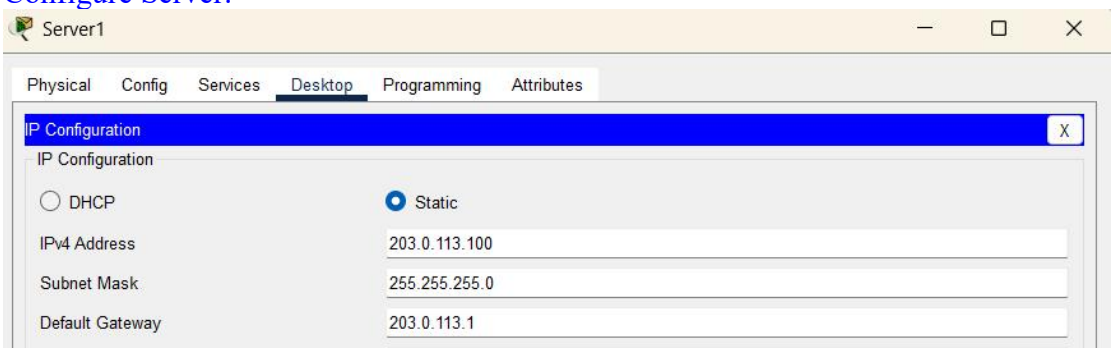
Configure Server:



Router Configuration For WAN Link:

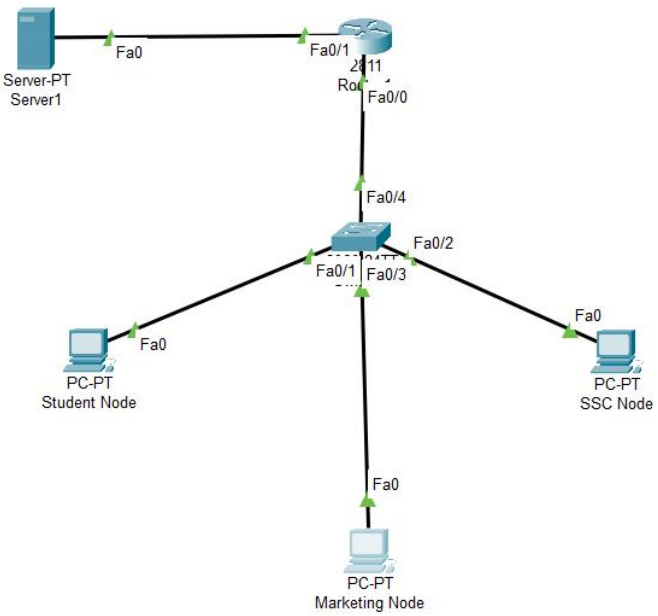
```
Router>en
Router#config t
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#int FastEthernet0/1
Router(config-if)#ip address 203.0.113.1 255.255.255.0
Router(config-if)#no shutdown

Router(config-if)#
%LINK-5-CHANGED: Interface FastEthernet0/1, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to up
exit
```

Applying the Facebook Restriction ACL:

```
Router(config)#access-list 199 deny ip 192.168.1.0 0.0.0.63 host 203.0.113.100
Router(config)#access-list 199 permit ip any any
Router(config)#int FastEthernet0/1
Router(config-if)#ip access-group 199 out
Router(config-if)#end
Router#
%SYS-5-CONFIG_I: Configured from console by console
```



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Test From Student node :

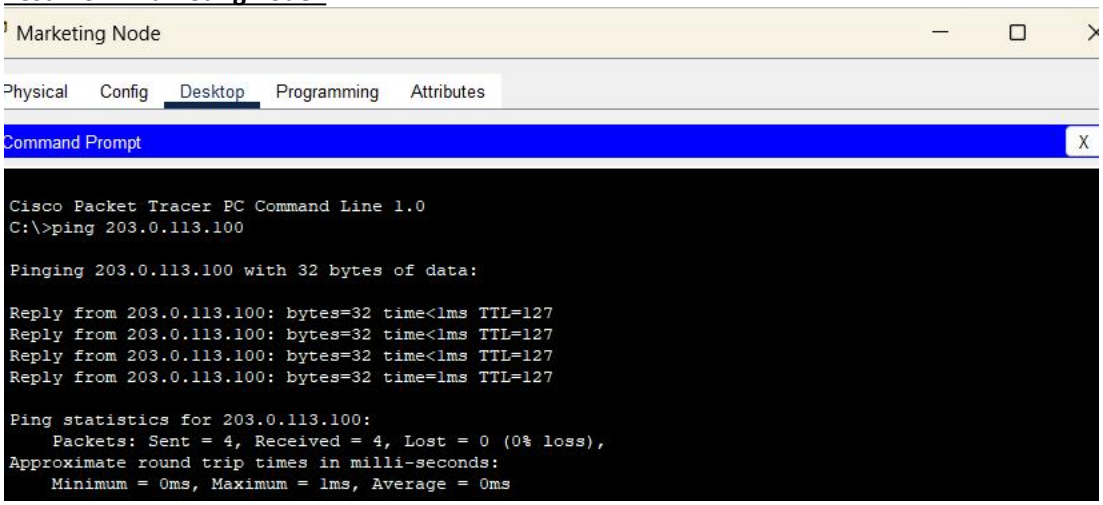
```
C:\>ping 203.0.113.100

Pinging 203.0.113.100 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 203.0.113.100:
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),
```

FAILED hence Facebook is blocked!

Test From SSC node :

```
C:\>ping 203.0.113.100

Pinging 203.0.113.100 with 32 bytes of data:

Request timed out.
Reply from 203.0.113.100: bytes=32 time<1ms TTL=127
Reply from 203.0.113.100: bytes=32 time<1ms TTL=127
Reply from 203.0.113.100: bytes=32 time<1ms TTL=127

Ping statistics for 203.0.113.100:
    Packets: Sent = 4, Received = 3, Lost = 1 (25% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 0ms, Average = 0ms

C:\>
```

Test From Marketing node :



Both are successful,hence Facebook is not blocked!

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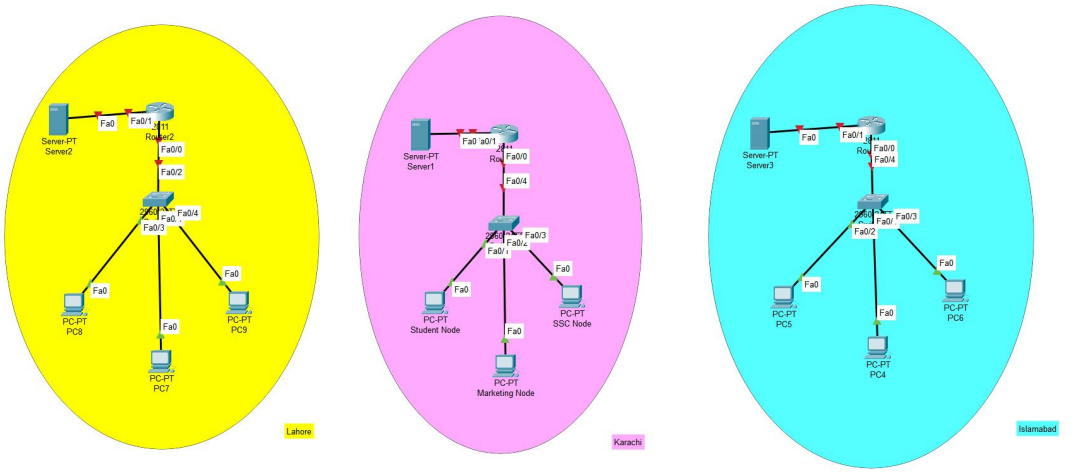
This pilot project assignment report details the successful design and configuration of the network infrastructure for the Karachi campus, meeting all requirements for user segregation and access control while maintaining budget constraints and reliability.



Topologies for three different cities(Karachi,Lahore and Islamabad)

1. Core Topology and Cost-Effective Design

The design is built on the **Star Topology** and the **Router-on-a-Stick (ROAS)** method, chosen specifically for cost-efficiency.

The network uses **VLANs (Virtual Local Area Networks)** to logically segment the three user groups (Student, SSC, Marketing). The ROAS method connects the switch and router via a single physical **trunk link**, saving hardware costs by only using one router interface (**Fa0/0**), which is logically divided into sub-interfaces (e.g., **Fa0/0.10**) to handle all inter-VLAN routing using the **IEEE 802.1Q** protocol.

IP Assignment for All Branches

To simplify inter-campus routing via the future Wide Area Network (WAN), each branch is assigned a unique aggregate network (0/24) that is internally subnetted:

Branch	User Groups (VLAN 10, 20, 30)	Aggregate Network	Default Gateways
Karachi (KHI)	Student, SSC, Marketing	192.168.1.0/24	192.168.1.1, 1.65, 1.129
Lahore (LHR)	Student, SSC, Marketing	192.168.2.0/24	192.168.2.1, 2.65, 2.129
Islamabad (ISL)	Student, SSC, Marketing	192.168.3.0/24	192.168.3.1, 3.65, 3.129

To restrict students from accessing external sites like Facebook to prevent resource misuse, while permitting SSC and Marketing, **Extended ACL 199** was applied

outbound on the WAN interface (Fa0/1). ACL 199's first statement explicitly denies traffic from the Student Network (192.168.1.0/26) destined for the simulated Facebook IP (203.0.113.100). Verification confirmed that ping tests from the Student PC to the simulated Facebook server **failed**, but tests from the SSC and Marketing PCs **succeeded**.