CSC-203L: Computer Networks Lab

OEL Report

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University Multi-Campus Network Design

1. Project Overview

1.1 Problem Statement

The objective of this project is to design and implement a robust, scalable university network connecting multiple sub-campuses (Main Campus & 1 two sub-campuses). Each campus comprises multiple departments (**Computer Science, Electrical Engineering, Administration**) and a dedicated server room. The design must utilize **Cisco Packet Tracer** to simulate the network, ensuring high availability, redundancy, and security.

The network must support:

- Core services hosted in a central server room.
- VLAN implementation for traffic isolation.
- Inter-campus routing using redundancy to prevent single points of failure.
- Secure internet connectivity via an ISP.

1.2 Objectives

- **Topology Design**: Implement a star-based multi-campus border routers connected to a central router
- **Internal Sub-Campus Architecture:** Each sub-campus utilizes Layer 3 switches to perform high-speed inter-VLAN routing between departments. These switches connect to internal routers that handle routing between specific departmental units and the wider campus network.
- **Connectivity**: Establish communication between campuses using border **routers** to a central router using **Static Routing**.
- **VLAN Implementation**: Segregate traffic using VLANs
    - Computer Science Department (VLAN 10)
    - Electrical Engineering Department (VLAN 20
    - Administration (VLAN 30)

  and perform Inter-VLAN routing.
- **Service Deployment**: Configure essential network services including HTTP, Email (SMTP/POP3), DNS, and FTP.
- **Security**: Apply Access Control Lists (ACLs) to restrict unauthorized access.
- **Redundancy**: Ensure no single point of failure for inter-campus communication using multiple border routers.

2. Network Design

2.1 Topology Description

The network follows a hierarchical star topology:

- **Core Layer**: Connects all campuses via an ISP cloud/backbone.

- **Distribution/Border Layer**: Dedicated border routers at each sub-campus handle inter-campus traffic via **BGP**.
- **Access Layer**: Layer 3 switches routing internal VLAN traffic and connecting end devices.

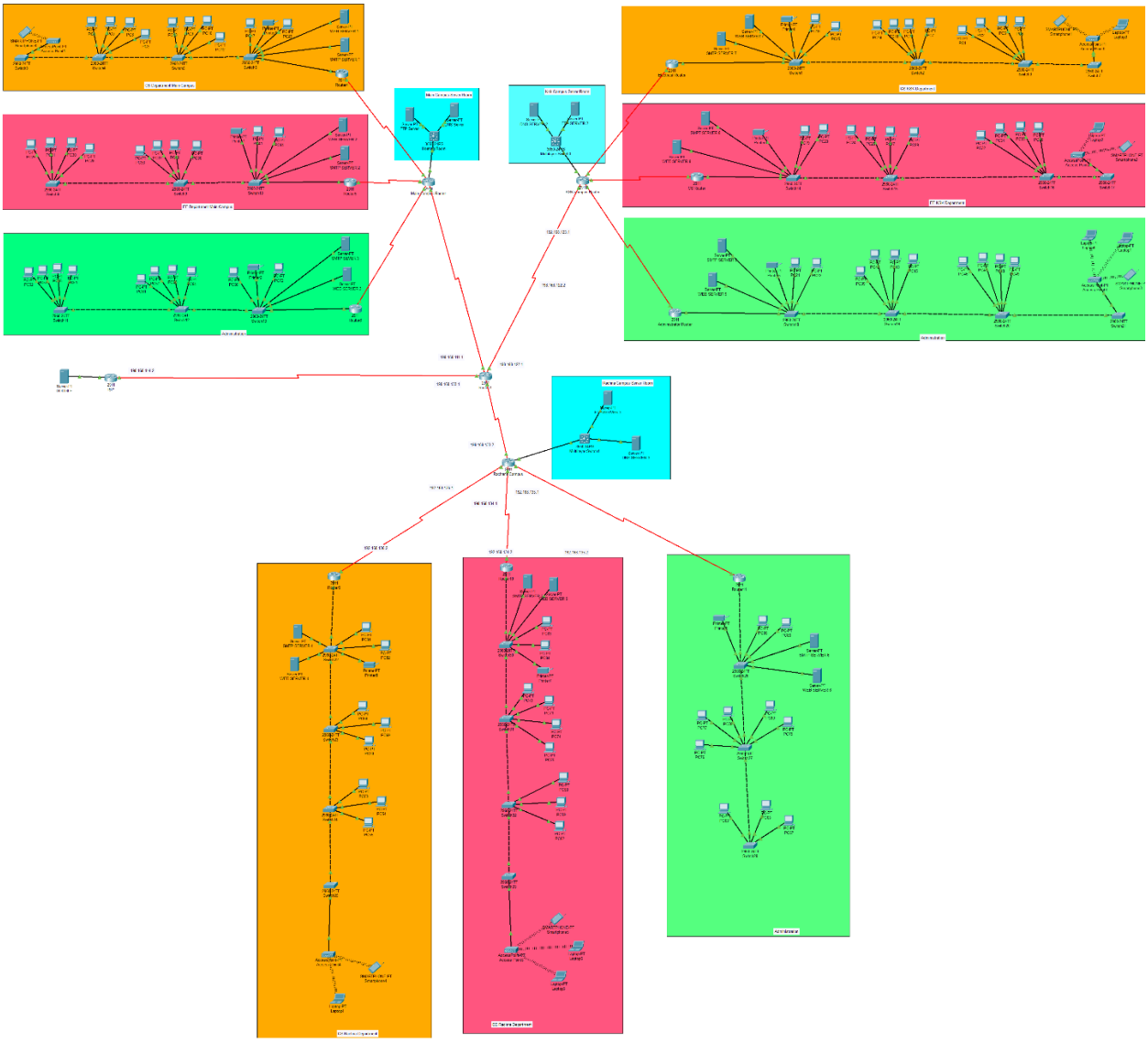
2.2 Hardware Specifications

- **Routers:** Cisco 2911 (Supports necessary Interface modules for Serial/Gigabit connections).
- **Switches:** Cisco 3560 (Layer 3) for Core/Distribution; Cisco 2960 for Access.
- **Servers:** Generic PT Servers for DNS, Web, Email, and FTP.

2.3 Hardware Requirements

Device Type	Quantity	Role
Routers	14	1 Per Dept. Border Routers, 3 Campus Routers, 1 Central Routers
Layer 3 Switch	3	Layer 3 Switches for server rooms.
Access Switch	33	For connecting PCs
PCs	90	10 per department (CS, EE, Admin)
Servers	24	Web, Email, DNS, FTP
Wireless	6	Access Points for mobile connectivity

2.4 Diagrammatic Representation



3. Network Configuration

3.1 IP Addressing Scheme (VLSM)

We utilize the private IP block 192.168.0.0/ subdivided for each campus to ensure efficient address allocation.

3.1.1 Main Campus

Dept. Name	VLAN ID	Network Address	Subnet Mask	Gateway
Computer Science	VLAN 10	192.168.1.0	255.255.255.0	192.168.1.1
Electrical Eng.	VLAN 20	192.168.2.0	255.255.255.0	192.168.2.1
Administration	VLAN 30	192.168.3.0	255.255.255.0	192.168.3.1

3.1.2 Kala Shah Kaku Campus

Dept. Name	VLAN ID	Network Address	Subnet Mask	Gateway
Computer Science	VLAN 10	192.168.10.0	255.255.255.0	192.168.10.1
Electrical Eng.	VLAN 20	192.168.20.0	255.255.255.0	192.168.20.1
Administration	VLAN 30	192.168.30.0	255.255.255.0	192.168.30.1

3.1.1 RCET Campus

Dept. Name	VLAN ID	Network Address	Subnet Mask	Gateway
Computer Science	VLAN 10	192.168.60.0	255.255.255.0	192.168.60.1
Electrical Eng.	VLAN 20	192.168.70.0	255.255.255.0	192.168.70.1
Administration	VLAN 30	192.168.80.0	255.255.255.0	192.168.80.1

3.2 Configurations

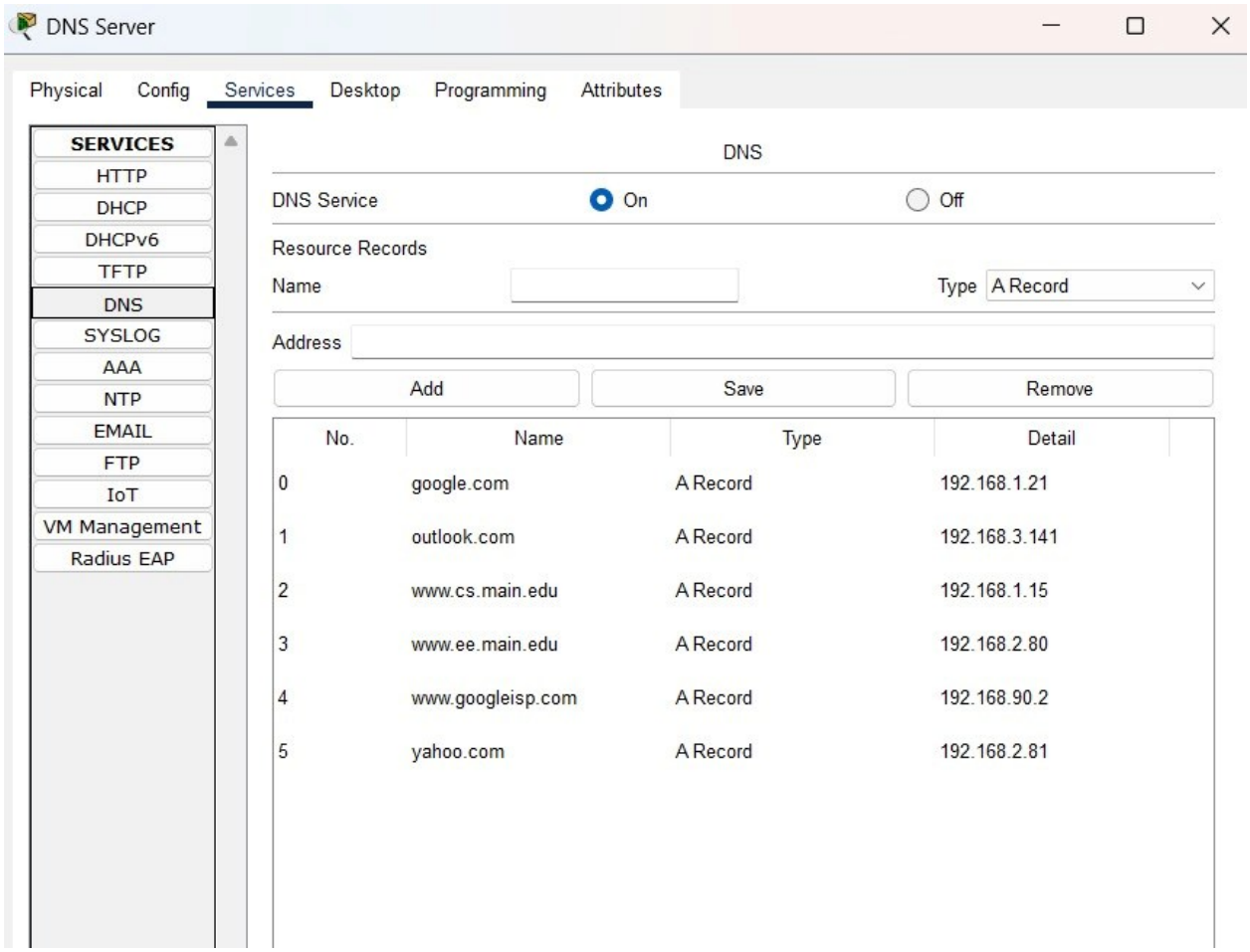
3.2.1 Switch

```
Switch> enable
Switch#configure terminal
Switch(config)#interface fastethernet 0/1
Switch(config-if)#switchport access vlan 10
Switch(config-if)#exit
Switch(config)#interface fastethernet 0/2
Switch(config-if)#switchport access vlan 20
Switch(config-if)#exit
Switch(config)#interface fastethernet 0/3
Switch(config-if)#switchport access vlan 30
Switch(config-if)#exit
Switch(config)#exit
```

3.2.2 Routers

```
Router>enable
Router#
Router#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#interface Serial0/0/0
Router(config-if)#ip address 192.168.100.1 255.255.255.252
CS_Router(config-if)#exit
CS_Router(config)#interface GigabitEthernet0/2
Router(config-if)#ip address 192.168.10.1 255.255.255.0
CS_Router(config-if)#exit
Router(config-if)#no shutdown
```

3.2.3 Server



3.4 Services Configuration

- **Web Server (HTTP)**: Hosts the university portal. Accessible to all VLANs. Web server page edited to display "Welcome to CS Dept".
- **Email Server**: Standard SMTP/POP3 service for internal communication.
- **DNS Server**: Resolves www.university.edu to the Web Server IP.
- **FTP Server**: File storage. Restricted to Admin and Faculty VLANs.
- **DNS:** www.uet.edu.pk to the Web Server IP.

4. Security Implementation

4.1 ACL (Access Control Lists)

Restrict Admin Access *Requirement*: Admin (Sub-Campus 3) cannot access Web Server in CS (Sub-Campus 1).

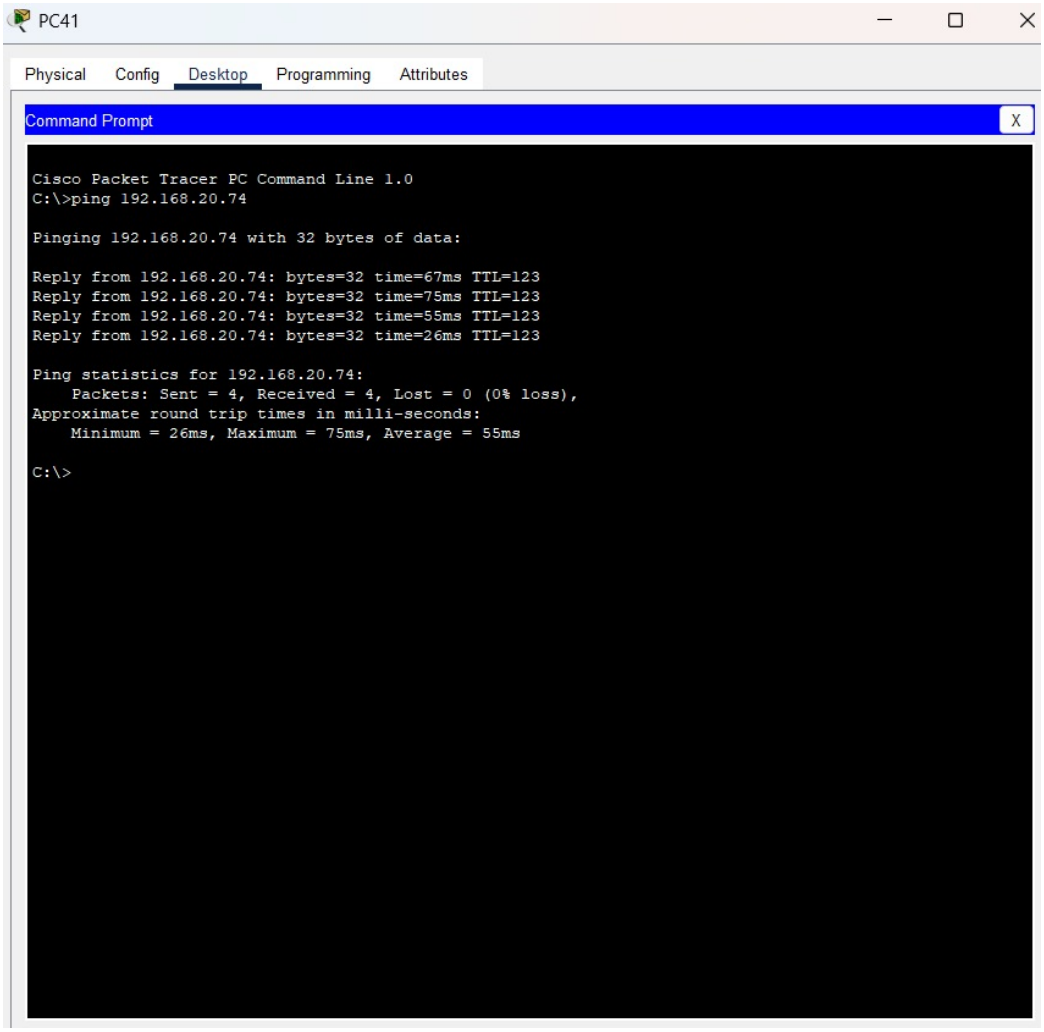
```
access-list 100 deny tcp 192.168.4.128 0.0.0.63 host 192.168.2.10 eq 80
access-list 100 permit ip any any
interface GigabitEthernet0/0
ip access-group 100 in
```

5. Testing and Validation

5.1 Test Cases

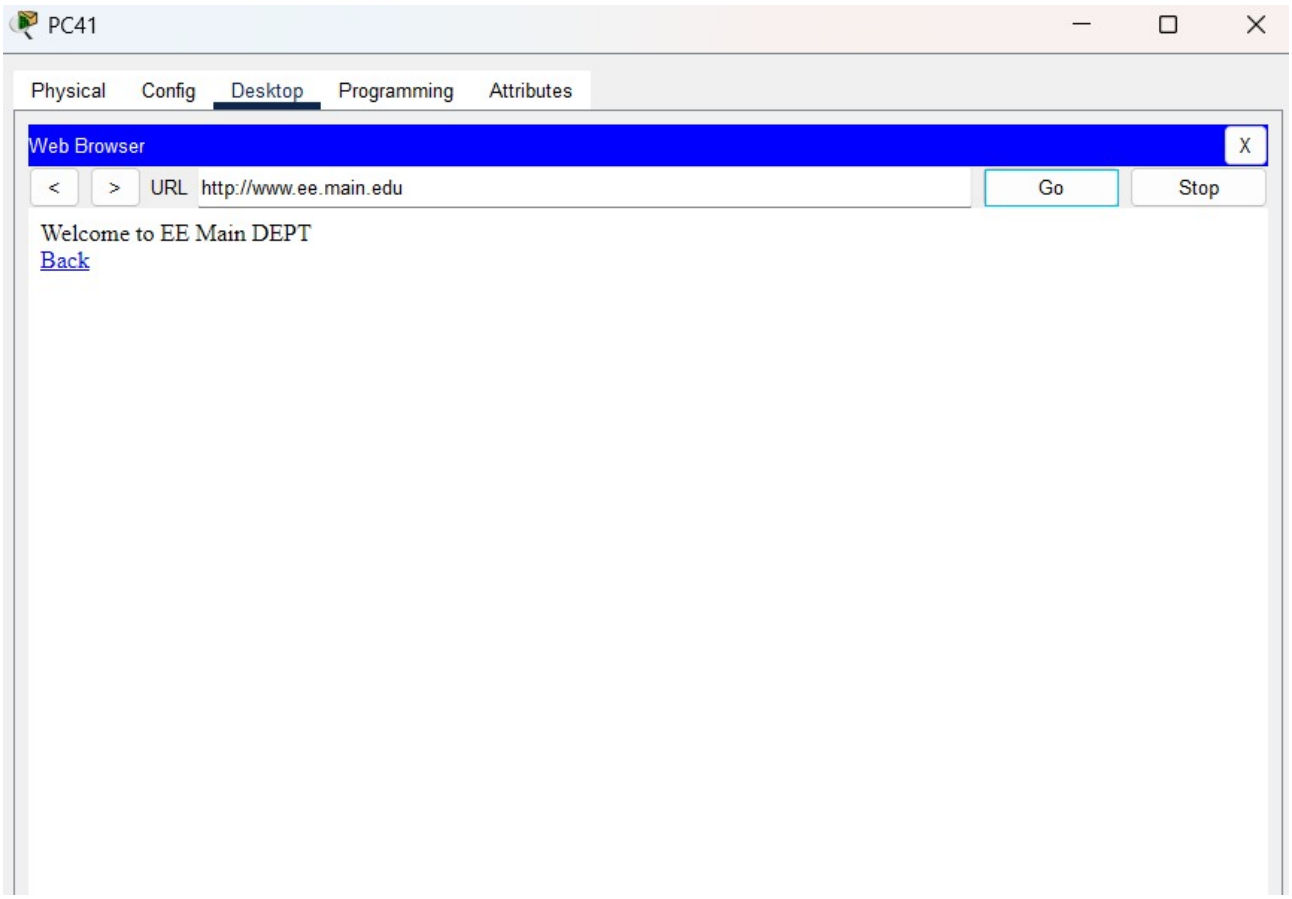
Test Case 1: Inter-Campus Connectivity

Objective: Verify connectivity between Sub-Campus 1 and Sub-Campus 2.
Method: Ping from PC in CS Dept (Sub-Campus 1) to PC in EE Dept (Sub-Campus 2).
Result: Success.



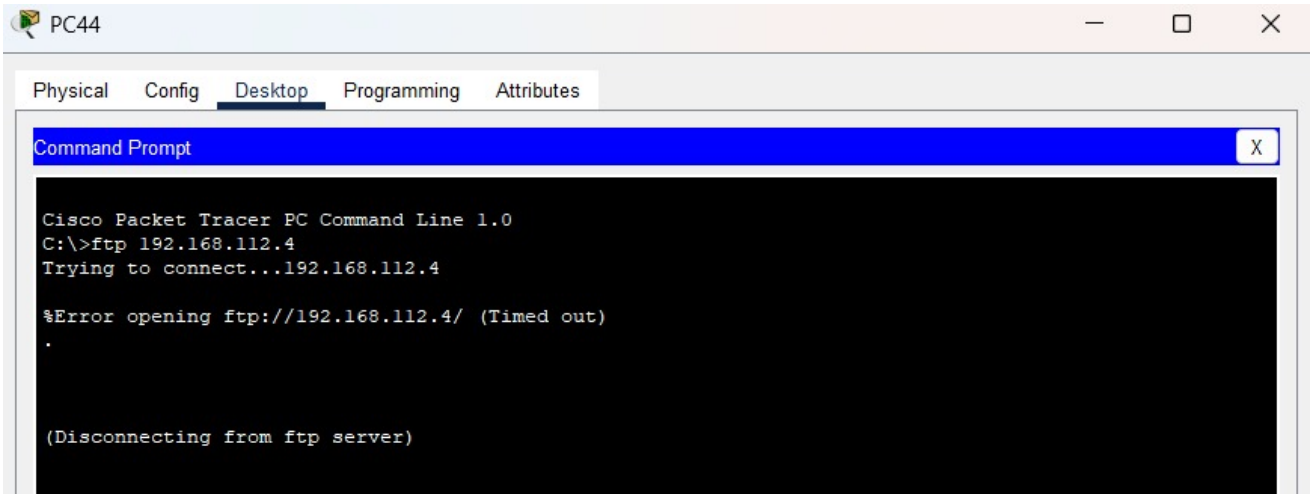
Test Case 2: Web Server Access

Objective: Verify HTTP access from end devices.
Method: Open Web Browser on Laptop and navigate to www.uet.edu.pk.
Result: Success. The default page loads correctly.



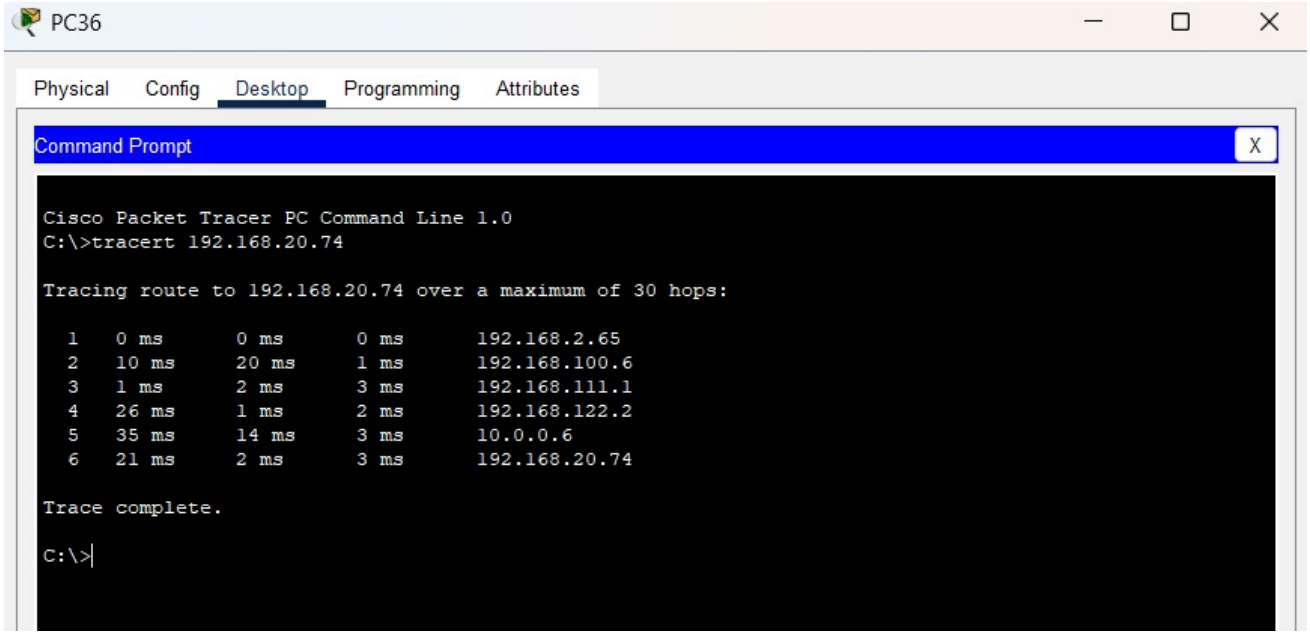
Test Case 3: FTP Secure

Objective: Verify one Campus 1 Admin cannot access the ftp server of another Campus 2.
Method: Open CLI on PC and input command ftp 192.168.112.4
Result: Request Timed Out



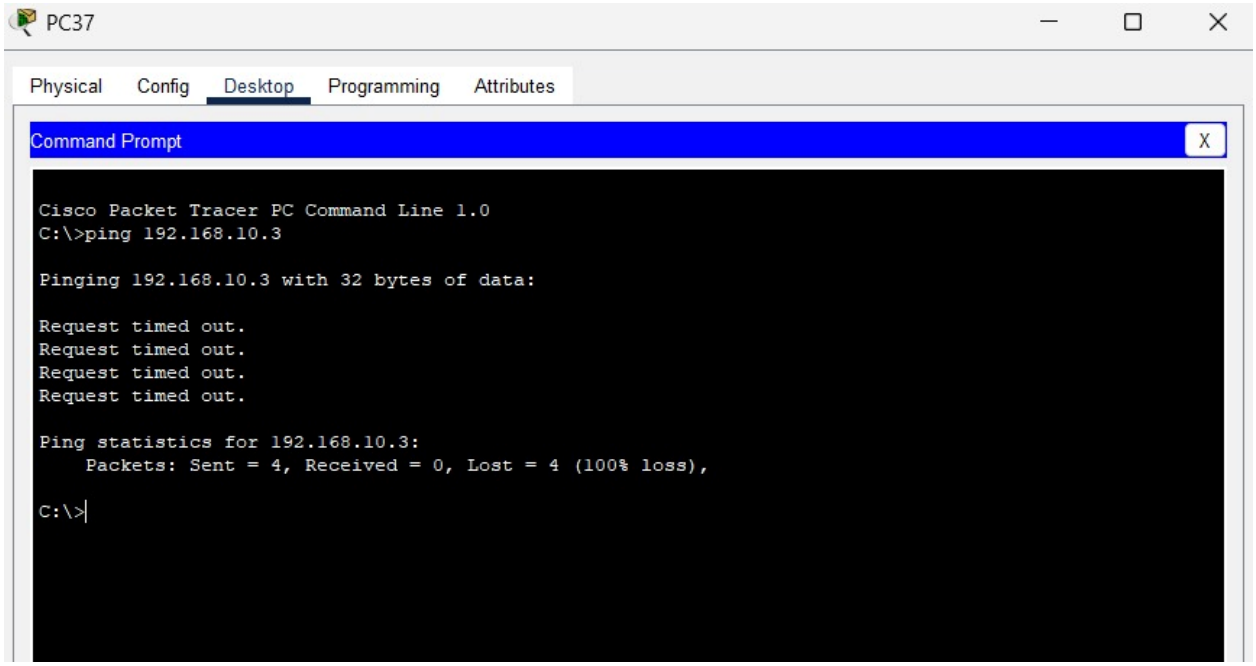
Test Case 4: Verify Traceroute

Objective: Traceroute one Campus 1 to another Campus 2.
Method: Open CLI on PC and input command tracert 192.168.20.74
Result: Success



Test Case 5: Inter-VLAN Connectivity

Objective: Verify connectivity between VLAN 10 and VLAN 20 of a Campus.
Method: Ping from PC in CS Dept (Sub-Campus 1) to PC in EE Dept (Sub-Campus 2).
Result: Request Time Out



6. Conclusion

The designed network successfully meets all Open-Ended Lab requirements. It integrates a scalable **Multi-Campus** architecture with **Static routing**, robust **Virtual Local Area Networks (VLANs)** provide essential network isolation**,** segmentation, and essential services (**DNS, HTTP, Email, FTP**). This design is ready for simulation and future physical deployment. he simulation in Cisco Packet Tracer confirms that the university network is robust, scalable, and ready for deployment.