رواد مصر الرقمية

Project Report on

“University Campus Networking”

Course Title: Cisco Network Administrator

Group code: QAL_ISS2_M1e

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Abstract:

This report provides a comprehensive look at the design of the university system network, implemented through Cisco Packet Tracer, with the aim of facilitating communication between the university administration and the rest of the colleges. The primary objectives of this project revolve around formulating and implementing a robust, scalable, and forward-looking network infrastructure. A hierarchical model was used, and redundancy measures were incorporated at each layer to enhance reliability., creating wireless networks for individual departments, creating distinct VLANs and subnets, and implementing Border Gateway Protocol (BGP) for routing. Configuration details include setting up DHCP servers, assigning static IP addresses, implementing Domain Name Server (DNS), implementing E-mail server that manages the sending, receiving, and storage of email messages, implementing Secure Shell (SSH) for secure access, Configuring switchport security or Port-Security on the switches, Configuring standard and extended Access Control Lists (ACL), implementing Site-to-Site IPsec (VPN) , and Port Address Translation (NAT) for managing outbound communications, implementing access point (AP) is a term used for a network device that bridges wired and wireless networks. The report emphasizes the importance of rigorous testing and validation processes, ensuring the successful deployment of a resilient network infrastructure that not only meets current business requirements, but also positions the organization strategically for technological advancement and future expansion.

Background:

Amidst the ever-evolving landscape of modern higher education, the design of a robust and scalable network infrastructure is paramount for supporting the diverse needs of a university campus. As universities expand and grow, the strategic importance of network routing and switching becomes increasingly evident. These elements play a crucial role in ensuring seamless communication, efficient data transfer, and reliable access to resources for students, faculty, staff, and administrators.

This project focuses on developing a comprehensive network design for a university campus, utilizing Cisco Packet Tracer to simulate and test various network configurations. The design will be tailored to meet the specific requirements and growth plans of the university, ensuring a reliable and efficient network that can support the demands of academic and administrative activities.

Objectives:

The primary objectives of a university campus network design project are to:

Establish a hierarchical network structure with redundancy at all levels.

Deploy wireless networks tailored to the specific needs of different departments and user groups.

Implement Virtual Local Area Networks (VLANs) and subnets to segregate traffic and enhance security.

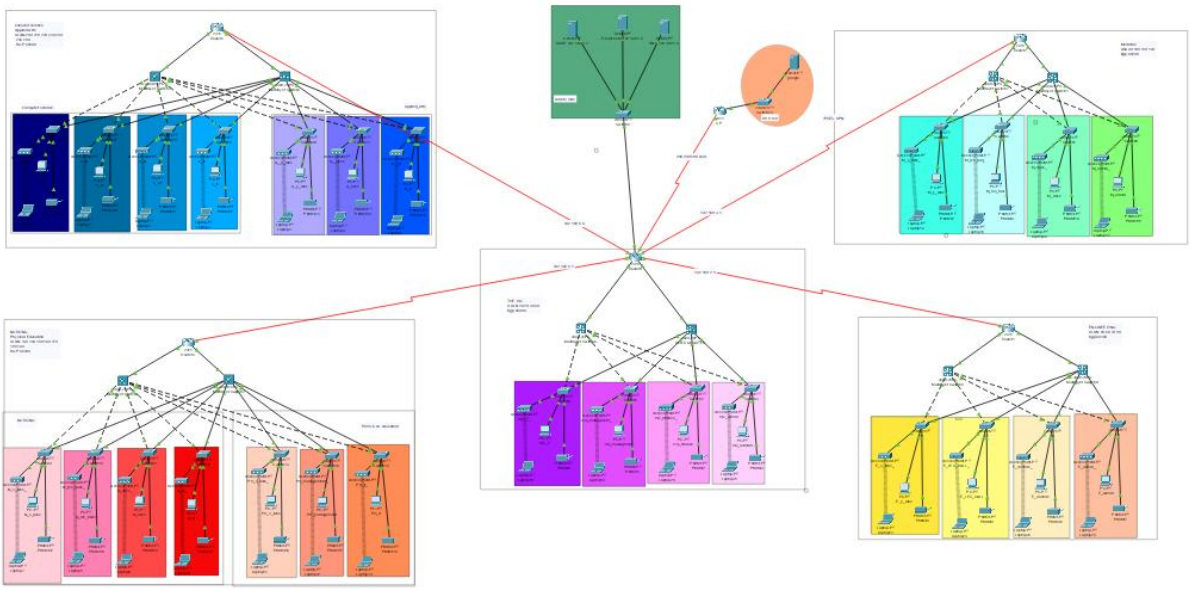
Configure routing protocols, security protocols, and advanced features like SSH and PAT to optimize network performance and security.

Configure backup is primarily for network redundancy and high availability.

By achieving these objectives, a university can develop a network infrastructure that is scalable, resilient, and capable of supporting the diverse needs of students, faculty, staff, and administrators, both now and in the future.

Network Design

1. Topology:



2. Components

The network design for the project incorporates the following devices

1. Routers (6):
    - HQ
    - 5 routers for the colleges
2. Multilayer switches (10)
3. Layer 2 Switches (28):
    - Connect individual departments to the core layer.
    - Facilitate communication within respective VLANs.
4. End-User Devices (PCs, laptops, printers)

5. DHCP Servers (1):
    - Located in the server room.
    - Dynamically allocate IP addresses to end-user devices
6. Server Room Devices (Servers, etc.)
    - DNS server, E-mail server, etc.
    - Devices in the server room are allocated static IP addresses.
    - These devices may include servers, storage units, and networking equipment.
7. Google server (1)

3. Addressing Table

Routers

Device	interface	Ip Address	Subnet mask	Default gateway
Router 0 (HQ)	G0/0.10	192.168.10.1	255.255.255.128	N/A
	G0/0.20	192.168.20.1	255.255.255.128	N/A
	G0/0.30	192.168.30.1	255.255.255.128	N/A
	G0/0.40	192.168.40.1	255.255.255.128	N/A
	G0/1	192.168.1.1	255.255.255.0	N/A
	G0/2.10	192.168.10.129	255.255.255.128	N/A
	G0/2.20	192.168.20.129	255.255.255.128	N/A
	G0/2.30	192.168.30.129	255.255.255.128	N/A
	G0/2.40	192.168.40.129	255.255.255.128	N/A
	S0/0/0	192.168.2.1	255.255.255.0	N/A
	S0/0/1	192.168.3.1	255.255.255.0	N/A
	S0/1/0	192.168.4.1	255.255.255.0	N/A
	S0/1/1	192.168.5.5	255.255.255.0	N/A
	S0/2/0	200.200.200.2	255.255.255.252	N/A
Router 1	G0/0.50	192.168.50.1	255.255.255.128	N/A
	G0/0.60	192.168.60.1	255.255.255.128	N/A
	G0/0.70	192.168.70.1	255.255.255.128	N/A
	G0/0.80	192.168.80.1	255.255.255.128	N/A
	G0/1.50	192.168.50.129	255.255.255.128	N/A

(Engineering)	G0/1.60	192.168.60.129	255.255.255.128	N/A
	G0/1.70	192.168.70.129	255.255.255.128	N/A
	G0/1.80	192.168.80.129	255.255.255.128	N/A
	G0/2	192.168.3.1	255.255.255.0	N/A
	S0/0/0	192.168.2.2	255.255.255.0	N/A
Router 2(Medicine)	G0/0.90	192.168.90.1	255.255.255.128	N/A
	G0/0.100	192.168.100.1	255.255.255.128	N/A
	G0/0.110	192.168.110.1	255.255.255.128	N/A
	G0/0.120	192.168.120.1	255.255.255.128	N/A
	G0/1.90	192.168.90.129	255.255.255.128	N/A
	G0/1.100	192.168.100.129	255.255.255.128	N/A
	G0/1.110	192.168.110.129	255.255.255.128	N/A
	G0/1.120	192.168.120.129	255.255.255.128	N/A
	S0/0/0	192.168.3.2	255.255.255.0	N/A
Router 3 (Nursing & Physical Education)	G0/0.130	192.168.130.1	255.255.255.128	N/A
	G0/0.140	192.168.140.1	255.255.255.128	N/A
	G0/0.150	192.168.150.1	255.255.255.128	N/A
	G0/0.160	192.168.160.1	255.255.255.128	N/A
	G0/0.170	192.168.170.1	255.255.255.128	N/A
	G0/0.180	192.168.180.1	255.255.255.128	N/A
	G0/0.190	192.168.190.1	255.255.255.128	N/A
	G0/1.130	192.168.130.129	255.255.255.128	N/A
	G0/1.140	192.168.140.129	255.255.255.128	N/A
	G0/1.150	192.168.150.129	255.255.255.128	N/A
	G0/1.160	192.168.160.129	255.255.255.128	N/A
	G0/1.170	192.168.170.129	255.255.255.128	N/A
	G0/1.180	192.168.180.129	255.255.255.128	N/A
	G0/1.190	192.168.190.120	255.255.255.128	N/A
	S0/0/0	192.168.4.2	255.255.255.0	N/A
Router 4 (computer science &	G0/0.200	192.168.200.1	255.255.255.128	N/A
	G0/0.210	192.168.210.1	255.255.255.128	N/A
	G0/0.220	192.168.220.1	255.255.255.128	N/A

Applied Arts)	G0/0.230	192.168.230.1	255.255.255.128	N/A
	G0/0.240	192.168.240.1	255.255.255.128	N/A
	G0/0.245	192.168.245.1	255.255.255.128	N/A
	G0/0.250	192.168.250.1	255.255.255.128	N/A
	G0/1.200	192.168.200.129	255.255.255.128	N/A
	G0/1.210	192.168.210.129	255.255.255.128	N/A
	G0/1.220	192.168.220.129	255.255.255.128	N/A
	G0/1.230	192.168.230.129	255.255.255.128	N/A
	G0/1.240	192.168.240.129	255.255.255.128	N/A
	G0/1.245	192.168.245.129	255.255.255.128	N/A
	G0/1.250	192.168.250.129	255.255.255.128	N/A
	S0/0/0	192.168.5.1	255.255.255.0	N/A

Routing Configuration

1. Router Configuration

Basic Router Configuration

```
conf t                                  # Enter global configuration mode
hostname HQ                             # Set the hostname for the device to "HQ"
enable password cisco                   # Set the enable password for privileged EXEC mode
banner motd #welcome#                   # Configure a message of the day (MOTD) banner
no ip domain lookup                     # Disable DNS lookup for unknown commands
line console 0                          # Enter console line configuration mode
 password cisco                         # Set console line password to "cisco"
 login                                  # Enable login authentication for the console
 exit                                   # Exit back to global configuration mode
login block-for 60 attempts 3 within 30 # Lock login for 60 sec if 3 failed attempts occur
service password-encryption             # Encrypt all passwords in the configuration file
ip domain name cisco.net                # Set the domain name of the device to "cisco.net"
```

```
username admin password cisco          # Create a local user account with username "admin"
crypto key generate rsa                # Generate RSA encryption keys for SSH
 1024                                  # Set the RSA key size to 1024 bits
line vty 0 15                          # Enter VTY line configuration mode for lines 0 to 15
 login local                           # Use local user database for VTY line authentication
 transport input ssh                   # Allow only SSH protocol for remote access
do wr                                  # Save the running configuration to the startup conf
```

2. Static and Dynamic Routing

Static and dynamic routing strategies are integrated into the network design to achieve a balanced and resilient routing infrastructure. Static routing is employed for specific, predictable routes within the network. For example, static routes are configured on routers to direct traffic to the dedicated DHCP servers in the server room, ensuring a fixed and predetermined path for critical internal communication. On the other hand, dynamic routing, specifically BGP, is implemented for adaptive and automated route selection. BGP dynamically adjusts to changes in the network, making it suitable for scalability and flexibility. This combination of static and dynamic routing provides a robust and versatile routing solution, catering to predefined and evolving routing needs within the "University Campus Networking" project.

BGP on Routers R0, R1, R2, R3 and R4

HQ router (R0):

```
Router(config)# router bgp 65000
Router(config-router)# network 192.168.10.0 mask 255.255.255.0
Router(config-router)# network 192.168.20.0 mask 255.255.255.0
Router(config-router)# network 192.168.30.0 mask 255.255.255.0
Router(config-router)# network 192.168.40.0 mask 255.255.255.0
Router(config-router)# network 192.168.1.0 mask 255.255.255.0
Router(config-router)# network 192.168.6.0 mask 255.255.255.0
Router(config-router)# network 200.200.200.0 mask 255.255.255.254
Router(config-router)# neighbor 192.168.2.2 remote-as 65100
Router(config-router)# neighbor 192.168.3.2 remote-as 65200
Router(config-router)# neighbor 192.168.4.2 remote-as 65300
Router(config-router)# neighbor 192.168.5.1 remote-as 65400
Router(config-router)# neighbor 200.200.200.1 remote-as 65010
```

Engineering router(R1)

```
Router(config)# router bgp 65100
Router(config-router)# network 192.168.50.0 mask 255.255.255.0
Router(config-router)# network 192.168.60.0 mask 255.255.255.0
Router(config-router)# network 192.168.70.0 mask 255.255.255.0
Router(config-router)# network 192.168.80.0 mask 255.255.255.0
Router(config-router)# neighbor 192.168.2.1 remote-as 65000
```

Medicine router (R2)

```
Router(config)# router bgp 65200
Router(config-router)# network 192.168.90.0 mask 255.255.255.0
Router(config-router)# network 192.168.100.0 mask 255.255.255.0
```

```
Router(config-router)# network 192.168.110.0 mask 255.255.255.0
Router(config-router)# network 192.168.120.0 mask 255.255.255.0
Router(config-router)# neighbor 192.168.3.1 remote-as 65000
```

Nursing & Education router(R3)

```
Router(config)# router bgp 65300
Router(config-router)# network 192.168.130.0 mask 255.255.255.0
Router(config-router)# network 192.168.140.0 mask 255.255.255.0
Router(config-router)# network 192.168.150.0 mask 255.255.255.0
Router(config-router)# network 192.168.160.0 mask 255.255.255.0
Router(config-router)# network 192.168.170.0 mask 255.255.255.0
Router(config-router)# network 192.168.180.0 mask 255.255.255.0
Router(config-router)# network 192.168.190.0 mask 255.255.255.0
Router(config-router)# neighbor 192.168.4.1 remote-as 65000
```

Computer Science & Applied Arts router(R4)

```
Router(config)# router bgp 65400
Router(config-router)# network 192.168.200.0 mask 255.255.255.0
Router(config-router)# network 192.168.210.0 mask 255.255.255.0
Router(config-router)# network 192.168.220.0 mask 255.255.255.0
Router(config-router)# network 192.168.230.0 mask 255.255.255.0
Router(config-router)# network 192.168.240.0 mask 255.255.255.0
Router(config-router)# network 192.168.245.0 mask 255.255.255.0
Router(config-router)# network 192.168.250.0 mask 255.255.255.0
Router(config-router)# neighbor 192.168.5.5 remote-as 65000
```

Switching Configuration

1. Switch Configuration

Basic SW configuration

```
hostname Google
enable password cisco
banner motd #welcome#
no ip domain lookup
line console 0
password cisco
login
exit
service password-encryption
do wr
```

2. VLAN and Inter-VLAN Routing

Virtual LANs (VLANs) are utilized to logically segment the network into separate broadcast domains, enhancing both security and efficiency. In this project, VLANs ranging from VLAN 10 to VLAN 250 are used to isolate different departments, including Student Labs (S_Labs), Lecture Halls (Lec_Hall), and Administration or IT. Each VLAN is given a specific name and mapped to designated switch ports using the `switchport access vlan` command. This approach not only reduces broadcast traffic but also improves network management. VLAN configurations are applied on individual switches to ensure a secure and well-structured network infrastructure. Additionally, inter-VLAN routing is enabled using Layer 3 switches to facilitate communication between different VLANs.

VLAN Configuration

HQ Building

Multilayer Switch 0

```
Switch>enable
Switch# config terminal
```

```
Switch(config)#vlan 10
Switch(config-vlan)#name IT
Switch(config-vlan)#exit
Switch(config)#int f0/1
Switch(config-if)#switchport mode access
Switch(config-if)#switchport access vlan 10
Switch(config-if)#exit
Switch(config)#vlan 20
Switch(config-vlan)#name management
Switch(config-vlan)#exit
Switch(config)#int f0/7
Switch(config-if)#switchport mode access
Switch(config-if)#switchport access vlan 20
Switch(config-if)#exit
Switch(config)#vlan 30
Switch(config-vlan)#name finance
Switch(config-vlan)#exit
Switch(config)#int f0/13
Switch(config-if)#switchport mode access
Switch(config-if)#switchport access vlan 30
Switch(config-if)#exit
Switch(config)#vlan 40
Switch(config-vlan)#name admin
Switch(config-vlan)#exit
Switch(config)#int f0/24
Switch(config-if)#switchport mode access
Switch(config-if)#switchport access vlan 40
Switch(config-if)#exit
```

```
Switch(config)#vlan 99
Switch(config-vlan)#name vlan99
Switch(config-vlan)#exit
Switch(config)#int G0/1
Switch(config-if)# switchport trunk encapsulation dot1q
Switch(config-if)# switchport trunk allowed vlan 10,20,30,40,99
Switch(config-if)#exit
```

Multilayer Switch 1 (Redundancy)

```
Switch>enable
Switch# config terminal
Switch(config)#vlan 1
Switch(config-vlan)#name VLAN0010
Switch(config-vlan)#exit
Switch(config)#int f0/2
Switch(config-if)#switchport mode access
Switch(config-if)#switchport access vlan 10
Switch(config-if)#exit
Switch(config)#vlan 20
Switch(config-vlan)#name VLAN0020
Switch(config-vlan)#exit
Switch(config)#int f0/3
Switch(config-if)#switchport mode access
Switch(config-if)#switchport access vlan 20
Switch(config-if)#exit
Switch(config)#vlan 30
Switch(config-vlan)#name VLAN0030
Switch(config-vlan)#exit
```

```
Switch(config)#int f0/4
Switch(config-if)#switchport mode access
Switch(config-if)#switchport access vlan 30
Switch(config-if)#exit
Switch(config)#vlan 40
Switch(config-vlan)#name VLAN0040
Switch(config-vlan)#exit
Switch(config)#int f0/5
Switch(config-if)#switchport mode access
Switch(config-if)#switchport access vlan 40
Switch(config-if)#exit
Switch(config)#vlan 99
Switch(config-vlan)#exit
Switch(config)#int f0/1
Switch(config-if)# switchport trunk encapsulation dot1q
Switch(config-if)# switchport trunk allowed vlan 10,20,30,40,99
Switch(config-if)#exit
```

Layer 2 Switch 1

```
Switch>enable
Switch# config terminal
Switch(config)#vlan 10
Switch(config-vlan)#name IT
Switch(config-vlan)#exit
Switch(config)#interface range fa0/1-24
Switch(config-if-range)# switchport mode access
Switch(config-if-range)# switchport access vlan 10
Switch(config-if-range)#exit
```

Layer 2 Switch 2

```
Switch>enable
Switch# config terminal
Switch(config)#vlan 20
Switch(config-vlan)#name management
Switch(config-vlan)#exit
Switch(config)#interface range fa0/1-24
Switch(config-if-range)# switchport mode access
Switch(config-if-range)# switchport access vlan 20
Switch(config-if-range)#exit
```

Layer 2 Switch 3

```
Switch>enable
Switch# config terminal
Switch(config)#vlan 30
Switch(config-vlan)#name finance
Switch(config-vlan)#exit
Switch(config)#interface range fa0/1-24
Switch(config-if-range)# switchport mode access
Switch(config-if-range)# switchport access vlan 30
Switch(config-if-range)#exit
```

Layer 2 Switch 4

```
Switch>enable
Switch# config terminal
Switch(config)#vlan 40
Switch(config-vlan)#name admin
```

```
Switch(config-vlan)#exit
Switch(config)#interface range fa0/1-24
Switch(config-if-range)# switchport mode access
Switch(config-if-range)# switchport access vlan 40
Switch(config-if-range)#exit
```

Faculty of Engineering Building:

Multilayer Switch 2

```
Switch>enable
Switch# config terminal
Switch(config)#vlan 50
Switch(config-vlan)#name E_s_labs
Switch(config-vlan)#exit
Switch(config)#int f0/1
Switch(config-if)#switchport mode access
Switch(config-if)#switchport access vlan 50
Switch(config-if)#exit
Switch(config)#vlan 60
Switch(config-vlan)#name E_LEC_HALL
Switch(config-vlan)#exit
Switch(config)#int f0/2
Switch(config-if)#switchport mode access
Switch(config-if)#switchport access vlan 60
Switch(config-if)#exit
Switch(config)#vlan 70
Switch(config-vlan)#name E_docs
Switch(config-vlan)#exit
Switch(config)#int f0/3
```

```
Switch(config-if)#switchport mode access
Switch(config-if)#switchport access vlan 70
Switch(config-if)#exit
Switch(config)#vlan 80
Switch(config-vlan)#name E_admin
Switch(config-vlan)#exit
Switch(config)#int f0/4
Switch(config-if)#switchport mode access
Switch(config-if)#switchport access vlan 80
Switch(config-if)#exit
Switch(config)#vlan 99
Switch(config-vlan)#name vlan99
Switch(config-vlan)#exit
Switch(config)#int G0/1
Switch(config-if)# switchport trunk encapsulation dot1q
Switch(config-if)# switchport trunk allowed vlan 50,60,70,80,99
Switch(config-if)#exit
```

Multilayer Switch 3 (Redundancy)

```
Switch>enable
Switch# config terminal
Switch(config)#vlan 50
Switch(config-vlan)#name VLAN0050
Switch(config-vlan)#exit
Switch(config)#int f0/2
Switch(config-if)#switchport mode access
Switch(config-if)#switchport access vlan 50
Switch(config-if)#exit
```

```
Switch(config)#vlan 60
Switch(config-vlan)#name VLAN0060
Switch(config-vlan)#exit
Switch(config)#int f0/3
Switch(config-if)#switchport mode access
Switch(config-if)#switchport access vlan 60
Switch(config-if)#exit
Switch(config)#vlan 70
Switch(config-vlan)#name VLAN0070
Switch(config-vlan)#exit
Switch(config)#int f0/4
Switch(config-if)#switchport mode access
Switch(config-if)#switchport access vlan 70
Switch(config-if)#exit
Switch(config)#vlan 80
Switch(config-vlan)#name VLAN0080
Switch(config-vlan)#exit
Switch(config)#int f0/5
Switch(config-if)#switchport mode access
Switch(config-if)#switchport access vlan 80
Switch(config-if)#exit
Switch(config)#vlan 99
Switch(config-vlan)#name vlan99
Switch(config-vlan)#exit
Switch(config)# int f0/1
Switch(config-if)# switchport trunk encapsulation dot1q
Switch(config-if)# switchport trunk allowed vlan 50,60,70,80,99
Switch(config-if)#exit
```

Layer 2 Switch 5

```
Switch>enable
Switch# config terminal
Switch(config)#vlan 50
Switch(config-vlan)#name name E_s_labs
Switch(config-vlan)#exit
Switch(config)#interface range fa0/1-24
Switch(config-if-range)# switchport mode access
Switch(config-if-range)# switchport access vlan 50
Switch(config-if-range)#exit
```

Layer 2 Switch 6

```
Switch>enable
Switch# config terminal
Switch(config)#vlan 60
Switch(config-vlan)#name name E_lec_Hall
Switch(config-vlan)#exit
Switch(config)#interface range fa0/1-24
Switch(config-if-range)# switchport mode access
Switch(config-if-range)# switchport access vlan 60
Switch(config-if-range)#exit
```

Layer 2 Switch 7

```
Switch>enable
Switch# config terminal
Switch(config)#vlan 70
Switch(config-vlan)#name name E_Docs
```

```
Switch(config-vlan)#exit
Switch(config)#interface range fa0/1-24
Switch(config-if-range)# switchport mode access
Switch(config-if-range)# switchport access vlan 70
Switch(config-if-range)#exit
```

Layer 2 Switch 8

```
Switch>enable
Switch# config terminal
Switch(config)#vlan 80
Switch(config-vlan)#name name E_admin
Switch(config-vlan)#exit
Switch(config)#interface range fa0/1-24
Switch(config-if-range)# switchport mode access
Switch(config-if-range)# switchport access vlan 80
Switch(config-if-range)#exit
```

Faculty of Medicine Building:

Multilayer Switch 4

```
Switch>enable
Switch# config terminal
Switch(config)#vlan 90
Switch(config-vlan)#name M_s_labs
Switch(config-vlan)#exit
Switch(config)#int f0/1
Switch(config-if)#switchport mode access
Switch(config-if)#switchport access vlan 90
Switch(config-if)#exit
```

```
Switch(config)#vlan 100
Switch(config-vlan)#name M_LEC_HALL
Switch(config-vlan)#exit
Switch(config)#int f0/2
Switch(config-if)#switchport mode access
Switch(config-if)#switchport access vlan 100
Switch(config-if)#exit
Switch(config)#vlan 110
Switch(config-vlan)#name M_docs
Switch(config-vlan)#exit
Switch(config)#int f0/3
Switch(config-if)#switchport mode access
Switch(config-if)#switchport access vlan 110
Switch(config-if)#exit
Switch(config)#vlan 120
Switch(config-vlan)#name M_admin
Switch(config-vlan)#exit
Switch(config)#int f0/4
Switch(config-if)#switchport mode access
Switch(config-if)#switchport access vlan 120
Switch(config-if)#exit
Switch(config)#vlan 99
Switch(config-vlan)#name vlan99
Switch(config-vlan)#exit
Switch(config)#int G0/1
Switch(config-if)# switchport trunk encapsulation dot1q
Switch(config-if)# switchport trunk allowed vlan 90, 99,100,110,120
Switch(config-if)#exit
```

Multilayer Switch 5 (Redundancy)

```
Switch>enable
Switch# config terminal
Switch(config)#vlan 90
Switch(config-vlan)#name VLAN0090
Switch(config-vlan)#exit
Switch(config)#int f0/2
Switch(config-if)#switchport mode access
Switch(config-if)#switchport access vlan 90
Switch(config-if)#exit
Switch(config)#vlan 100
Switch(config-vlan)#name VLAN0100
Switch(config-vlan)#exit
Switch(config)#int f0/3
Switch(config-if)#switchport mode access
Switch(config-if)#switchport access vlan 100
Switch(config-if)#exit
Switch(config)#vlan 110
Switch(config-vlan)#name VLAN0110
Switch(config-vlan)#exit
Switch(config)#int f0/4
Switch(config-if)#switchport mode access
Switch(config-if)#switchport access vlan 110
Switch(config-if)#exit
Switch(config)#vlan 120
Switch(config-vlan)#name VLAN0120
Switch(config-vlan)#exit
Switch(config)#int f0/5
```

```
Switch(config-if)#switchport mode access
Switch(config-if)#switchport access vlan 120
Switch(config-if)#exit
Switch(config)#vlan 99
Switch(config-vlan)#name vlan99
Switch(config-vlan)#exit
Switch(config)# int f0/1
Switch(config-if)# switchport trunk encapsulation dot1q
Switch(config-if)# switchport trunk allowed vlan 90, 99,100,110,120
Switch(config-if)#exit
```

Layer 2 Switch 9

```
Switch>enable
Switch# config terminal
Switch(config)#vlan 90
Switch(config-vlan)#name M_s_labs
Switch(config-vlan)#exit
Switch(config)#interface range fa0/1-24
Switch(config-if-range)# switchport mode access
Switch(config-if-range)# switchport access vlan 90
Switch(config-if-range)#exit
```

Layer 2 Switch 10

```
Switch>enable
Switch# config terminal
Switch(config)#vlan 100
Switch(config-vlan)#name M_lec_hall
Switch(config-vlan)#exit
```

```
Switch(config)#interface range fa0/1-24
Switch(config-if-range)# switchport mode access
Switch(config-if-range)# switchport access vlan 100
Switch(config-if-range)#exit
```

Layer 2 Switch 11

```
Switch>enable
Switch# config terminal
Switch(config)#vlan 110
Switch(config-vlan)#name M_docs
Switch(config-vlan)#exit
Switch(config)#interface range fa0/1-24
Switch(config-if-range)# switchport mode access
Switch(config-if-range)# switchport access vlan 110
Switch(config-if-range)#exit
```

Layer 2 Switch 12

```
Switch>enable
Switch# config terminal
Switch(config)#vlan 120
Switch(config-vlan)#name M_admin
Switch(config-vlan)#exit
Switch(config)#interface range fa0/1-24
Switch(config-if-range)# switchport mode access
Switch(config-if-range)# switchport access vlan 120
Switch(config-if-range)#exit
```

Faculty of Nursing & Faculty of Physical.E Building:

Multilayer Switch 6

```
Switch>enable
```

```
Switch# config terminal
Switch(config)#vlan 130
Switch(config-vlan)#name N_s_labs
Switch(config-vlan)#exit
Switch(config)#int f0/1
Switch(config-if)#switchport mode access
Switch(config-if)#switchport access vlan 130
Switch(config-if)#exit
Switch(config)#vlan 140
Switch(config-vlan)#name N_LEC_HALL
Switch(config-vlan)#exit
Switch(config)#int f0/2
Switch(config-if)#switchport mode access
Switch(config-if)#switchport access vlan 140
Switch(config-if)#exit
Switch(config)#vlan 150
Switch(config-vlan)#name N_docs
Switch(config-vlan)#exit
Switch(config)#int f0/3
Switch(config-if)#switchport mode access
Switch(config-if)#switchport access vlan 150
Switch(config-if)#exit
Switch(config)#vlan 160
Switch(config-vlan)#name N_it
Switch(config-vlan)#exit
Switch(config)#int f0/4
Switch(config-if)#switchport mode access
Switch(config-if)#switchport access vlan 160
```

```
Switch(config-if)#exit
Switch(config)#vlan 170
Switch(config-vlan)#name PH_s_labs
Switch(config-vlan)#exit
Switch(config)#int f0/5
Switch(config-if)#switchport mode access
Switch(config-if)#switchport access vlan 170
Switch(config-if)#exit
Switch(config)#vlan 180
Switch(config-vlan)#name PH_management
Switch(config-vlan)#exit
Switch(config)#int f0/6
Switch(config-if)#switchport mode access
Switch(config-if)#switchport access vlan 180
Switch(config-if)#exit
Switch(config)#vlan 190
Switch(config-vlan)#name PH_it
Switch(config-vlan)#exit
Switch(config)#int f0/7
Switch(config-if)#switchport mode access
Switch(config-if)#switchport access vlan 190
Switch(config-if)#exit
Switch(config)#vlan 99
Switch(config-vlan)#name vlan99
Switch(config-vlan)#exit
Switch(config)#int G0/1
Switch(config-if)# switchport trunk encapsulation dot1q
```

```
Switch(config-if)# switchport trunk allowed vlan
99,130,140,150,160,170,180,190

Switch(config-if)#exit
```

Multilayer Switch 7 (Redundancy)

```
Switch>enable

Switch# config terminal

Switch(config)#vlan 130

Switch(config-vlan)#name VLAN0130

Switch(config-vlan)#exit

Switch(config)#int f0/1

Switch(config-if)#switchport mode access

Switch(config-if)#switchport access vlan 130

Switch(config-if)#exit

Switch(config)#vlan 140

Switch(config-vlan)#name VLAN0140

Switch(config-vlan)#exit

Switch(config)#int f0/2

Switch(config-if)#switchport mode access

Switch(config-if)#switchport access vlan 140

Switch(config-if)#exit

Switch(config)#vlan 150

Switch(config-vlan)#name VLAN0150

Switch(config-vlan)#exit

Switch(config)#int f0/3

Switch(config-if)#switchport mode access

Switch(config-if)#switchport access vlan 150

Switch(config-if)#exit

Switch(config)#vlan 160
```

```
Switch(config-vlan)#name VLAN0160
Switch(config-vlan)#exit
Switch(config)#int f0/4
Switch(config-if)#switchport mode access
Switch(config-if)#switchport access vlan 160
Switch(config-if)#exit
Switch(config)#vlan 170
Switch(config-vlan)#name VLAN0170
Switch(config-vlan)#exit
Switch(config)#int f0/5
Switch(config-if)#switchport mode access
Switch(config-if)#switchport access vlan 170
Switch(config-if)#exit
Switch(config)#vlan 180
Switch(config-vlan)#name VLAN0180
Switch(config-vlan)#exit
Switch(config)#int f0/6
Switch(config-if)#switchport mode access
Switch(config-if)#switchport access vlan 180
Switch(config-if)#exit
Switch(config)#vlan 190
Switch(config-vlan)#name VLAN0190
Switch(config-vlan)#exit
Switch(config)#int f0/7
Switch(config-if)#switchport mode access
Switch(config-if)#switchport access vlan 190
Switch(config-if)#exit
Switch(config)#vlan 99
```

```
Switch(config-vlan)#name vlan99
Switch(config-vlan)#exit
Switch(config)#int F0/8
Switch(config-if)# switchport trunk encapsulation dot1q
Switch(config-if)# switchport trunk allowed vlan
99,130,140,150,160,170,180,190
Switch(config-if)#exit
```

Layer 2 Switch 13

```
Switch>enable
Switch# config terminal
Switch(config)#vlan 130
Switch(config-vlan)#name N_s_labs
Switch(config-vlan)#exit
Switch(config)#interface range fa0/1-24
Switch(config-if-range)# switchport mode access
Switch(config-if-range)# switchport access vlan 130
Switch(config-if-range)#exit
```

Layer 2 Switch 14

```
Switch>enable
Switch# config terminal
Switch(config)#vlan 140
Switch(config-vlan)#name N_lec_hall
Switch(config-vlan)#exit
Switch(config)#interface range fa0/1-24
Switch(config-if-range)# switchport mode access
```

```
Switch(config-if-range)# switchport access vlan 140
Switch(config-if-range)#exit
```

Layer 2 Switch 15

```
Switch>enable
Switch# config terminal
Switch(config)#vlan 150
Switch(config-vlan)#name N_docs
Switch(config-vlan)#exit
Switch(config)#interface range fa0/1-24
Switch(config-if-range)# switchport mode access
Switch(config-if-range)# switchport access vlan 150
Switch(config-if-range)#exit
```

Layer 2 Switch 16

```
Switch>enable
Switch# config terminal
Switch(config)#vlan 160
Switch(config-vlan)#name N_it
Switch(config-vlan)#exit
Switch(config)#interface range fa0/1-24
Switch(config-if-range)# switchport mode access
Switch(config-if-range)# switchport access vlan 160
Switch(config-if-range)#exit
```

Layer 2 Switch 17:

```
Switch>enable
Switch# config terminal
Switch(config)#vlan 170
Switch(config-vlan)#name PH_s_labs
```

```
Switch(config-vlan)#exit
Switch(config)#interface range fa0/1-24
Switch(config-if-range)# switchport mode access
Switch(config-if-range)# switchport access vlan 170
Switch(config-if-range)#exit
```

Layer 2 Switch 18

```
Switch>enable
Switch# config terminal
Switch(config)#vlan 180
Switch(config-vlan)#name PH_management
Switch(config-vlan)#exit
Switch(config)#interface range fa0/1-24
Switch(config-if-range)# switchport mode access
Switch(config-if-range)# switchport access vlan 180
Switch(config-if-range)#exit
```

Layer 2 Switch 19:

```
Switch>enable
Switch# config terminal
Switch(config)#vlan 190
Switch(config-vlan)#name PH_it
Switch(config-vlan)#exit
Switch(config)#interface range fa0/1-24
Switch(config-if-range)# switchport mode access
Switch(config-if-range)# switchport access vlan 190
Switch(config-if-range)#exit
```

Faculty of Computer science & Applied Arts Building:

Multilayer Switch 8

```
Switch>enable
Switch# config terminal
Switch(config)#vlan 200
Switch(config-vlan)#name C_docs
Switch(config-vlan)#exit
Switch(config)#int f0/1
Switch(config-if)#switchport mode access
Switch(config-if)#switchport access vlan 200
Switch(config-if)#exit
Switch(config)#vlan 210
Switch(config-vlan)#name C_it
Switch(config-vlan)#exit
Switch(config)#int f0/2
Switch(config-if)#switchport mode access
Switch(config-if)#switchport access vlan 210
Switch(config-if)#exit
Switch(config)#vlan 220
Switch(config-vlan)#name C_ai
Switch(config-vlan)#exit
Switch(config)#int f0/3
Switch(config-if)#switchport mode access
Switch(config-if)#switchport access vlan 220
Switch(config-if)#exit
Switch(config)#vlan 230
Switch(config-vlan)#name C_is
Switch(config-vlan)#exit
Switch(config)#int f0/4
Switch(config-if)#switchport mode access
```

```
Switch(config-if)#switchport access vlan 230
Switch(config-if)#exit
Switch(config)#vlan 240
Switch(config-vlan)#name A_s_labs
Switch(config-vlan)#exit
Switch(config)#int f0/5
Switch(config-if)#switchport mode access
Switch(config-if)#switchport access vlan 240
Switch(config-if)#exit
Switch(config)#vlan 245
Switch(config-vlan)#name A_docs
Switch(config-vlan)#exit
Switch(config)#int f0/6
Switch(config-if)#switchport mode access
Switch(config-if)#switchport access vlan 245
Switch(config-if)#exit
Switch(config)#vlan 250
Switch(config-vlan)#name A_it
Switch(config-vlan)#exit
Switch(config)#int f0/7
Switch(config-if)#switchport mode access
Switch(config-if)#switchport access vlan 250
Switch(config-if)#exit
Switch(config)#vlan 99
Switch(config-vlan)#name vlan99
Switch(config-vlan)#exit
Switch(config)#int G0/1
Switch(config-if)# switchport trunk encapsulation dot1q
```

```
Switch(config-if)# switchport trunk allowed vlan
99,200,210,220,230,240,245,250
Switch(config-if)#exit
```

Multilayer Switch 9 (Redundancy)

```
Switch>enable
Switch# config terminal
Switch(config)#vlan 200
Switch(config-vlan)#name VLAN0200
Switch(config-vlan)#exit
Switch(config)#int f0/2
Switch(config-if)#switchport mode access
Switch(config-if)#switchport access vlan 200
Switch(config-if)#exit
Switch(config)#vlan 210
Switch(config-vlan)#name VLAN0210
Switch(config-vlan)#exit
Switch(config)#int f0/3
Switch(config-if)#switchport mode access
Switch(config-if)#switchport access vlan 210
Switch(config-if)#exit
Switch(config)#vlan 220
Switch(config-vlan)#name VLAN0220
Switch(config-vlan)#exit
Switch(config)#int f0/4
Switch(config-if)#switchport mode access
Switch(config-if)#switchport access vlan 220
Switch(config-if)#exit
```

```
Switch(config)#vlan 230
Switch(config-vlan)#name VLAN0230
Switch(config-vlan)#exit
Switch(config)#int f0/5
Switch(config-if)#switchport mode access
Switch(config-if)#switchport access vlan 230
Switch(config-if)#exit
Switch(config)#vlan 240
Switch(config-vlan)#name VLAN0240
Switch(config-vlan)#exit
Switch(config)#int f0/6
Switch(config-if)#switchport mode access
Switch(config-if)#switchport access vlan 240
Switch(config-if)#exit
Switch(config)#vlan 245
Switch(config-vlan)#name VLAN0245
Switch(config-vlan)#exit
Switch(config)#int f0/7
Switch(config-if)#switchport mode access
Switch(config-if)#switchport access vlan 245
Switch(config-if)#exit
Switch(config)#vlan 250
Switch(config-vlan)#name VLAN0250
Switch(config-vlan)#exit
Switch(config)#int f0/8
Switch(config-if)#switchport mode access
Switch(config-if)#switchport access vlan 250
Switch(config-if)#exit
```

```
Switch(config)#vlan 99
Switch(config-vlan)#name vlan99
Switch(config-vlan)#exit
Switch(config)#int F0/1
Switch(config-if)# switchport trunk encapsulation dot1q
Switch(config-if)# switchport trunk allowed vlan
99,200,210,220,230,240,245,250
Switch(config-if)#exit
```

Layer 2 Switch 20:

```
Switch>enable
Switch# config terminal
Switch(config)#vlan 200
Switch(config-vlan)#name C _docs
Switch(config-vlan)#exit
Switch(config)#interface range fa0/1-24
Switch(config-if-range)# switchport mode access
Switch(config-if-range)# switchport access vlan 200
Switch(config-if-range)#exit
```

Layer 2 Switch 21:

```
Switch>enable
Switch# config terminal
Switch(config)#vlan 210
Switch(config-vlan)#name C _it
Switch(config-vlan)#exit
Switch(config)#interface range fa0/1-24
Switch(config-if-range)# switchport mode access
```

```
Switch(config-if-range)# switchport access vlan 210
Switch(config-if-range)#exit
```

Layer 2 Switch 22:

```
Switch>enable
Switch# config terminal
Switch(config)#vlan 220
Switch(config-vlan)#name C _ai
```

Vlans Network

Vlan	Network	Department
Vlan10	192.168.10.0	HQ_it
Vlan20	192.168.20.0	HQ_management
Vlan30	192.168.30.0	HQ_finance
Vlan40	192.168.40.0	HQ_admin
Vlan50	192.168.50.0	E_s_labs
Vlan60	192.168.60.0	E_lec_hall
Vlan70	192.168.70.0	E_doctors
Vlan80	192.168.80.0	E_admin
Vlan90	192.168.90.0	M_s_labs
Vlan100	192.168.100.0	M_lec_hall
Vlan110	192.168.110.0	M_doctors
Vlan120	192.168.120.0	M_admin
Vlan130	192.168.130.0	N_s_labs
Vlan140	192.168.140.0	N_lec_hall
Vlan150	192.168.150.0	N_doctors
Vlan160	192.168.160.0	N_it
Vlan170	192.168.170.0	PH_s_labs
Vlan180	192.168.180.0	PH_management

Vlan190	192.168.190.0	PH_it
Vlan200	192.168.200.0	C_it
Vlan210	192.168.210.0	C_docs
Vlan220	192.168.220.0	C_ai
Vlan230	192.168.230.0	C_is
Vlan240	192.168.240.0	A_s_labs
Vlan245	192.168.245.0	A_lec_hall
Vlan250	192.168.250.0	A_doctors

Security Measures

1. PAT

Port Address Translation (PAT) is a technique used in networking to map private IP addresses within a local network to a single public IP address. This process allows multiple devices on a private network to access external networks, such as the internet, using one public IP address.

PAT to map private IPs to a single public IP

```
HQ(config)#int g0/0.10

HQ(config-subif)#ip nat inside

HQ(config-subif)#int g0/0.20

HQ(config-subif)#ip nat inside

HQ(config-subif)#int g0/0.30

HQ(config-subif)#ip nat inside

HQ(config-subif)#int g0/0.40

HQ(config-subif)#ip nat inside

HQ(config-subif)#ex

HQ(config)#int g0/2.10

HQ(config-subif)#ip nat inside

HQ(config-subif)#int g0/2.20

HQ(config-subif)#ip nat inside

HQ(config-subif)#int g0/2.30

HQ(config-subif)#ip nat inside

HQ(config-subif)#int g0/2.40
```

```
HQ(config-subif)#ip nat inside

HQ(config-subif)#ex

HQ(config)#int g0/1

HQ(config-if)#ip nat inside

HQ(config-if)#ex

HQ(config)#int s0/0/0

HQ(config-if)#ip nat inside

HQ(config-if)#ex

HQ(config)#int s0/0/1

HQ(config-if)#ip nat inside

HQ(config-if)#ex

HQ(config)#int s0/1/0

HQ(config-if)#ip nat inside

HQ(config-if)#ex

HQ(config)#int s0/1/1

HQ(config-if)#ip nat inside

HQ(config-if)#ex

HQ(config)#int s0/2/0

HQ(config-if)#ip nat outside

HQ(config-if)#ex

HQ(config)#access-list 1 permit 192.168.10.0 0.0.0.255

HQ(config)#access-list 1 permit 192.168.20.0 0.0.0.255

HQ(config)#access-list 1 permit 192.168.30.0 0.0.0.255

HQ(config)#access-list 1 permit 192.168.40.0 0.0.0.255

HQ(config)#access-list 1 permit 192.168.50.0 0.0.0.255
```

```
HQ(config)#access-list 1 permit 192.168.60.0 0.0.0.255
HQ(config)#access-list 1 permit 192.168.70.0 0.0.0.255
HQ(config)#access-list 1 permit 192.168.80.0 0.0.0.255
HQ(config)#access-list 1 permit 192.168.90.0 0.0.0.255
HQ(config)#access-list 1 permit 192.168.100.0 0.0.0.255
HQ(config)#access-list 1 permit 192.168.110.0 0.0.0.255
HQ(config)#access-list 1 permit 192.168.120.0 0.0.0.255
HQ(config)#access-list 1 permit 192.168.130.0 0.0.0.255
HQ(config)#access-list 1 permit 192.168.140.0 0.0.0.255
HQ(config)#access-list 1 permit 192.168.150.0 0.0.0.255
HQ(config)#access-list 1 permit 192.168.160.0 0.0.0.255
HQ(config)#access-list 1 permit 192.168.170.0 0.0.0.255
HQ(config)#access-list 1 permit 192.168.180.0 0.0.0.255
HQ(config)#access-list 1 permit 192.168.190.0 0.0.0.255
HQ(config)#access-list 1 permit 192.168.200.0 0.0.0.255
HQ(config)#access-list 1 permit 192.168.210.0 0.0.0.255
HQ(config)#access-list 1 permit 192.168.220.0 0.0.0.255
HQ(config)#access-list 1 permit 192.168.230.0 0.0.0.255
HQ(config)#access-list 1 permit 192.168.240.0 0.0.0.255
HQ(config)#access-list 1 permit 192.168.245.0 0.0.0.255
HQ(config)#access-list 1 permit 192.168.250.0 0.0.0.255
HQ(config)#ip nat inside source list 1 int s0/2/0 overload
```

2. Port Security

Applying switch port security in the server room is a crucial step in safeguarding the network infrastructure. By restricting access to the servers and other critical devices, we can significantly reduce the risk of unauthorized access and potential security breaches.port security for the switch server.

port security for server switch

```
Switch(config)# interface GigabitEthernet0/1-24

Switch(config-if)# switchport port-security maximum 1

Switch(config-if)# switchport port-security mac-address sticky

Switch(config-if)# switchport port-security violation shutdown

Switch# copy running-config startup-config
```

3. VPN

A Site-to-Site IPsec VPN is a crucial tool for securely connecting a medicine branch to its headquarters, especially in the healthcare industry where data privacy and security are paramount.

Update the router

```
license boot module c2900 technology-package securityk9         # Enable the Security (securityk9) technology package license on the Cisco 2900 series router, allowing advanced security features like VPN and firewall

do wr

do reload
```

ACL

```
access-list 111 permit ip 192.168.0.0 0.0.0.255 192.168.0.0 0.0.0.255
```

VPN for HQ branch

```
HQ(config)# crypto isakmp policy 10

HQ(config-isakmp)# encryption aes 256

HQ(config-isakmp)# authentication pre-share
```

```
HQ(config-isakmp)# group 5
HQ(config-isakmp)# exit
HQ(config)# crypto isakmp key vpn55 address 192.168.3.1
HQ(config)# crypto ipsec transform-set VPN_SET esp-aes esp-sha-hmac
HQ(cfg-crypto-trans)# exit
HQ(config)# crypto map VPN_MAP 10 ipsec-isakmp
HQ(config-crypto-map)# set peer 192.168.3.1
HQ(config-crypto-map)# set transform-set VPN_SET
HQ(config-crypto-map)# match address 111
HQ(config-crypto-map)# exit
HQ(config)# interface s0/0/1
HQ(config-if)# crypto map VPN_MAP
```

VPN for Medicine branch

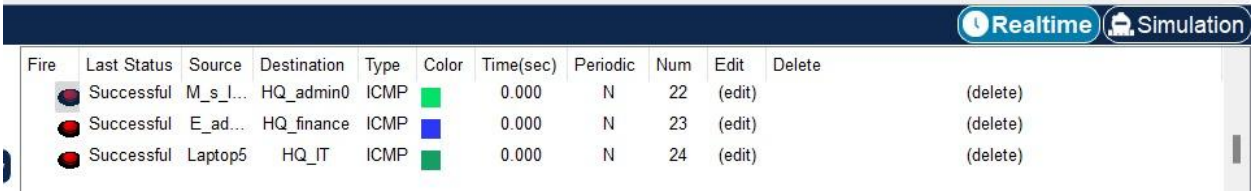
```
Med(config)# crypto isakmp policy 10
Med(config-isakmp)# encryption aes 256
Med(config-isakmp)# authentication pre-share
Med(config-isakmp)# group 5
Med(config-isakmp)# exit
Med(config)# crypto isakmp key vpn55 address 192.168.3.2
Med(config)# crypto ipsec transform-set VPN_SET esp-aes esp-sha-hmac
Med(cfg-crypto-trans)# exit
Med(config)# crypto map VPN_MAP 10 ipsec-isakmp
Med(config-crypto-map)# set peer 192.168.3.2
Med(config-crypto-map)# set transform-set VPN_SET
Med(config-crypto-map)# match address 111
Med(config-crypto-map)# exit
Med(config)# interface s0/0/0
Med(config-if)# crypto map VPN_MAP
```

Testing and Validation

Simulation

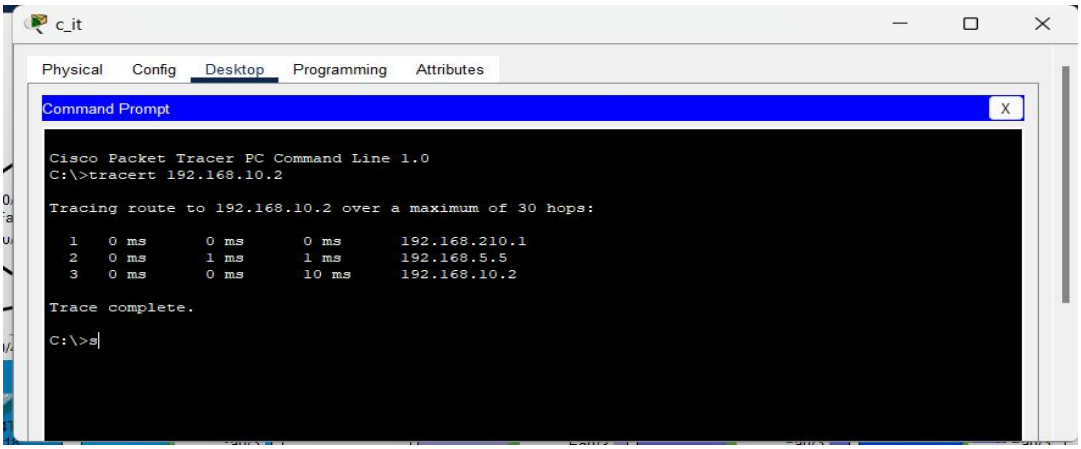
Packet Tracer was utilized to simulate and test the designed network. Packet Tracer is a network simulation tool that provides a virtual environment for designing, configuring, and testing network scenarios. The simulation process involves:

- Network Topology Design: The network topology, including routers, switches, PCs, servers, and other devices, was designed within Packet Tracer based on the specified requirements.
- Configuration Implementation: Using the designed topology, configurations were implemented on routers, switches, and other network devices according to the provided guidelines. Cisco Packet Tracer allows users to configure devices with a user-friendly interface similar to actual Cisco devices.
- Traffic Simulation: Packet Tracer allows the simulation of network traffic and communication between devices. This involves generating traffic, testing

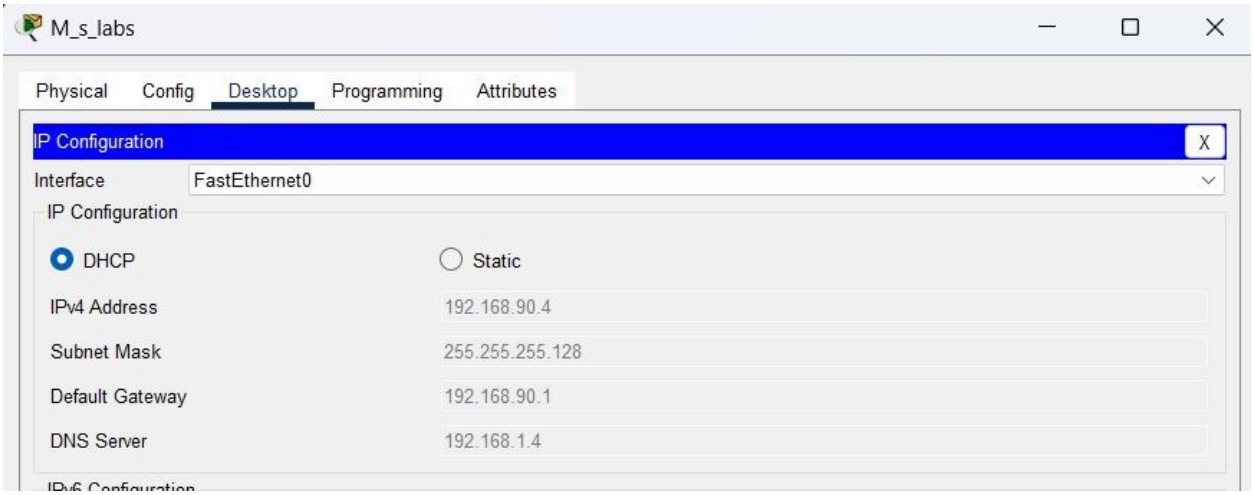


connectivity, and ensuring that data flows as expected.

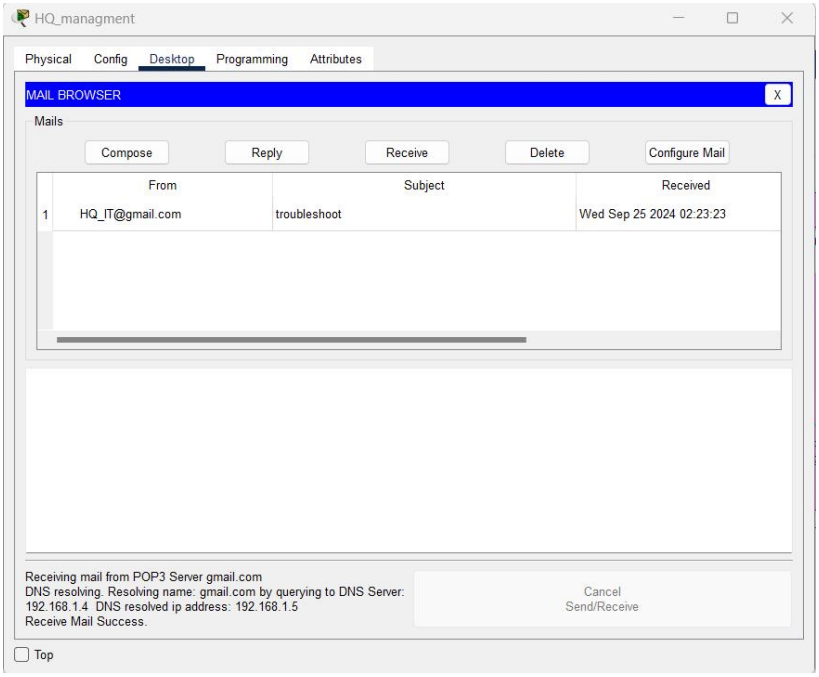
- Verification of Redundancy and Failover: The hierarchical design with redundancy at every layer, including routers, multiple multilayer switches, was tested to verify failover mechanisms and ensure network resilience.



- DHCP and IP Address Allocation: Dynamic Host Configuration Protocol (DHCP) functionality and IP address allocation were tested to ensure that devices received the correct IP addresses dynamically and that devices in the server room had static IP assignments.



- E-mail server : A mail server (sometimes called an email server) is a software program that sends and receives email.



Troubleshooting

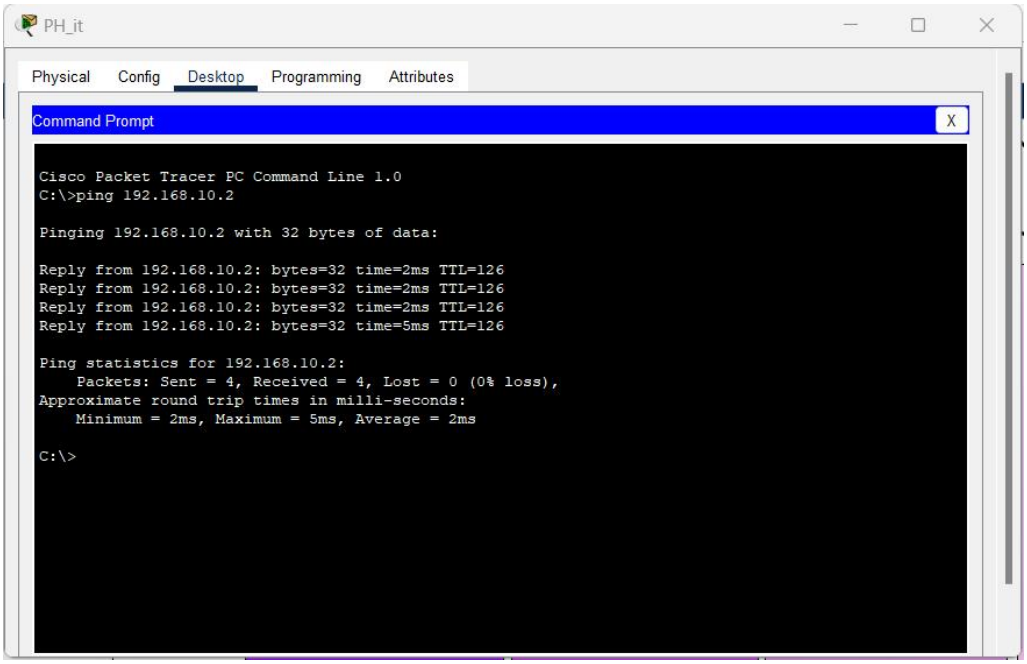
During the testing phase, several common troubleshooting steps were taken to address issues:

- Device Connectivity: Ensured that all devices could communicate within their respective VLANs and across different departments. Verified inter-VLAN routing configurations on multilayer switches.
- DHCP Issues: Investigated and resolved any DHCP-related issues, ensuring that DHCP servers were reachable and capable of assigning IP addresses to devices dynamically.
- Routing Configuration: Verified the Border Gateway Protocol (BGP) routing configurations on routers and multilayer switches, ensuring proper routing table updates and communication between different departments.

Results and Evaluation

- *Performance Metrics*

Performance metrics, including network latency, throughput, redundancy testing, DHCP response time, inter-VLAN routing performance, security, and NAT functionality, were measured during testing to ensure optimal network operation.



Achievement of Objectives

- Redundancy:
    1. multilayer switches
- Departmental Segmentation:
    2. VLANs for enhanced security and organization.
- Inter-VLAN Routing:
    3. Configured on multilayer switches.
- Security Measures:
    4. ACLs, port-security, SSH for access control, VPN.
- NAT Configurations:
    5. Effective private-to-public IP address translation.
- Thorough Testing:
    6. Ensured proper functionality and adherence to requirements.

Conclusion

In summary, the network design and implementation for the University network design have been successfully executed. Key achievements include a hierarchical network model with redundancy at multiple layers, departmental segmentation through VLANs, inter-VLAN routing, robust security measures, effective NAT, VPN configurations. Thorough testing using Cisco Packet Tracer ensured proper functionality and alignment with project requirements. The resulting network

provides scalability, security, and efficiency, meeting the specified needs of the organization.