Complex Computing Problem
Computer Communication Networks
CT-376

GROUP-17

Group members:

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Technologies to be Used:

Design a complex network topology in which the terminologies (i.e.Inter Vlan Routing, Router As a Stick, sub-netting, Telnet, Security (ACL), Eth-Trunk, Static Route, RIP, STP, VLAN, DHCP, and FTP) must be used.

Problem Statement:

Build a complex network topology using eNSP simulator where the above said terminologies are used. You may add your assumptions.

Problem Description:

The goal is to design and implement a comprehensive network topology using the Enterprise Network Simulation Platform (eNSP) that caters to the needs of a government building hosting multiple departments, including Administration, Finance, Human Resources, IT, Public Relations, and Security. This network must incorporate the following key networking elements:

1. **Subnetting**: Logical division of the network to ensure isolation and efficient IP address management for each department.
2. **Telnet**: Remote management of routers and switches with secure access controls.

3. **Access Control Lists (ACLs)**: Implementation of security policies to control access between departments.
4. **Eth-Trunk (LACP based)**: Link aggregation to provide redundancy and load balancing between switches.
5. **Static Routes**: Manual routing entries to ensure proper packet delivery across different subnets.
6. **RIP (Routing Information Protocol)**: Dynamic routing protocol to facilitate automatic route updates and simplify network management.
7. **STP (Spanning Tree Protocol) Conversion**: Prevention of network loops and ensuring a loop-free topology.
8. **VLAN (Router on a Stick)**: VLAN segmentation and inter-VLAN routing to manage broadcast domains and improve network performance.
9. **DHCP**: Dynamic IP address allocation for devices within the network.
10. **FTP**: Secure file transfer within the network for various departmental needs

Technologies Used:

- Inter Vlan Routing
- Router As a Stick
- Sub-netting
- Telnet
- Security (ACL)
- Eth-Trunk
- Static Route
- RIP
- STP
- VLAN
- DHCP
- FTP

Complex Computing Problem Assessment Rubrics

| Course Code: CT-376		Course Title: Computer Communication Networks	
Criteria and Scales			
Excellent **(3)**	**Good** **(2)**	**Average** **(1)**	**Poor** **(0)**
Criterion 1: Understanding the Problem: How well the problem statement is understood by the student			
Understands the problem clearly and identify the underlying issues and functionalities.	Adequately understands the problem and identifies the underlying issues and functionalities.	Inadequately defines the problem and identifies the underlying issues and functionalities.	Fails to define the problem adequately and does not identify the underlying issues and functionalities.
Criterion 2: Research: The amount of research that is used in solving the problem			
Contains all the information needed for solving the problem	Good research leads to a successful solution	Mediocre research which may or may not lead to an adequate solution	No apparent research
Criterion 3: Code: How complete the code is along with the assumptions?			
Complete the code according to the selected functionalities of the given case with clear assumptions	Incomplete code according to the selected functionalities of the given case with clear assumptions	Incomplete code according to the selected functionalities of the given case with unclear assumptions	Wrong code and naming conventions
Criterion 4: Report: How thorough and well organized is the solution?			
All the necessary information is organized for easy use in solving the problem	Good information organized well could lead to a good solution	Mediocre information which may or may not lead to a solution	No report provided
Criterion 5: Labeling: How well defined and labeled is the solution?			
All the necessary information is labelled (i.e. port no.) for better understanding	Good information about the topology is labelled	Incomplete label according to the selected functionalities	Not Labelled

Total Marks: _____

Teacher's Signature: _____

Introduction:

In today's highly interconnected world, government organizations rely heavily on robust and secure networking infrastructures to ensure efficient and secure communication and data exchange. These networks must support a variety of departments, each with unique requirements and security policies. The integration of multiple networking technologies such as subnetting, access control lists (ACLs), dynamic routing, and VLANs is essential to provide a scalable and manageable environment. Additionally, technologies like Eth-Trunk (LACP), STP, DHCP, FTP, and Telnet must be seamlessly incorporated to ensure redundancy, loop prevention, dynamic IP allocation, secure file transfer, and remote management capabilities

System Topology:
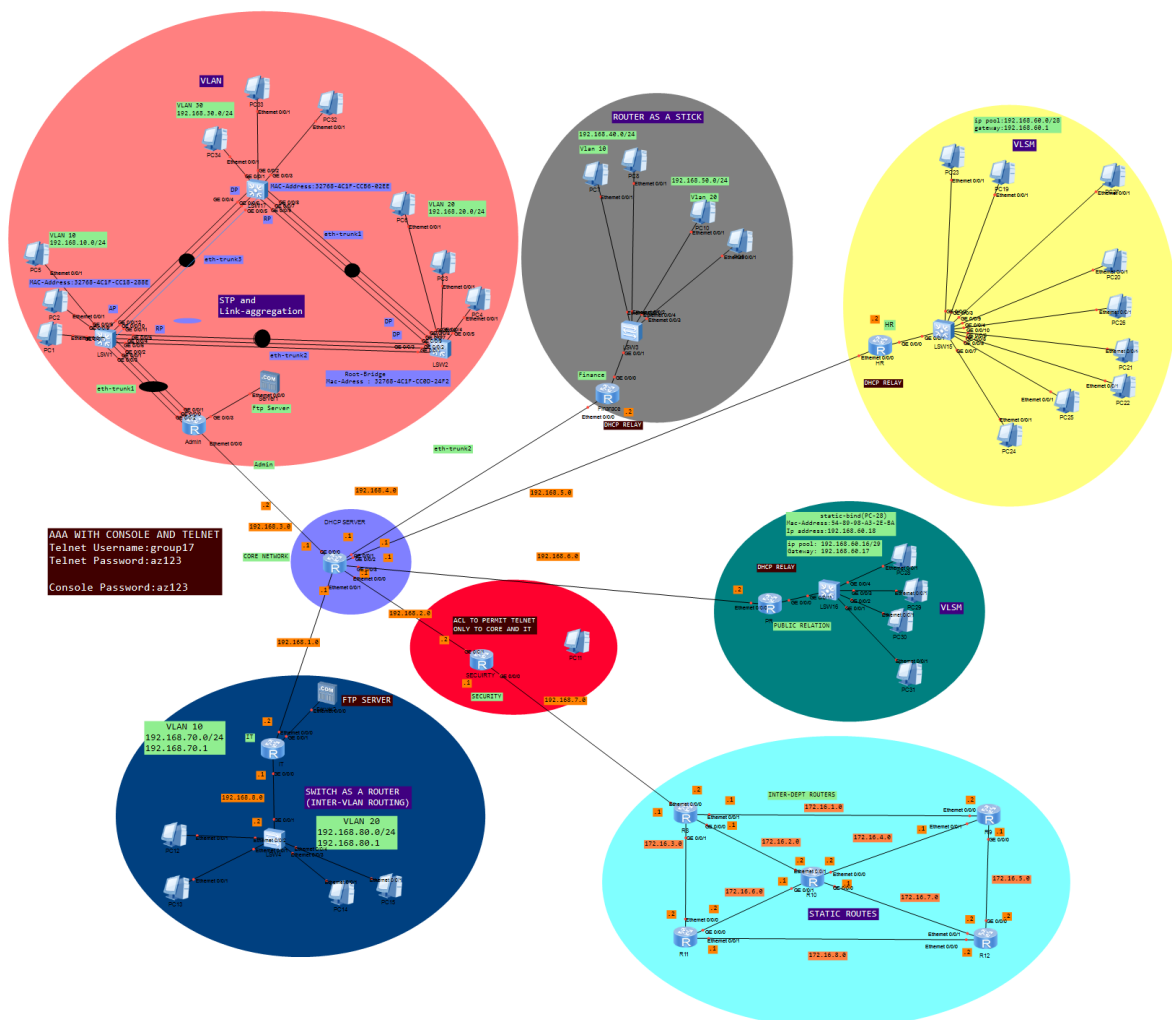
Configuration:

Working Networks:

IP Pools

Static Routes

R8-R9

- **Network:** 172.168.1.0/24

R8-R10

- **Network:** 172.16.2.0/24

R8-R11

- **Network:** 172.16.3.0/24

R9-R10

- **Network:** 172.16.4.0/24

R9-R12

- **Network:** 172.16.5.0/24

R10-RII

- **Network:** 172.16.6.0/24

R10-R12

- **Network:** 172.16.7.0/29

R11-R12

- **Network:** 172.16.8.0/24

RIP Networks

DHCP-FTP

- **Network:** 1110/24

DHCP-Sec

- **Network:** 2.2.2.0/24

DHCP-FITP/IT

- **Network:** 192.168.1.0/24

DHCP-Sec

- **Network:** 192.168.2.0/24

DHCP-Admin

- **Network:** 192.168.3.0/24

DHCP-Finance

- **Network:** 192.168.4.0/24

DHCP-HR

- **Network:** 192.168.5.0/24

DHCP-Public

- **Network:** 192.168.6.0/24

SEC-INTER Dept Router

- **Network:** 192.168.7.0/24

FTP-Switch as Router

- **Network:** 192.168.8.0/24

VLANs

VLAN 10

- **Network:** 192.168.10.0/24

VLAN 20

- **Network:** 192.168.20.0/24

VLAN 30

- **Network:** 192.168.30.0/24

Network Segments

VLSM on HR and Public Relation

- **Network 1:** 192.168.60.0/28
- **Network 2:** 192.168.60.16/29

Router on a Stick

Network 1

- **Network:** 192.168.50.0/24
- **Gateway:** 192.168.50.1

Network 2

- **Network:** 192.168.90.0/24
- **Gateway:** 192.168.40.1

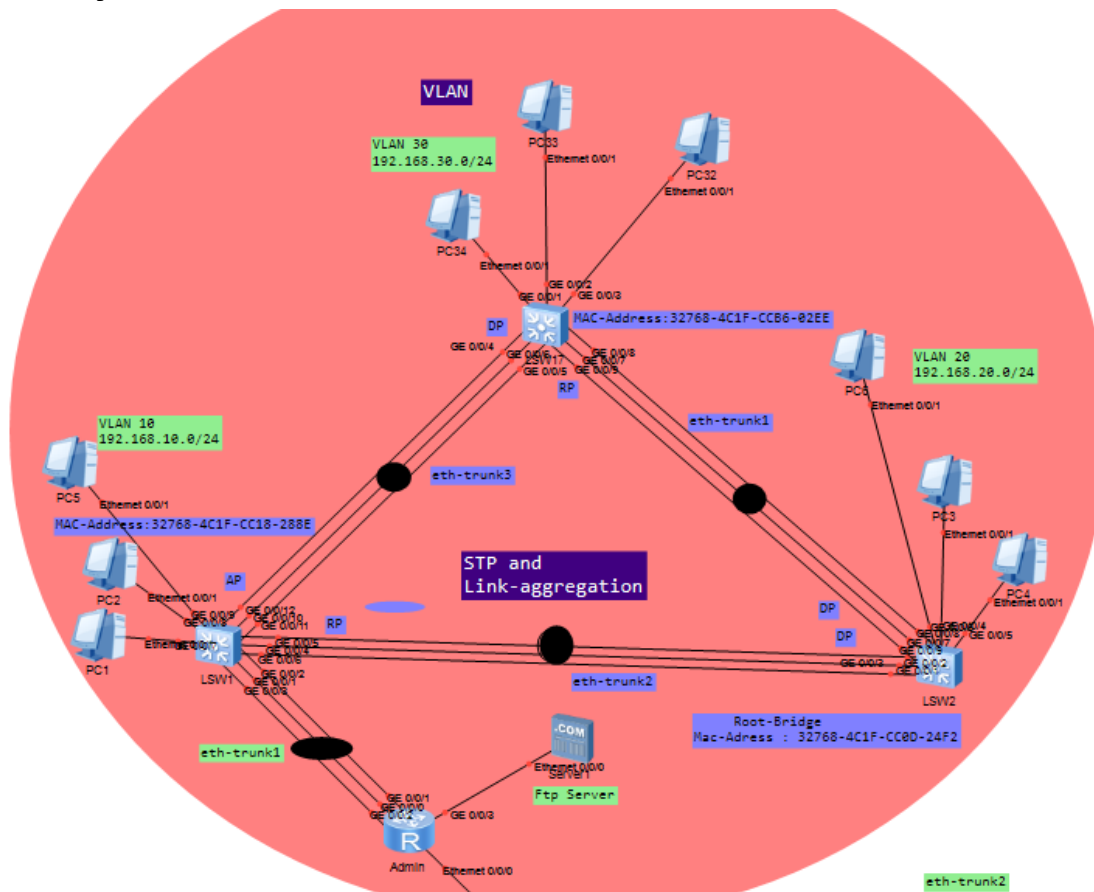**Switch as a Router**

VLAN 10

- **Network:** 192.168.70.0/24

VLAN 20

- **Network:** 192.168.80.0/24

Sub-System 1:

Configurations:
LACP:

The configurations involve three network switches (switch1, switch2, and switch17) with VLANs 10, 20, and 30. Switch1 has all three VLANs configured and three trunk interfaces allowing various VLAN combinations. Switch2 and switch17 each have two trunk interfaces allowing different VLAN sets. All trunk ports use static LACP for link aggregation. Switch1 has additional settings for clustering, NTDP, NDP, and illegal MAC address alarms. This setup enhances network redundancy, load balancing, and VLAN traffic segregation, ensuring efficient communication and fault tolerance across the network.

[switch1]display this

```
#
sysname switch1
#
vlan batch 10 20 30
#
cluster enable
ntdp enable
```

```
ndp enable
#
drop illegal-mac alarm
#
[switch1-Eth-Trunk1]display this
#
interface Eth-Trunk1
 port link-type trunk
 port trunk allow-pass vlan 10 20 30
 mode lacp-static
#
[switch1-Eth-Trunk2]display this
#
interface Eth-Trunk2
 port link-type trunk
 port trunk allow-pass vlan 10 20
 mode lacp-static
#
[switch1-Eth-Trunk3]display this
#
interface Eth-Trunk3
 port link-type trunk
 port trunk allow-pass vlan 10 30
 mode lacp-static
#
[switch2-Eth-Trunk1]display this
#
interface Eth-Trunk1
 port link-type trunk
 port trunk allow-pass vlan 20 30
 mode lacp-static
[switch2-Eth-Trunk2]display this
#
interface Eth-Trunk2
 port link-type trunk
 port trunk allow-pass vlan 10 20
 mode lacp-static
#
[switch17-Eth-Trunk1]display this
#
interface Eth-Trunk1
 port link-type trunk
 port trunk allow-pass vlan 20 30
 mode lacp-static
#
[switch17-Eth-Trunk3]display this
#
```

interface Eth-Trunk3
 port link-type trunk
 port trunk allow-pass vlan 10 30
 mode lacp-static
#

Sub-System 2:

Topology:
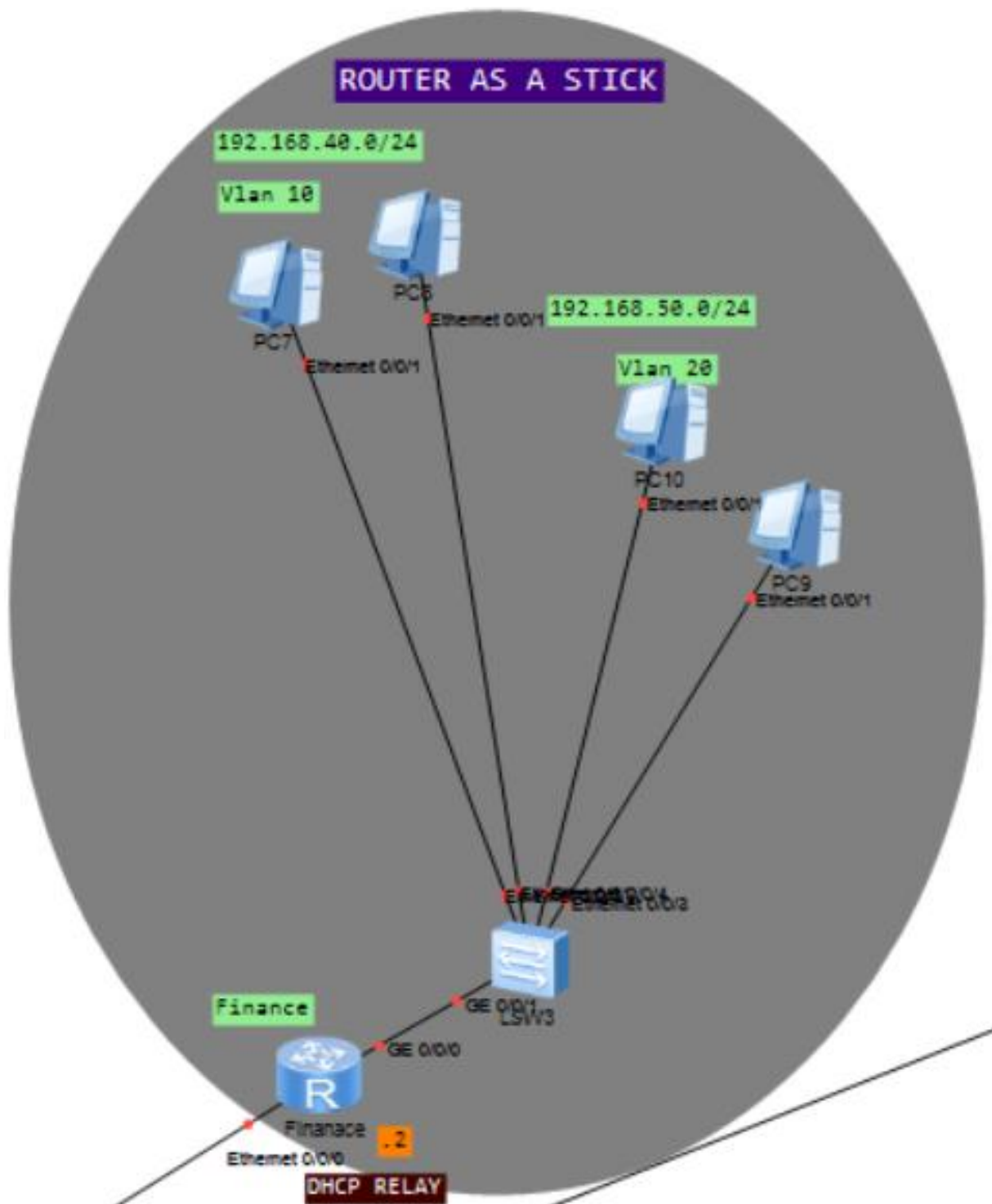
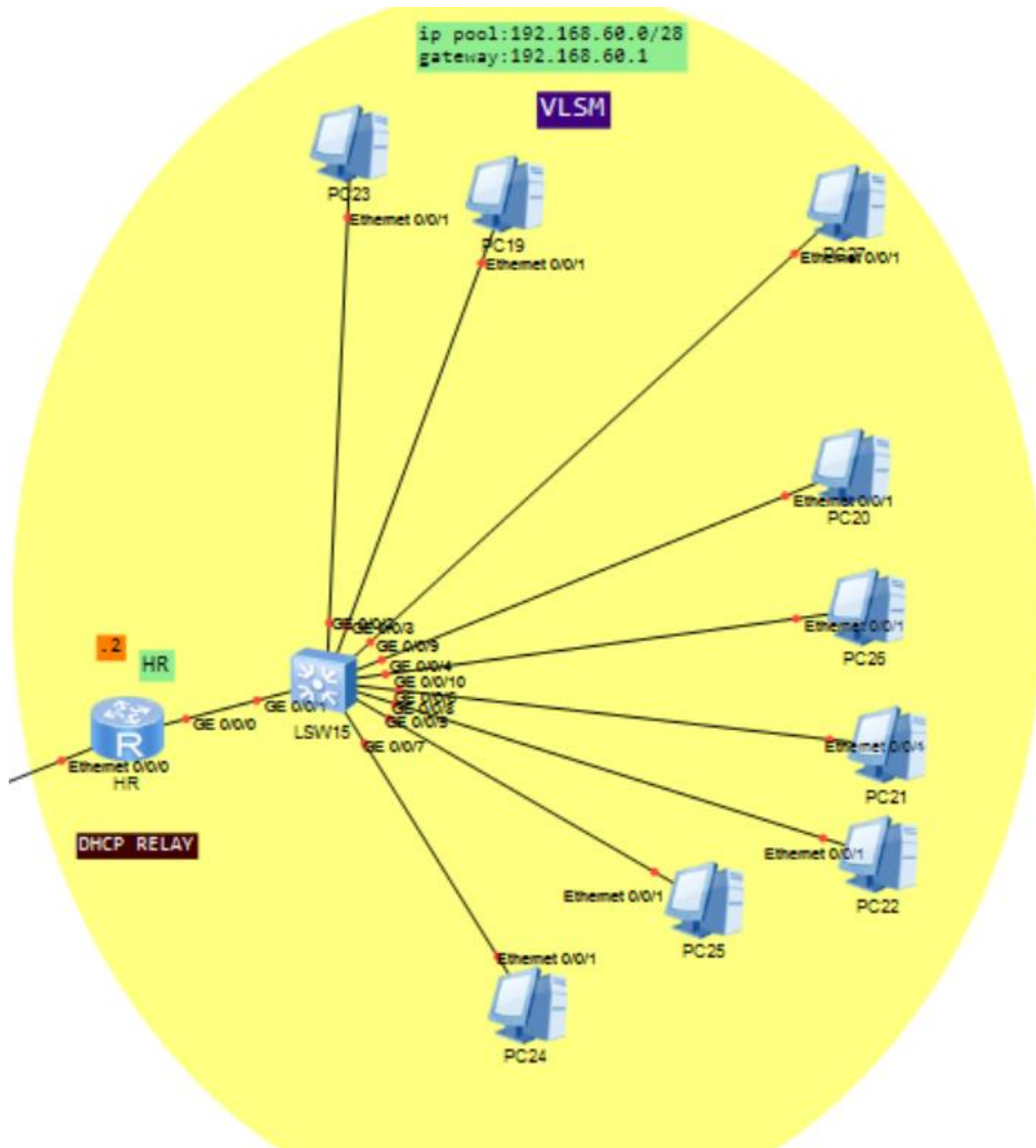# Configurations:

Router in a stick and DHCP Relay:

The Finance router serves as a DHCP relay for VLANs 10 and 20 on switch3. VLANs are configured on switch3 with trunking enabled on GigabitEthernet0/0/1, allowing VLANs 10 and 20. Each VLAN interface on Finance router's GigabitEthernet0/0/0 interface has DHCP relay configured to forward requests to DHCP server at 192.168.4.1. The network setup ensures segmented IP addressing and DHCP service distribution across VLANs 10 and 20, facilitating efficient communication within the Finance department's network.

```
[Finance]display this
#
sysname Finance
#
undo nap slave enable
#
dhcp enable
#
[Finance-Ethernet0/0/0]display this
#
interface Ethernet0/0/0
 ip address 192.168.4.2 255.255.255.0
#
[switch3]display this
#
sysname switch3
#
vlan batch 10 20
#
cluster enable
ntdp enable
ndp enable
#
drop illegal-mac alarm
#
[switch3-Ethernet0/0/1]interface gigabitEthernet 0/0/1
[switch3-GigabitEthernet0/0/1]display this
#
interface GigabitEthernet0/0/1
 port link-type trunk
 port trunk allow-pass vlan 10 20
#
[Finance-GigabitEthernet0/0/0.10]display this
#
interface GigabitEthernet0/0/0.10
 dot1q termination vid 10
 ip address 192.168.40.1 255.255.255.0
 dhcp select relay
 dhcp relay server-ip 192.168.4.1
#
[Finance-GigabitEthernet0/0/0.20]display this
#
interface GigabitEthernet0/0/0.20
```

dot1q termination vid 20
ip address 192.168.50.1 255.255.255.0
dhcp select relay
dhcp relay server-ip 192.168.4.1
#

Sub-System 3:

Topology:
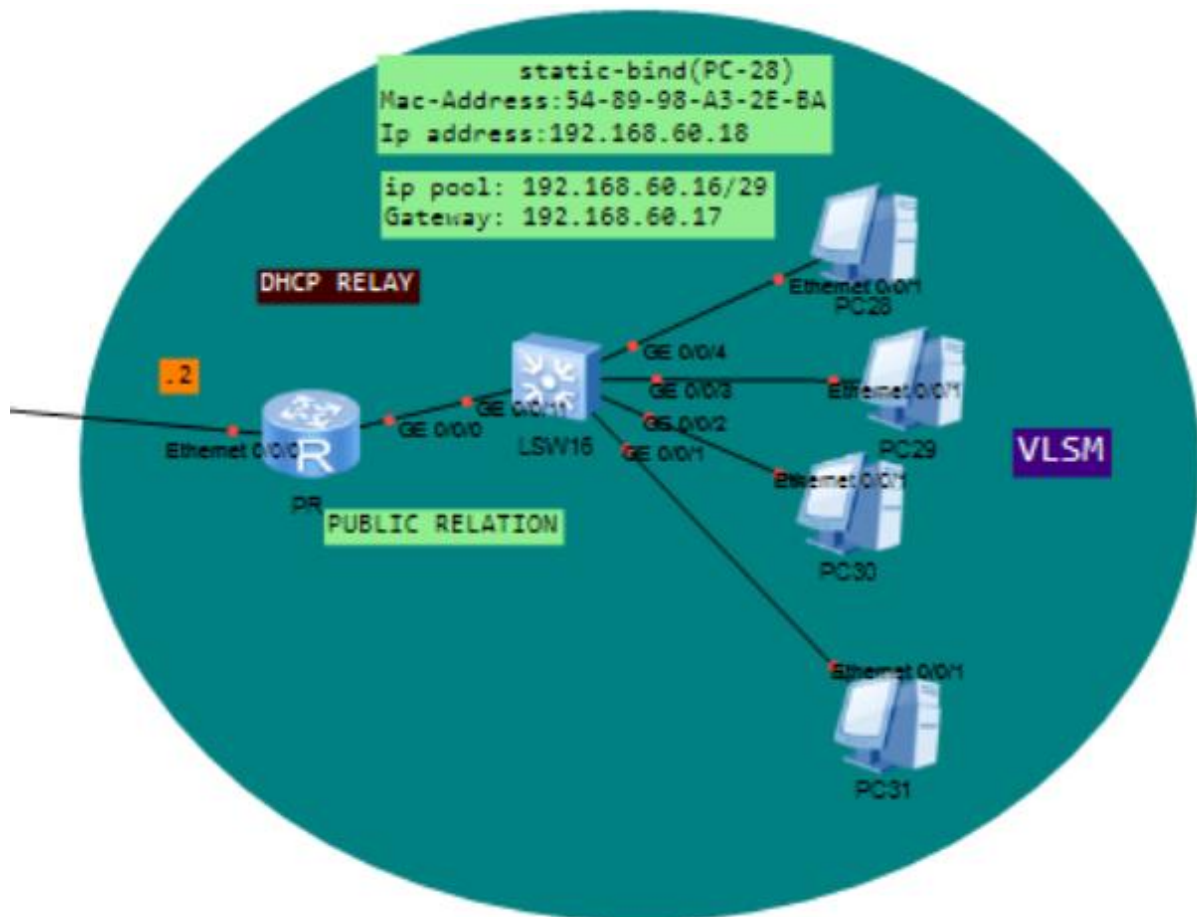
Configurations:

VLSM and DHCP Relay:

Both routers are configured with DHCP relay for GigabitEthernet0/0/0 interfaces to forward DHCP requests to servers at 192.168.5.1 (HR) and 192.168.6.1 (PR). Each router runs RIP version 2 to advertise routes for local networks (192.168.5.0/24, 192.168.60.0/28 for HR and 192.168.6.0/24, 192.168.60.0/29 for PR). The HR router has an additional Ethernet interface configured with IP address 192.168.5.2/24, while the PR router has an Ethernet interface with IP address 192.168.6.2/24. Both routers have disabled NAP slave functionality. These configurations support dynamic routing and DHCP relay operations within their respective networks.

```
[HR]display this
#
sysname HR
#
undo nap slave enable
#
dhcp enable
#
[HR-Ethernet0/0/0]display this
#
interface Ethernet0/0/0
 ip address 192.168.5.2 255.255.255.0
#
[HR-GigabitEthernet0/0/0]display this
#
interface GigabitEthernet0/0/0
 ip address 192.168.60.1 255.255.255.240
```

```
 dhcp select relay
 dhcp relay server-ip 192.168.5.1
#
[HR-rip-1]display this
#
rip 1
 version 2
 network 192.168.5.0
 network 192.168.60.0
#
[PR]display this
#
sysname PR
#
undo nap slave enable
#
dhcp enable
#
[PR-Ethernet0/0/0]display this
#
interface Ethernet0/0/0
 ip address 192.168.6.2 255.255.255.0
#
[PR-GigabitEthernet0/0/0]display this
#
interface GigabitEthernet0/0/0
 ip address 192.168.60.17 255.255.255.248
 dhcp select relay
 dhcp relay server-ip 192.168.6.1
#
[PR-rip-1]display this
#
rip 1
 version 2
 network 192.168.6.0
 network 192.168.60.0
#
```

SUB-SYSTEM 4:
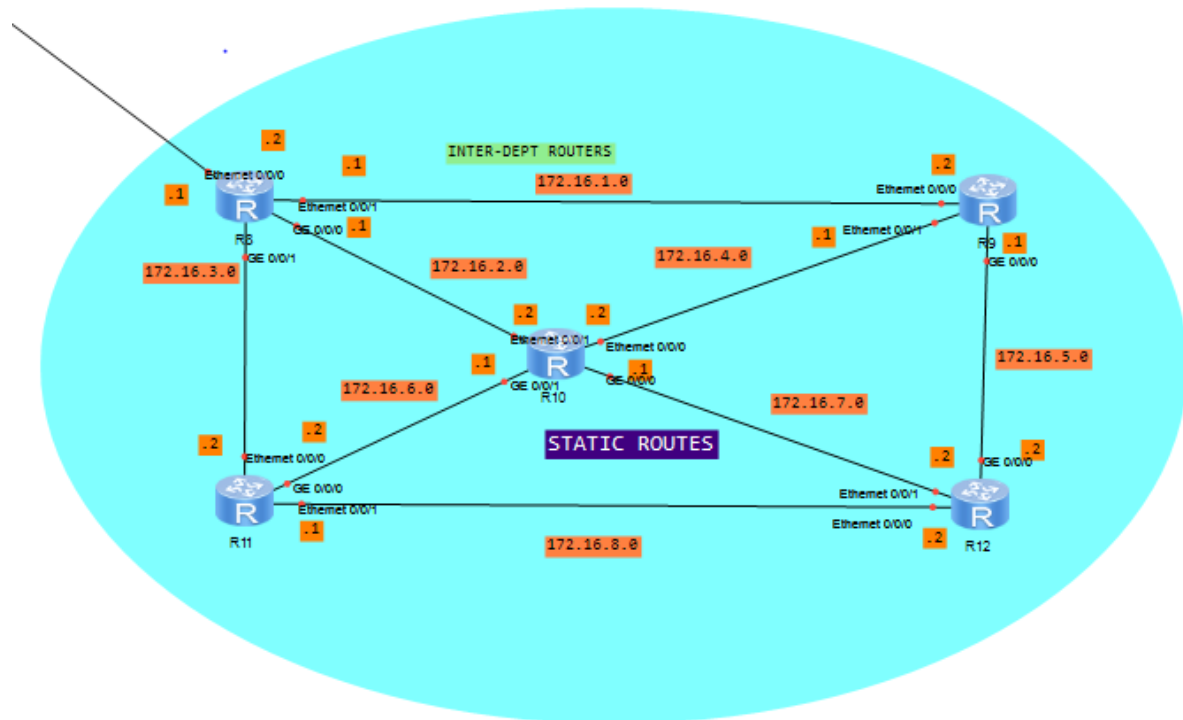
Configurations:

Static Routing:

Router R8

- **System Name**: R8
- **NAP Slave**: Disabled
- **Static Routes**:
  - 172.16.5.0/24 via 172.16.1.2
  - 172.16.7.0/24 via 172.16.2.2
  - 172.16.8.0/24 via 172.16.3.2
- **RIP Version 2**:
  - Networks: 192.168.7.0, 172.16.0.0

Router R9

- **System Name**: R9
- **NAP Slave**: Disabled
- **Static Routes**:
  - 172.16.3.0/24 via 172.16.1.1
  - 172.16.4.0/24 via 172.16.6.0
  - 172.16.5.0/24 via 172.16.8.0
  - 172.16.6.0/24 via 172.16.4.2
  - 172.16.7.0/24 via 172.16.2.2
  - 172.16.8.0/24 via 172.16.5.2
- **RIP**:
  - Networks: 172.16.0.0, 192.168.7.0

Router R10

- **System Name**: R10
- **NAP Slave**: Disabled

- **Static Routes**:
  - 172.16.1.0/24 via 172.16.2.1
  - 172.16.3.0/24 via 172.16.2.1
  - 172.16.5.0/24 via 172.16.7.2
  - 172.16.8.0/24 via 172.16.7.2
- **RIP**:
  - Network: 172.16.0.0

Router R11

- **System Name**: R11
- **NAP Slave**: Disabled
- **Static Routes**:
  - 172.16.1.0/24 via 172.16.3.1
  - 172.16.4.0/24 via 172.16.6.1
  - 172.16.5.0/24 via 172.16.8.2
- **RIP**:
  - Network: 172.16.0.0

Router R12

- **System Name**: R12
- **NAP Slave**: Disabled
- **Static Routes**:
  - 172.16.1.0/24 via 172.16.5.1
  - 172.16.2.0/24 via 172.16.7.1
  - 172.16.3.0/24 via 172.16.8.1
  - 172.16.4.0/24 via 172.16.7.1
  - 172.16.6.0/24 via 172.16.7.1
- **RIP**:
  - Network: 172.16.0.0

```
[R8]display this
#
sysname R8
#
undo nap slave enable
#
ip route-static 172.16.5.0 255.255.255.0 172.16.1.2
ip route-static 172.16.7.0 255.255.255.0 172.16.2.2
ip route-static 172.16.8.0 255.255.255.0 172.16.3.2
#
[R8-rip-1]display this
#
rip 1
 version 2
 network 192.168.7.0
 network 172.16.0.0
#
[R9]display this
#
sysname R9
#
undo nap slave enable
#
ip route-static 172.16.3.0 255.255.255.0 172.16.1.1
ip route-static 172.16.4.0 255.255.255.0 172.16.6.0
```

```
ip route-static 172.16.5.0 255.255.255.0 172.16.8.0
ip route-static 172.16.6.0 255.255.255.0 172.16.4.2
ip route-static 172.16.7.0 255.255.255.0 172.16.2.2
ip route-static 172.16.8.0 255.255.255.0 172.16.5.2
#
[R9]rip
[R9-rip-1]display this
#
rip 1
 network 172.16.0.0
 network 192.168.7.0
#
[R10]display this
#
sysname R10
#
undo nap slave enable
#
ip route-static 172.16.1.0 255.255.255.0 172.16.2.1
ip route-static 172.16.3.0 255.255.255.0 172.16.2.1
ip route-static 172.16.5.0 255.255.255.0 172.16.7.2
ip route-static 172.16.8.0 255.255.255.0 172.16.7.2
#
[R10]rip
[R10-rip-1]display this
#
rip 1
 network 172.16.0.0
#
[R11]display this
#
sysname R11
#
undo nap slave enable
#
ip route-static 172.16.1.0 255.255.255.0 172.16.3.1
ip route-static 172.16.4.0 255.255.255.0 172.16.6.1
ip route-static 172.16.5.0 255.255.255.0 172.16.8.2
#
[R11-rip-1]display this
#
rip 1
 network 172.16.0.0
#
[R12]display this
#
sysname R12
#
undo nap slave enable
#
ip route-static 172.16.1.0 255.255.255.0 172.16.5.1
ip route-static 172.16.2.0 255.255.255.0 172.16.7.1
```

```
ip route-static 172.16.3.0 255.255.255.0 172.16.8.1
ip route-static 172.16.4.0 255.255.255.0 172.16.7.1
ip route-static 172.16.6.0 255.255.255.0 172.16.7.1
#
[R12-rip-1]display this
#
rip 1
 network 172.16.0.0
#
```

SUB-SYSTEM 5:
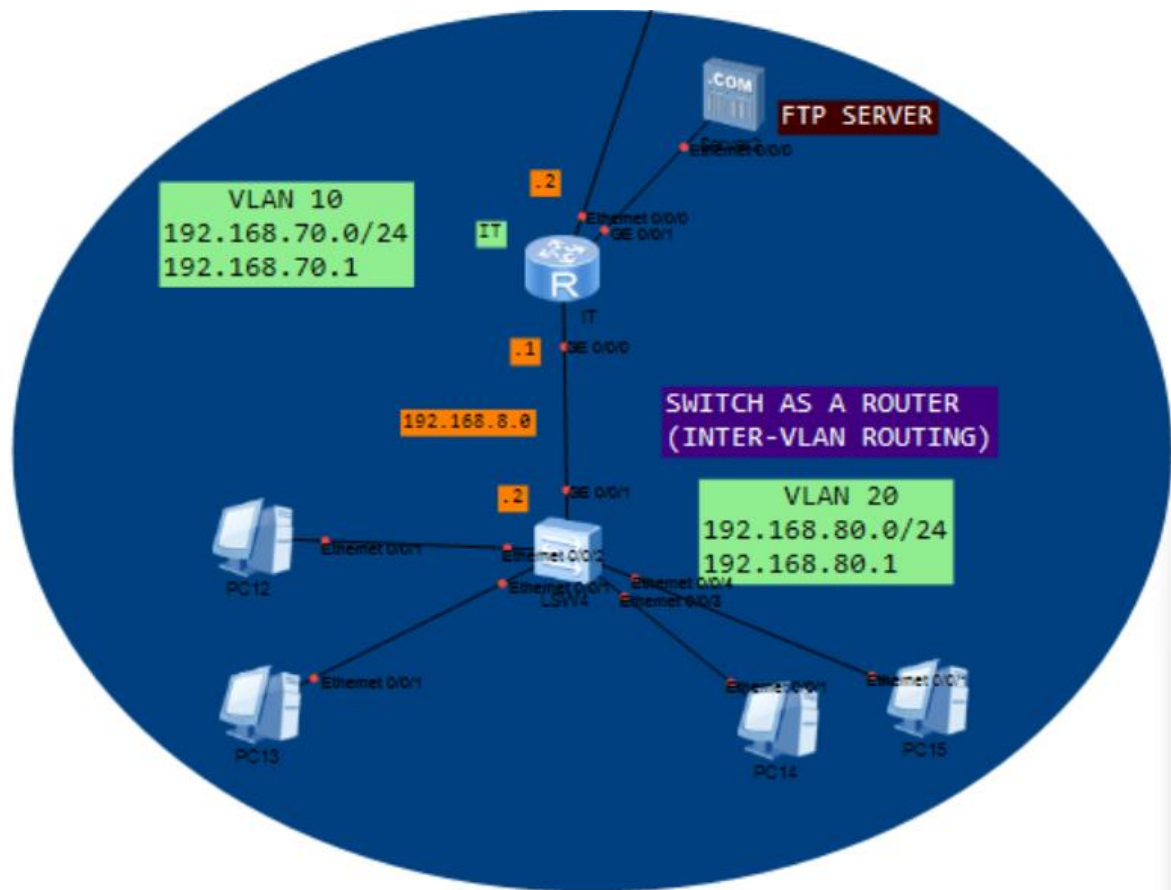
Configurations:

FTP server and Switch As A Router:

The IT router manages multiple networks with RIP for dynamic routing. It has interfaces configured with specific IP addresses (192.168.8.1 and 192.168.200.1) to facilitate connectivity within the network. LSW4 switch supports VLANs 10 and 20 with respective VLAN interfaces (Vlanif10 and Vlanif20) configured with IP addresses (192.168.70.1 and 192.168.80.1). This setup ensures network segmentation, efficient routing, and management capabilities across different segments of the IT department's network infrastructure.

```
[IT]display this
#
sysname IT
```

```
#
[IT-GigabitEthernet0/0/1]display this
#
interface GigabitEthernet0/0/1
 ip address 192.168.200.1 255.255.255.0
#
[IT-GigabitEthernet0/0/0]display this
#
interface GigabitEthernet0/0/0
 ip address 192.168.8.1 255.255.255.0
#
[IT-GigabitEthernet0/0/0]rip
[IT-rip-1]display this
#
rip 1
 version 2
 network 192.168.1.0
 network 192.168.8.0
 network 192.168.70.0
 network 192.168.80.0
#
[LSW4]display this
#
sysname LSW4
#
vlan batch 10 20
#
cluster enable
ntdp enable
ndp enable
#
drop illegal-mac alarm
#
[LSW4-Vlanif10]display this
#
interface Vlanif10
 ip address 192.168.70.1 255.255.255.0
#
[LSW4-Vlanif20]display this
#
interface Vlanif20
 ip address 192.168.80.1 255.255.255.0
#
```

```
[LSW4]display vlan
The total number of vlans is : 3
aZ123
U: Up;            D: Down;           TG: Tagged;          UT: Untagged;
MP: Vlan-mapping;                    ST: Vlan-stacking;
#: ProtocolTransparent-vlan;         *: Management-vlan;


VID  Type    Ports

1    common  UT:Eth0/0/5(D)      Eth0/0/6(D)       Eth0/0/7(D)       Eth0/0/8(D)
                Eth0/0/9(D)      Eth0/0/10(D)      Eth0/0/11(D)      Eth0/0/12(D)
                Eth0/0/13(D)     Eth0/0/14(D)      Eth0/0/15(D)      Eth0/0/16(D)
                Eth0/0/17(D)     Eth0/0/18(D)      Eth0/0/19(D)      Eth0/0/20(D)
                Eth0/0/21(D)     Eth0/0/22(D)      GE0/0/1(U)        GE0/0/2(D)

10   common  UT:Eth0/0/1(U)      Eth0/0/2(U)

             TG:GE0/0/1(U)

20   common  UT:Eth0/0/3(U)      Eth0/0/4(U)

             TG:GE0/0/1(U)
```
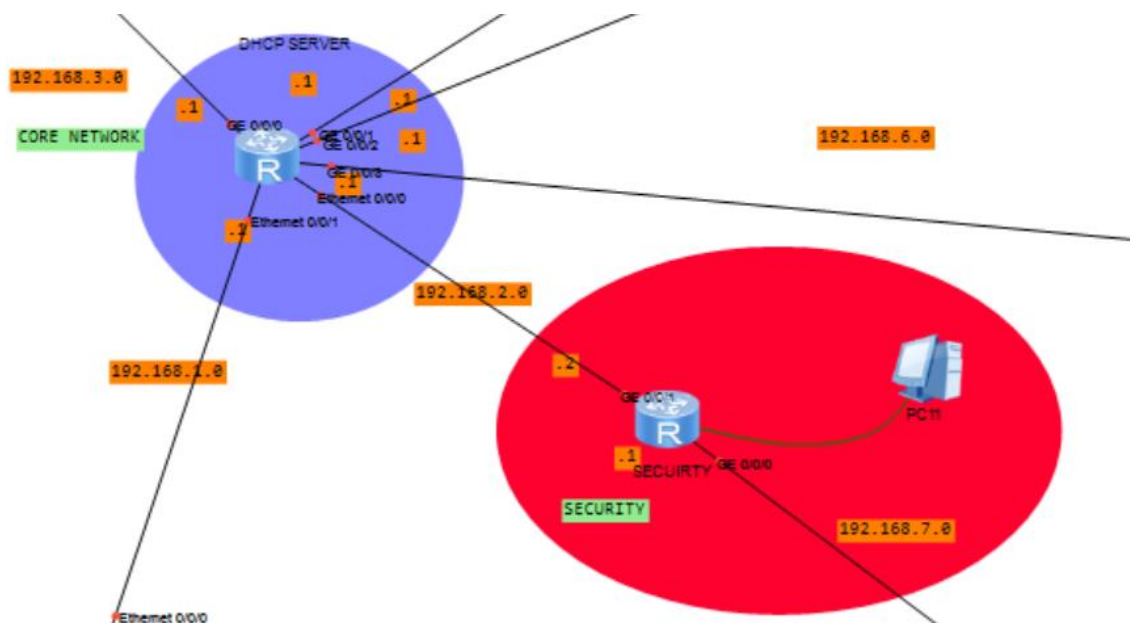
SUB-SYSTEM 6:

Configuration:
DHCP server and AR Router:

DHCP Server Configuration

- **RIP Version 2**: Configured for networks 192.168.1.0 to 192.168.6.0.
- **IP Pools**:
    - **Pool 1**: Network 192.168.60.0/28, gateway 192.168.60.1, DNS 8.8.8.8.
    - **Pool 2**: Network 192.168.60.16/29, gateway 192.168.60.17, DNS 8.8.8.8, static binding for IP 192.168.60.18 to MAC 5489-98a3-2eba.
    - **Pool 3**: Network 192.168.40.0/24, gateway 192.168.40.1, DNS 8.8.8.8.
    - **Pool 4**: Network 192.168.50.0/24, gateway 192.168.50.1, DNS 8.8.8.8.

Security Device Configuration

- **RIP Version 2**: Configured for networks 192.168.2.0 and 192.168.7.0.
- **ACL (Access Control List)**:
    - ACL 3000:
        - Rule 5: Deny ICMP from 172.16.1.2 to 192.168.2.1.
        - Rule 10: Deny TCP from 172.16.2.2 to 192.168.2.1 on port telnet.
        - Rule 20: Permit all IP traffic.
- **AAA (Authentication, Authorization, and Accounting)**:
    - Default schemes for authentication, authorization, and accounting.
    - Local users:
        - **admin**: HTTP service, encrypted password.
        - **group17**: Telnet service, privilege level 15, encrypted password.
- **User Interfaces**:
    - Console (con 0): Password authentication.
    - VTY (Virtual Terminal) 0-4: AAA authentication, privilege level 15.
    - VTY 16-20: Default settings.

```
[DHCP-SERVER-rip-1]display this
#
rip 1
 version 2
 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
#
[DHCP-SERVER-ip-pool-1]display this
#
ip pool 1
 gateway-list 192.168.60.1
 network 192.168.60.0 mask 255.255.255.240
 dns-list 8.8.8.8
#
[DHCP-SERVER-ip-pool-2]display this
#
ip pool 2
 gateway-list 192.168.60.17
 network 192.168.60.16 mask 255.255.255.248
 static-bind ip-address 192.168.60.18 mac-address 5489-98a3-2eba
 dns-list 8.8.8.8
#
[DHCP-SERVER-ip-pool-3]display this
#
ip pool 3
 gateway-list 192.168.40.1
 network 192.168.40.0 mask 255.255.255.0
 dns-list 8.8.8.8
```

```
#
[DHCP-SERVER-ip-pool-4]display this
#
ip pool 4
 gateway-list 192.168.50.1
 network 192.168.50.0 mask 255.255.255.0
 dns-list 8.8.8.8
#
[Secuirty-rip-1]display this
[V200R003C00]
#
rip 1
 version 2
 network 192.168.2.0
 network 192.168.7.0
#
[Secuirty-acl-adv-3000]display this
[V200R003C00]
#
acl number 3000
 rule 5 deny icmp source 172.16.1.2 0 destination 192.168.2.1 0
 rule 10 deny tcp source 172.16.2.2 0 destination 192.168.2.1 0 destination-port
 eq telnet
 rule 20 permit ip
#
[Secuirty-aaa]display this
[V200R003C00]
#
aaa
 authentication-scheme default
 authorization-scheme default
 accounting-scheme default
 domain default
 domain default_admin
 local-user admin password cipher %$%$K8m.Nt84DZ}e#<0`8bmE3Uw}%$%$
 local-user admin service-type http
 local-user group17 password cipher %$%$:xv_B}OfcL&P<OAligwIn!,b%$%$
 local-user group17 privilege level 15
 local-user group17 service-type telnet
#
[Secuirty-ui-vty0-4]display this
[V200R003C00]
#
user-interface con 0
 authentication-mode password
 set authentication password cipher %$%$Gm.B:mkCj6:br$P5{p'R,.[>:5va'YH$*Zah8p5|
{Z+3.[A,%$%$
user-interface vty 0 4
 authentication-mode aaa
 user privilege level 15
user-interface vty 16 20
#
```