Advanced Routing & Switching

Course work, Network Systems

(Group Project)

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Module Lecture: Mr. Chamindra Attanayake

Batch: 22.2

Module Code: CN301.3

1. Introduction

1.1 Overview of the Project

This project involves designing a modern, secure, scalable, and flexible network infrastructure for a supermarket chain that operates across multiple provinces. The supermarket is currently undergoing a digital transformation to better serve its customers and efficiently manage its operations through enhanced ICT systems. The network design must accommodate three types of outlets—Small, Standard, and Mega—each with different technical and service requirements.

The network infrastructure should:

Support future upgrades or downgrades of outlets without major reconfiguration.

Ensure centralized control via the head office in Paliyagoda.

Enable efficient communication, data sharing, surveillance, and system management.

Be implemented using routing and switching concepts from the course.

Include software-defined WAN (SDWAN) and private cloud infrastructure for central services.

1.2 Objective

The objective of this group project is to:

Design a complete enterprise-level network architecture for the supermarket chain.

Develop a detailed IP addressing and segmentation plan for all outlets and head office systems.

Use best practices in routing, switching, firewall deployment, and wireless configuration.

Demonstrate the design using Cisco Packet Tracer simulations.

Ensure the network supports all required features such as VoIP, CCTV, PoE, public Wi-Fi, digital signage, etc.

Present a solution that allows smooth expansion or downgrading of outlets based on customer demand.

2. Assumption

- **Firewall Limitation in Packet Tracer:**

Each branch is assumed to have two firewalls for redundancy and enhanced security. However, due to limitations in Cisco Packet Tracer, we are only able to implement a single firewall in the simulation.

- **Power over Ethernet (PoE) Usage:**

All IP cameras and IP phones are assumed to be connected using PoE (Power over Ethernet) cables. This allows both power and data transmission over a single Ethernet cable, simplifying installation and reducing infrastructure costs.

- **VPN Tunnel for SD-WAN Implementation:**

Although SD-WAN is part of the real-world network design, Packet Tracer does not support full SD-WAN configuration. Therefore, we simulate SD-WAN functionality by assuming the use of VPN tunnels for secure communication between branches and the head office.

3. Segmentation Requirements

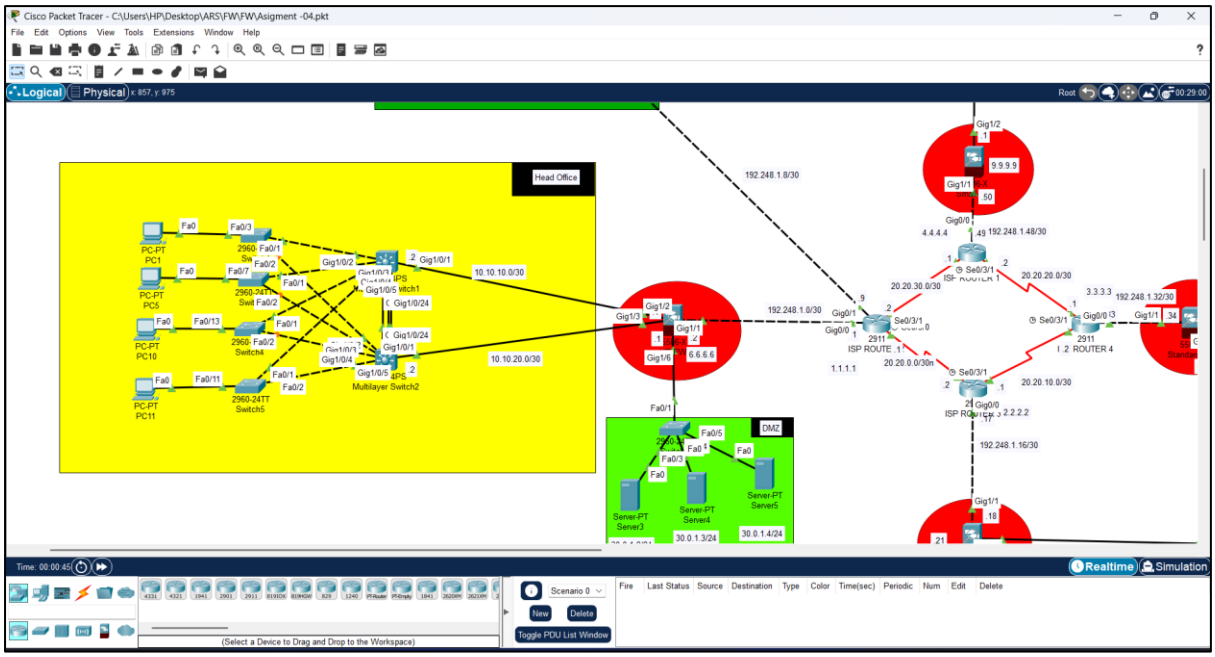
Define network segmentation using VLANs:

- **VLANs by Service**:
    - VLAN 10 - Management
    - VLAN 20 - POS
    - VLAN 30 - CCTV
    - VLAN 40 - VoIP
    - VLAN 50 - Staff Wi-Fi
    - VLAN 60 - Customer Wi-Fi
    - VLAN 70 - Digital Ads
    - VLAN 80 - ATM/Banking
    - VLAN 90 - Delivery

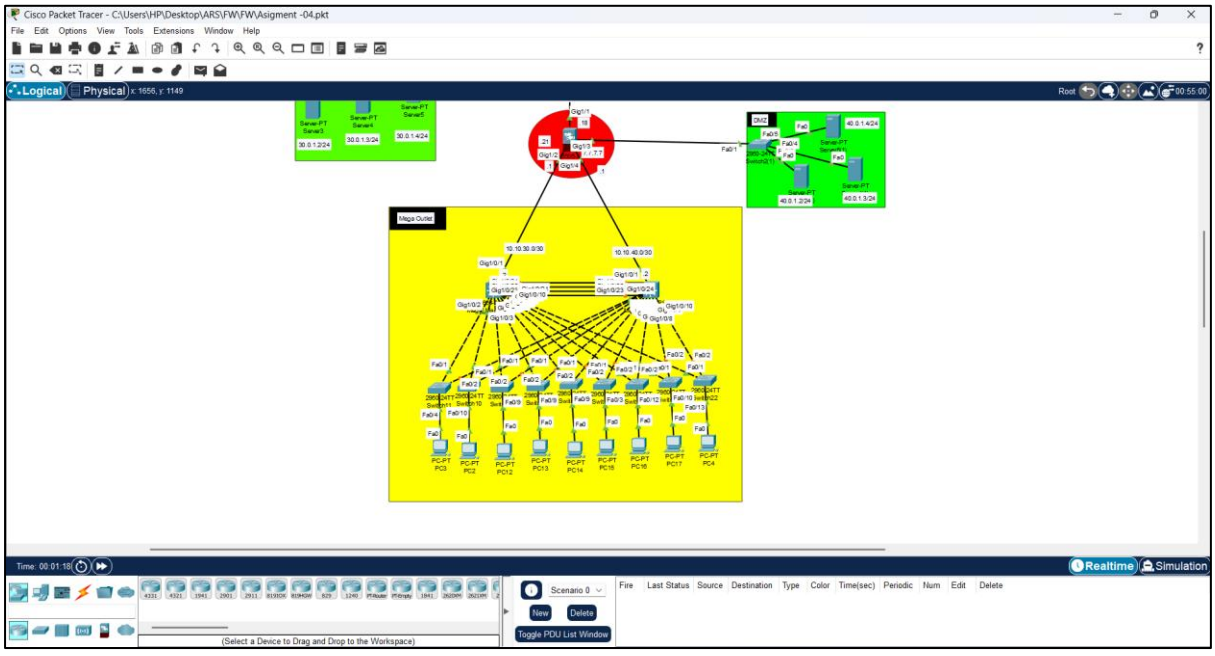
4. Network Design Overview

Diagrams for:

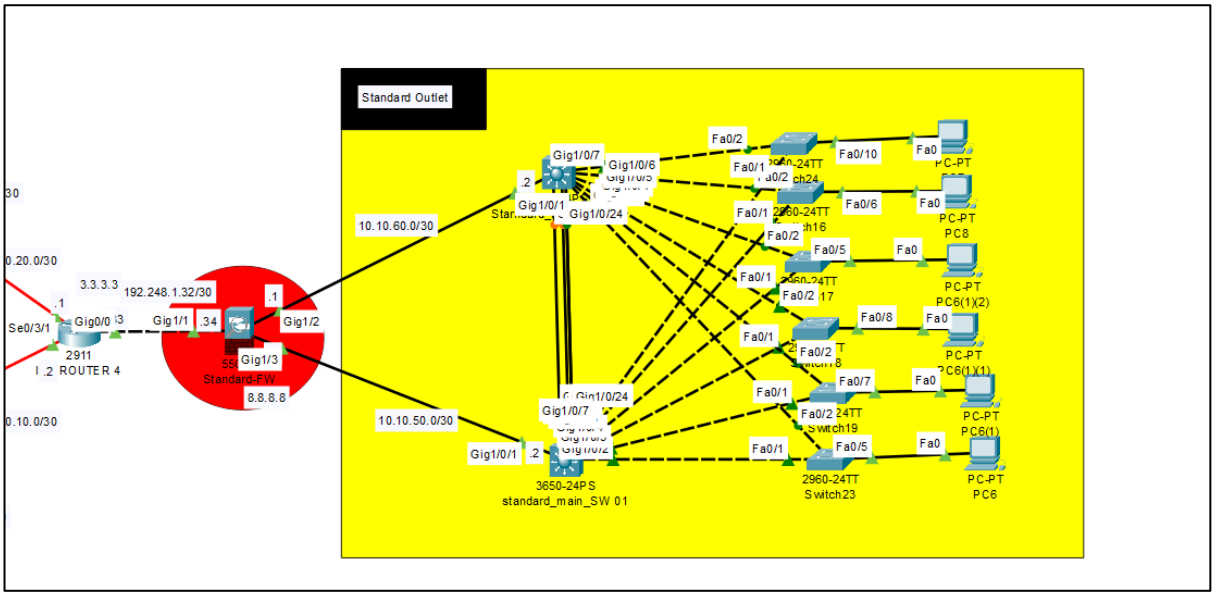
- Head Office (Private Cloud with SD-WAN)



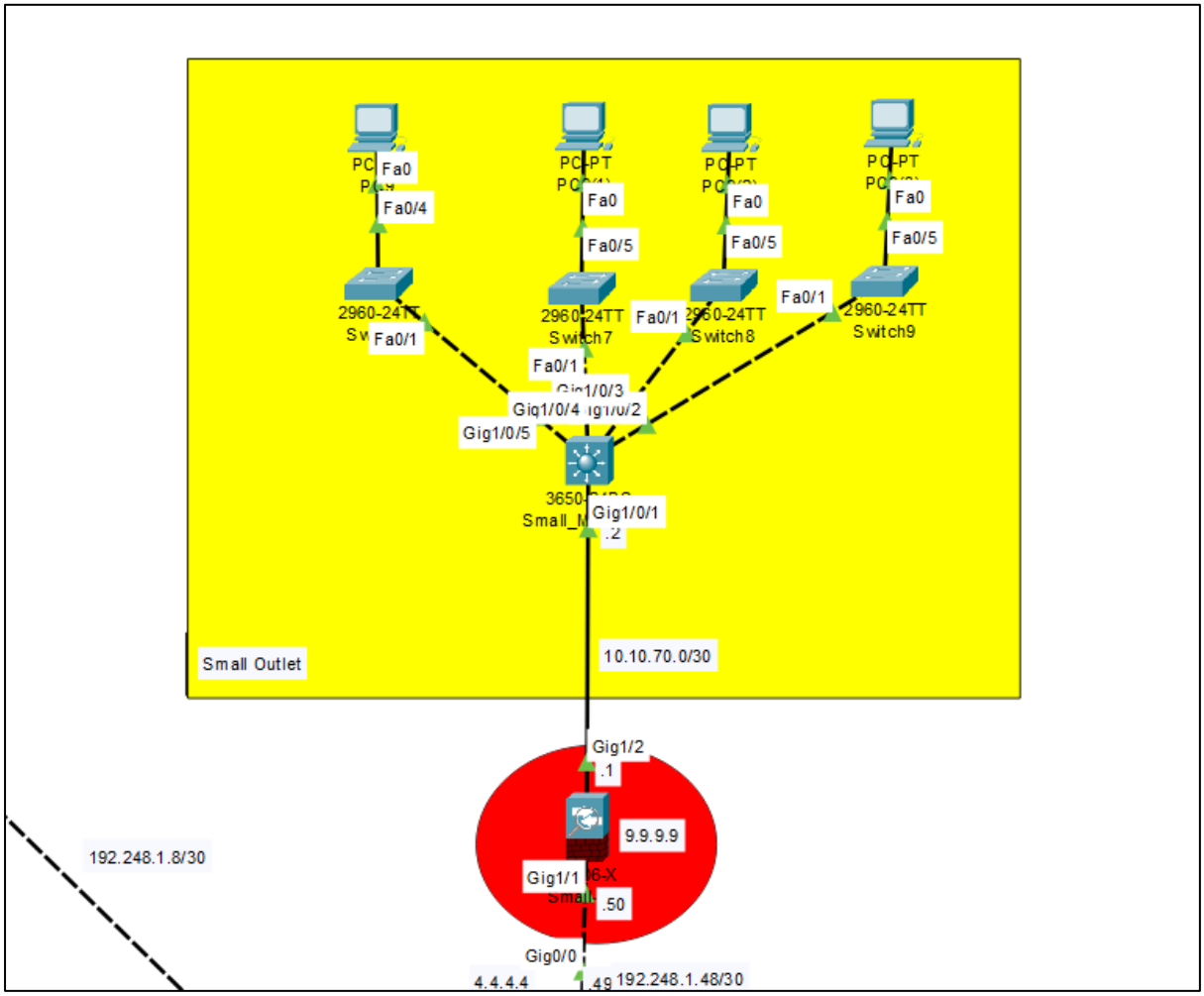
- Mega Outlet



- Standard Outlet



- Small Outlet



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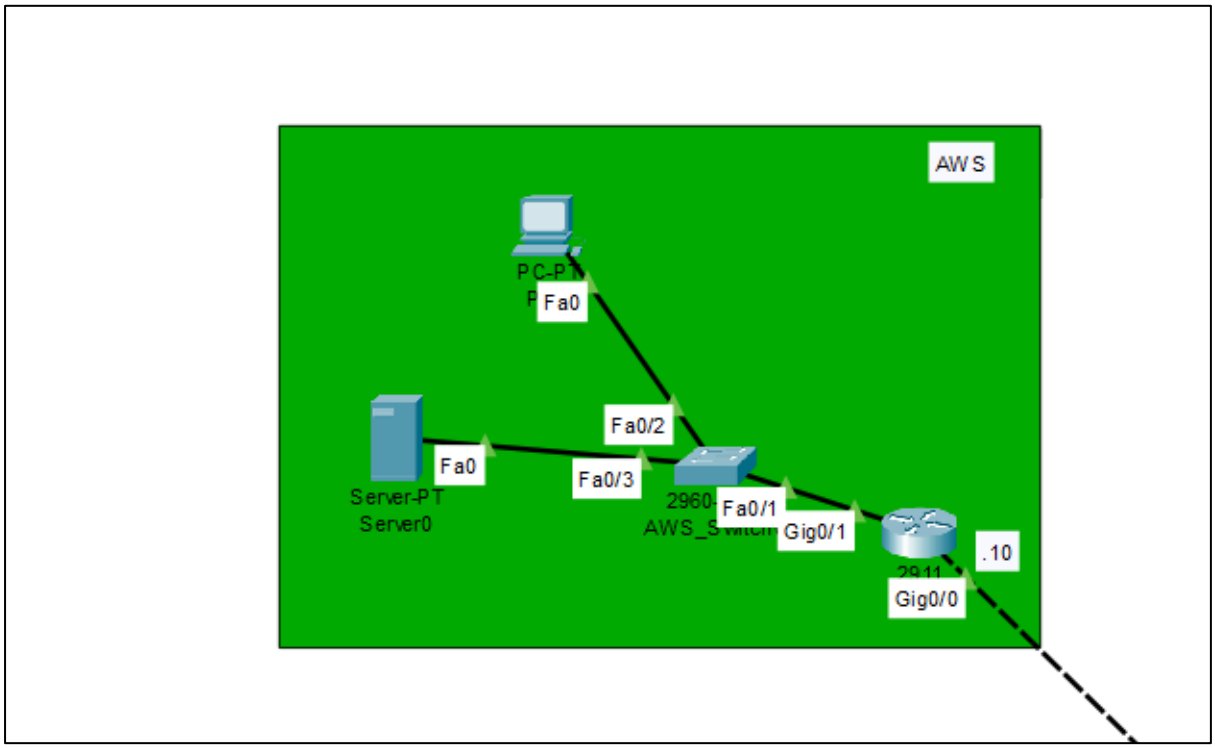


5. IP Addressing Plan

Head Office

Department/VLAN	Subnet	Gateway IP	Usage
Management VLAN	10.0.0.0/24	10.0.0.1	Admin, NOC
POS VLAN	10.0.1.0/24	10.0.1.1	Sales systems
CCTV VLAN	10.0.2.0/24	10.0.2.1	Security cameras (NVR)
VoIP VLAN	10.0.3.0/24	10.0.3.1	Phones, SIP systems
Staff Wi-Fi VLAN	10.0.4.0/24	10.0.4.1	Internal staff devices
Customer Wi-Fi VLAN	10.0.5.0/24	10.0.5.1	Guest network
Digital Ads VLAN	10.0.6.0/24	10.0.6.1	LCD panels, clocks
Delivery/Order VLAN	10.0.7.0/24	10.0.7.1	Logistics, tracking

Mega Outlet

VLAN Name	Subnet	Gateway IP
Management	10.1.0.0/24	10.1.0.1
POS	10.1.1.0/24	10.1.1.1
CCTV	10.1.2.0/24	10.1.2.1
VoIP	10.1.3.0/24	10.1.3.1
Staff Wi-Fi	10.1.4.0/24	10.1.4.1
Customer Wi-Fi	10.1.5.0/24	10.1.5.1
Digital Ads	10.1.6.0/24	10.1.6.1
ATM/Banking	10.1.7.0/24	10.1.7.1
Delivery	10.1.8.0/24	10.1.8.1

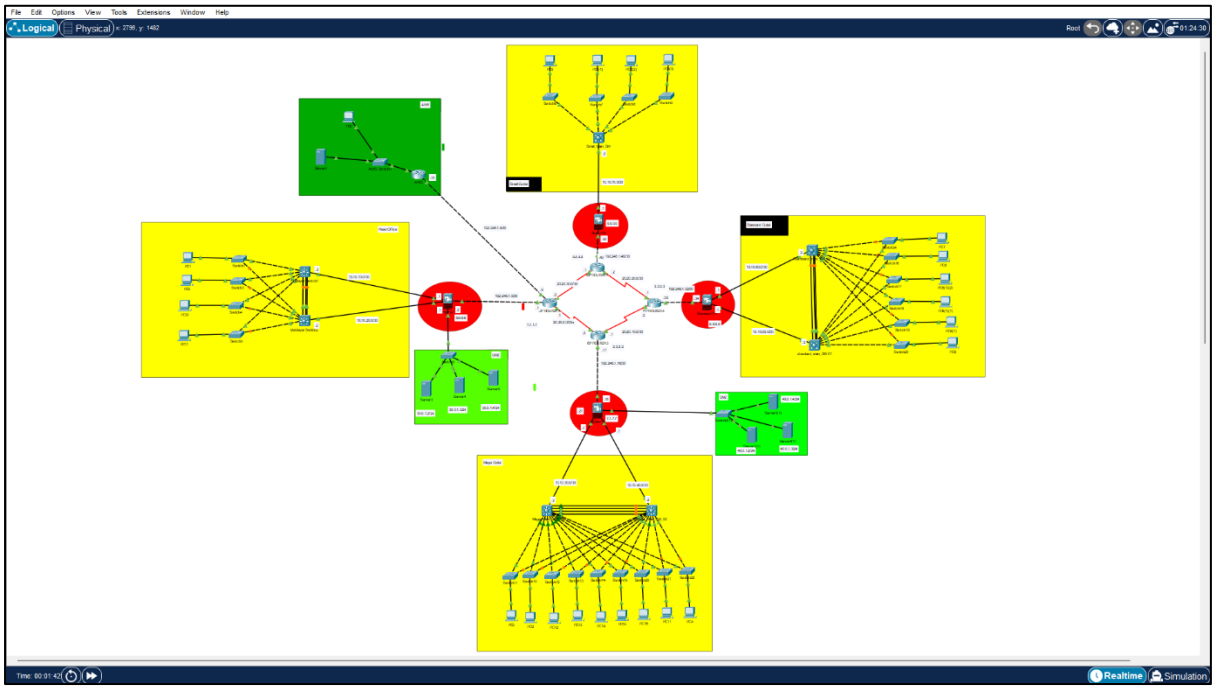
Standard Outlet

VLAN Name	Subnet	Gateway IP
Management	10.2.0.0/24	10.2.0.1
POS	10.2.1.0/24	10.2.1.1
CCTV	10.2.2.0/24	10.2.2.1
VoIP	10.2.3.0/24	10.2.3.1
Staff Wi-Fi	10.2.4.0/24	10.2.4.1
Customer Wi-Fi	10.2.5.0/24	10.2.5.1
Digital Ads	10.2.6.0/24	10.2.6.1
ATM/Banking	10.2.7.0/24	10.2.7.1
Delivery	10.2.8.0/24	10.2.8.1

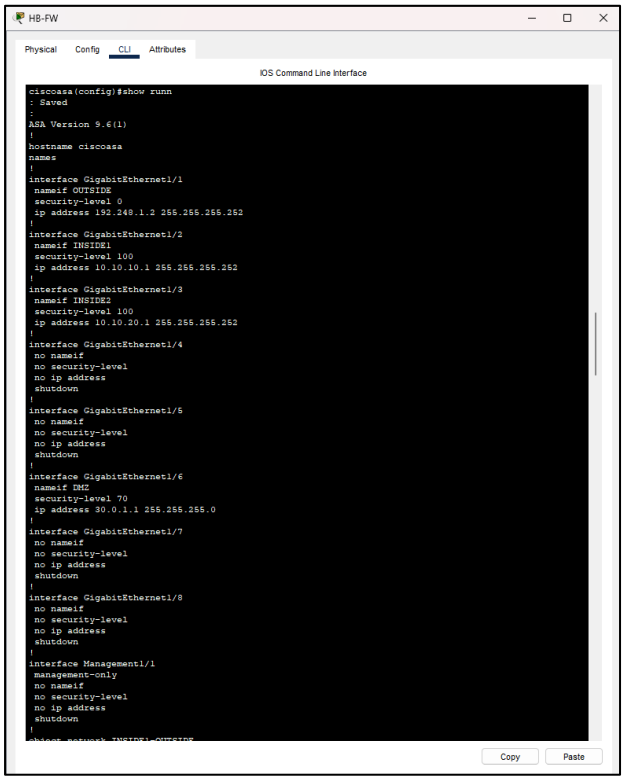
Small Outlet

VLAN Name	Subnet	Gateway IP
Management	10.3.0.0/26	10.3.0.1
POS	10.3.0.64/26	10.3.0.65
CCTV	10.3.1.0/26	10.3.1.1
VoIP	10.3.1.64/26	10.3.1.65
Staff Wi-Fi	10.3.2.0/26	10.3.2.1

6. Architectural Design



7. Packet Tracer Implementation



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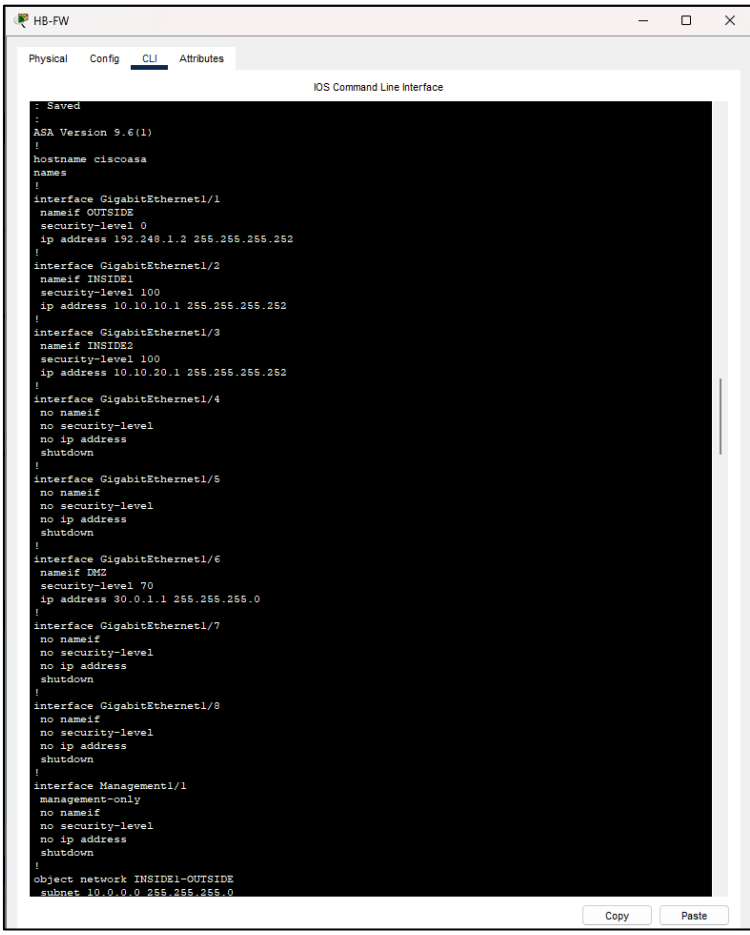

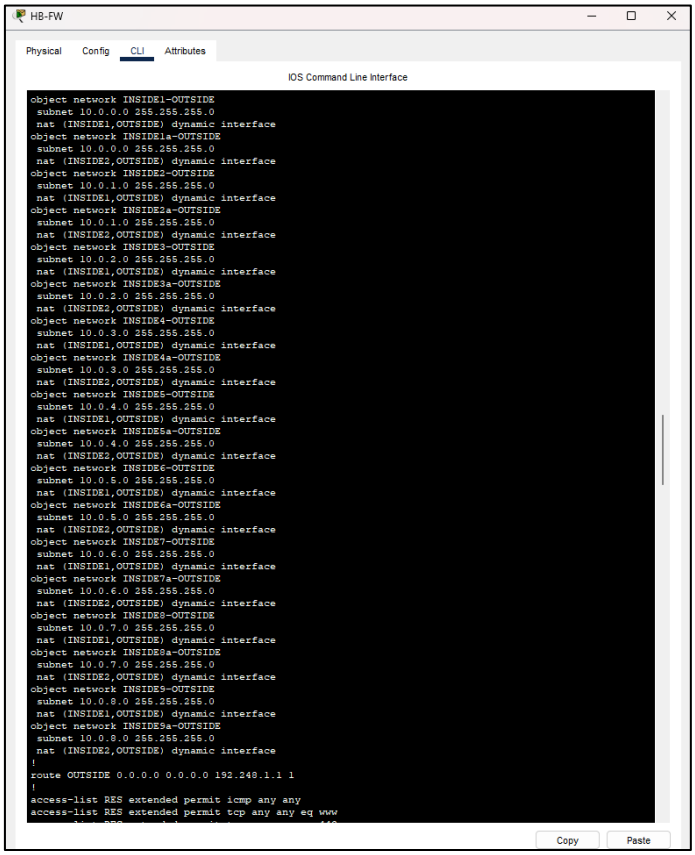
HB-FW
Physical
Config
CLI
Attributes
IOS Command Line Interface
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subnet 10.0.0.0 255.255.255.0
nat (INSIDE1,OUTSIDE) dynamic interface
object network INSIDE1a-OUTSIDE
subnet 10.0.0.0 255.255.255.0
nat (INSIDE2,OUTSIDE) dynamic interface
object network INSIDE2-OUTSIDE
subnet 10.0.1.0 255.255.255.0
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object network INSIDE2a-OUTSIDE
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access-list RES extended permit tcp any any eq www
Copy
Paste

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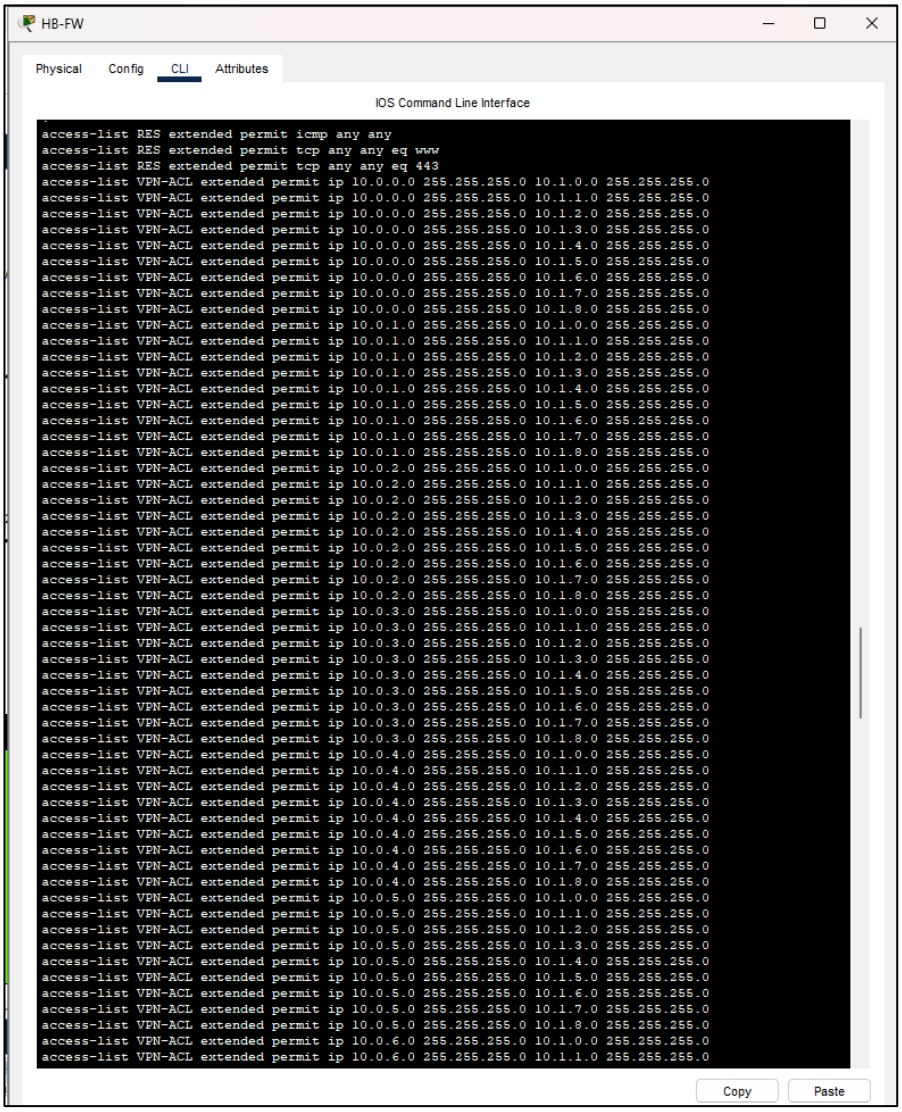
HB-FW
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IOS Command Line Interface
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HB-FW

Physical Config CLI Attributes

IOS Command Line Interface

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access-list VPN-ACL extended permit ip 10.0.2.0 255.255.255.0 10.2.3.0 255.255.255.0
access-list VPN-ACL extended permit ip 10.0.2.0 255.255.255.0 10.2.4.0 255.255.255.0
access-list VPN-ACL extended permit ip 10.0.2.0 255.255.255.0 10.2.5.0 255.255.255.0
access-list VPN-ACL extended permit ip 10.0.2.0 255.255.255.0 10.2.6.0 255.255.255.0
access-list VPN-ACL extended permit ip 10.0.2.0 255.255.255.0 10.2.7.0 255.255.255.0
access-list VPN-ACL extended permit ip 10.0.2.0 255.255.255.0 10.2.8.0 255.255.255.0
access-list VPN-ACL extended permit ip 10.0.3.0 255.255.255.0 10.2.0.0 255.255.255.0
access-list VPN-ACL extended permit ip 10.0.3.0 255.255.255.0 10.2.1.0 255.255.255.0
access-list VPN-ACL extended permit ip 10.0.3.0 255.255.255.0 10.2.2.0 255.255.255.0
access-list VPN-ACL extended permit ip 10.0.3.0 255.255.255.0 10.2.3.0 255.255.255.0
access-list VPN-ACL extended permit ip 10.0.3.0 255.255.255.0 10.2.4.0 255.255.255.0
```

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Physical Config CLI Attributes

IOS Command Line Interface

```
access-list VPN-ACL extended permit ip 10.0.3.0 255.255.255.0 10.2.1.0 255.255.255.0
access-list VPN-ACL extended permit ip 10.0.3.0 255.255.255.0 10.2.2.0 255.255.255.0
access-list VPN-ACL extended permit ip 10.0.3.0 255.255.255.0 10.2.3.0 255.255.255.0
access-list VPN-ACL extended permit ip 10.0.3.0 255.255.255.0 10.2.4.0 255.255.255.0
access-list VPN-ACL extended permit ip 10.0.3.0 255.255.255.0 10.2.5.0 255.255.255.0
access-list VPN-ACL extended permit ip 10.0.3.0 255.255.255.0 10.2.6.0 255.255.255.0
access-list VPN-ACL extended permit ip 10.0.3.0 255.255.255.0 10.2.7.0 255.255.255.0
access-list VPN-ACL extended permit ip 10.0.3.0 255.255.255.0 10.2.8.0 255.255.255.0
access-list VPN-ACL extended permit ip 10.0.4.0 255.255.255.0 10.2.0.0 255.255.255.0
access-list VPN-ACL extended permit ip 10.0.4.0 255.255.255.0 10.2.1.0 255.255.255.0
access-list VPN-ACL extended permit ip 10.0.4.0 255.255.255.0 10.2.2.0 255.255.255.0
access-list VPN-ACL extended permit ip 10.0.4.0 255.255.255.0 10.2.3.0 255.255.255.0
access-list VPN-ACL extended permit ip 10.0.4.0 255.255.255.0 10.2.4.0 255.255.255.0
access-list VPN-ACL extended permit ip 10.0.4.0 255.255.255.0 10.2.5.0 255.255.255.0
access-list VPN-ACL extended permit ip 10.0.4.0 255.255.255.0 10.2.6.0 255.255.255.0
access-list VPN-ACL extended permit ip 10.0.4.0 255.255.255.0 10.2.7.0 255.255.255.0
access-list VPN-ACL extended permit ip 10.0.4.0 255.255.255.0 10.2.8.0 255.255.255.0
access-list VPN-ACL extended permit ip 10.0.5.0 255.255.255.0 10.2.0.0 255.255.255.0
access-list VPN-ACL extended permit ip 10.0.5.0 255.255.255.0 10.2.1.0 255.255.255.0
access-list VPN-ACL extended permit ip 10.0.5.0 255.255.255.0 10.2.2.0 255.255.255.0
access-list VPN-ACL extended permit ip 10.0.5.0 255.255.255.0 10.2.3.0 255.255.255.0
access-list VPN-ACL extended permit ip 10.0.5.0 255.255.255.0 10.2.4.0 255.255.255.0
access-list VPN-ACL extended permit ip 10.0.5.0 255.255.255.0 10.2.5.0 255.255.255.0
access-list VPN-ACL extended permit ip 10.0.5.0 255.255.255.0 10.2.6.0 255.255.255.0
access-list VPN-ACL extended permit ip 10.0.5.0 255.255.255.0 10.2.7.0 255.255.255.0
access-list VPN-ACL extended permit ip 10.0.5.0 255.255.255.0 10.2.8.0 255.255.255.0
access-list VPN-ACL extended permit ip 10.0.6.0 255.255.255.0 10.2.0.0 255.255.255.0
access-list VPN-ACL extended permit ip 10.0.6.0 255.255.255.0 10.2.1.0 255.255.255.0
access-list VPN-ACL extended permit ip 10.0.6.0 255.255.255.0 10.2.2.0 255.255.255.0
access-list VPN-ACL extended permit ip 10.0.6.0 255.255.255.0 10.2.3.0 255.255.255.0
access-list VPN-ACL extended permit ip 10.0.6.0 255.255.255.0 10.2.4.0 255.255.255.0
access-list VPN-ACL extended permit ip 10.0.6.0 255.255.255.0 10.2.5.0 255.255.255.0
access-list VPN-ACL extended permit ip 10.0.6.0 255.255.255.0 10.2.6.0 255.255.255.0
access-list VPN-ACL extended permit ip 10.0.6.0 255.255.255.0 10.2.7.0 255.255.255.0
access-list VPN-ACL extended permit ip 10.0.6.0 255.255.255.0 10.2.8.0 255.255.255.0
access-list VPN-ACL extended permit ip 10.0.7.0 255.255.255.0 10.2.0.0 255.255.255.0
access-list VPN-ACL extended permit ip 10.0.7.0 255.255.255.0 10.2.1.0 255.255.255.0
access-list VPN-ACL extended permit ip 10.0.7.0 255.255.255.0 10.2.2.0 255.255.255.0
access-list VPN-ACL extended permit ip 10.0.7.0 255.255.255.0 10.2.3.0 255.255.255.0
access-list VPN-ACL extended permit ip 10.0.7.0 255.255.255.0 10.2.4.0 255.255.255.0
access-list VPN-ACL extended permit ip 10.0.7.0 255.255.255.0 10.2.5.0 255.255.255.0
access-list VPN-ACL extended permit ip 10.0.7.0 255.255.255.0 10.2.6.0 255.255.255.0
access-list VPN-ACL extended permit ip 10.0.7.0 255.255.255.0 10.2.7.0 255.255.255.0
access-list VPN-ACL extended permit ip 10.0.7.0 255.255.255.0 10.2.8.0 255.255.255.0
access-list VPN-ACL extended permit ip 10.0.8.0 255.255.255.0 10.2.0.0 255.255.255.0
access-list VPN-ACL extended permit ip 10.0.8.0 255.255.255.0 10.2.1.0 255.255.255.0
access-list VPN-ACL extended permit ip 10.0.8.0 255.255.255.0 10.2.2.0 255.255.255.0
access-list VPN-ACL extended permit ip 10.0.8.0 255.255.255.0 10.2.3.0 255.255.255.0
access-list VPN-ACL extended permit ip 10.0.8.0 255.255.255.0 10.2.4.0 255.255.255.0
access-list VPN-ACL extended permit ip 10.0.8.0 255.255.255.0 10.2.5.0 255.255.255.0
access-list VPN-ACL extended permit ip 10.0.8.0 255.255.255.0 10.2.6.0 255.255.255.0
access-list VPN-ACL extended permit ip 10.0.8.0 255.255.255.0 10.2.7.0 255.255.255.0
access-list VPN-ACL extended permit ip 10.0.8.0 255.255.255.0 10.2.8.0 255.255.255.0
access-list VPN-ACL extended permit ip 10.0.0.0 255.255.255.0 10.3.0.0 255.255.255.192
access-list VPN-ACL extended permit ip 10.0.0.0 255.255.255.0 10.3.0.64 255.255.255.192
access-list VPN-ACL extended permit ip 10.0.0.0 255.255.255.0 10.3.1.0 255.255.255.192
access-list VPN-ACL extended permit ip 10.0.0.0 255.255.255.0 10.3.1.64 255.255.255.192
access-list VPN-ACL extended permit ip 10.0.0.0 255.255.255.0 10.3.2.0 255.255.255.192
access-list VPN-ACL extended permit ip 10.0.1.0 255.255.255.0 10.3.0.0 255.255.255.192
access-list VPN-ACL extended permit ip 10.0.1.0 255.255.255.0 10.3.0.64 255.255.255.192
```

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Physical Config CLI Attributes

IOS Command Line Interface

```
access-list VPN-ACL extended permit ip 10.0.0.0 255.255.255.0 10.3.0.64 255.255.255.192
access-list VPN-ACL extended permit ip 10.0.0.0 255.255.255.0 10.3.1.0 255.255.255.192
access-list VPN-ACL extended permit ip 10.0.0.0 255.255.255.0 10.3.1.64 255.255.255.192
access-list VPN-ACL extended permit ip 10.0.0.0 255.255.255.0 10.3.2.0 255.255.255.192
access-list VPN-ACL extended permit ip 10.0.1.0 255.255.255.0 10.3.0.0 255.255.255.192
access-list VPN-ACL extended permit ip 10.0.1.0 255.255.255.0 10.3.0.64 255.255.255.192
access-list VPN-ACL extended permit ip 10.0.1.0 255.255.255.0 10.3.1.0 255.255.255.192
access-list VPN-ACL extended permit ip 10.0.1.0 255.255.255.0 10.3.1.64 255.255.255.192
access-list VPN-ACL extended permit ip 10.0.1.0 255.255.255.0 10.3.2.0 255.255.255.192
access-list VPN-ACL extended permit ip 10.0.2.0 255.255.255.0 10.3.0.0 255.255.255.192
access-list VPN-ACL extended permit ip 10.0.2.0 255.255.255.0 10.3.0.64 255.255.255.192
access-list VPN-ACL extended permit ip 10.0.2.0 255.255.255.0 10.3.1.0 255.255.255.192
access-list VPN-ACL extended permit ip 10.0.2.0 255.255.255.0 10.3.1.64 255.255.255.192
access-list VPN-ACL extended permit ip 10.0.2.0 255.255.255.0 10.3.2.0 255.255.255.192
access-list VPN-ACL extended permit ip 10.0.3.0 255.255.255.0 10.3.0.0 255.255.255.192
access-list VPN-ACL extended permit ip 10.0.3.0 255.255.255.0 10.3.0.64 255.255.255.192
access-list VPN-ACL extended permit ip 10.0.3.0 255.255.255.0 10.3.1.0 255.255.255.192
access-list VPN-ACL extended permit ip 10.0.3.0 255.255.255.0 10.3.1.64 255.255.255.192
access-list VPN-ACL extended permit ip 10.0.3.0 255.255.255.0 10.3.2.0 255.255.255.192
access-list VPN-ACL extended permit ip 10.0.4.0 255.255.255.0 10.3.0.0 255.255.255.192
access-list VPN-ACL extended permit ip 10.0.4.0 255.255.255.0 10.3.0.64 255.255.255.192
access-list VPN-ACL extended permit ip 10.0.4.0 255.255.255.0 10.3.1.0 255.255.255.192
access-list VPN-ACL extended permit ip 10.0.4.0 255.255.255.0 10.3.1.64 255.255.255.192
access-list VPN-ACL extended permit ip 10.0.4.0 255.255.255.0 10.3.2.0 255.255.255.192
access-list VPN-ACL extended permit ip 10.0.5.0 255.255.255.0 10.3.0.0 255.255.255.192
access-list VPN-ACL extended permit ip 10.0.5.0 255.255.255.0 10.3.0.64 255.255.255.192
access-list VPN-ACL extended permit ip 10.0.5.0 255.255.255.0 10.3.1.0 255.255.255.192
access-list VPN-ACL extended permit ip 10.0.5.0 255.255.255.0 10.3.1.64 255.255.255.192
access-list VPN-ACL extended permit ip 10.0.5.0 255.255.255.0 10.3.2.0 255.255.255.192
access-list VPN-ACL extended permit ip 10.0.6.0 255.255.255.0 10.3.0.0 255.255.255.192
access-list VPN-ACL extended permit ip 10.0.6.0 255.255.255.0 10.3.0.64 255.255.255.192
access-list VPN-ACL extended permit ip 10.0.6.0 255.255.255.0 10.3.1.0 255.255.255.192
access-list VPN-ACL extended permit ip 10.0.6.0 255.255.255.0 10.3.1.64 255.255.255.192
access-list VPN-ACL extended permit ip 10.0.6.0 255.255.255.0 10.3.2.0 255.255.255.192
access-list VPN-ACL extended permit ip 10.0.7.0 255.255.255.0 10.3.0.0 255.255.255.192
access-list VPN-ACL extended permit ip 10.0.7.0 255.255.255.0 10.3.0.64 255.255.255.192
access-list VPN-ACL extended permit ip 10.0.7.0 255.255.255.0 10.3.1.0 255.255.255.192
access-list VPN-ACL extended permit ip 10.0.7.0 255.255.255.0 10.3.1.64 255.255.255.192
access-list VPN-ACL extended permit ip 10.0.7.0 255.255.255.0 10.3.2.0 255.255.255.192
access-list VPN-ACL extended permit ip 10.0.8.0 255.255.255.0 10.3.0.0 255.255.255.192
access-list VPN-ACL extended permit ip 10.0.8.0 255.255.255.0 10.3.0.64 255.255.255.192
access-list VPN-ACL extended permit ip 10.0.8.0 255.255.255.0 10.3.1.0 255.255.255.192
access-list VPN-ACL extended permit ip 10.0.8.0 255.255.255.0 10.3.1.64 255.255.255.192
access-list VPN-ACL extended permit ip 10.0.8.0 255.255.255.0 10.3.2.0 255.255.255.192
!
!
access-group RES in interface OUTSIDE
!
!
class-map inspection_default
 match default-inspection-traffic
!
policy-map type inspect dns preset_dns_map
 parameters
  message-length maximum 512
policy-map global_policy
 class inspection_default
  inspect dns preset_dns_map
  inspect ftp
  inspect tftp
```

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Physical Config CLI Attributes

IOS Command Line Interface

```
class-map inspection_default
 match default-inspection-traffic
!
policy-map type inspect dns preset_dns_map
 parameters
  message-length maximum 512
policy-map global_policy
 class inspection_default
  inspect dns preset_dns_map
  inspect ftp
  inspect tftp
!
service-policy global_policy global
!
telnet timeout 5
ssh timeout 5
!
!
crypto ipsec ikev1 transform-set TEST esp-3des esp-sha-hmac
!
crypto map CMAP 10 match address VPN-ACL
crypto map CMAP 10 set peer 192.248.1.18 192.248.1.34 192.248.1.50
crypto map CMAP 10 set ikev1 transform-set TEST
crypto map CMAP interface OUTSIDE
crypto ikev1 enable OUTSIDE
crypto ikev1 policy 10
 encr 3des
 authentication pre-share
 group 2
!
crypto ikev1 policy 11
 encr 3des
 authentication pre-share
 group 2
!
crypto ikev1 policy 12
 encr 3des
 authentication pre-share
 group 2
!
tunnel-group 192.248.1.18 type ipsec-l2l
tunnel-group 192.248.1.18 ipsec-attributes
 ikev1 pre-shared-key cisco
tunnel-group 192.248.1.34 type ipsec-l2l
tunnel-group 192.248.1.34 ipsec-attributes
 ikev1 pre-shared-key cisco
tunnel-group 192.248.1.50 type ipsec-l2l
tunnel-group 192.248.1.50 ipsec-attributes
 ikev1 pre-shared-key cisco
!
router ospf 2
 router-id 6.6.6.6
 log-adjacency-changes
 network 10.10.10.0 255.255.255.252 area 0
 network 10.10.20.0 255.255.255.252 area 0
 network 192.248.1.0 255.255.255.252 area 0
 network 30.0.1.0 255.255.255.0 area 0
!
ciscoasa(config)#
```

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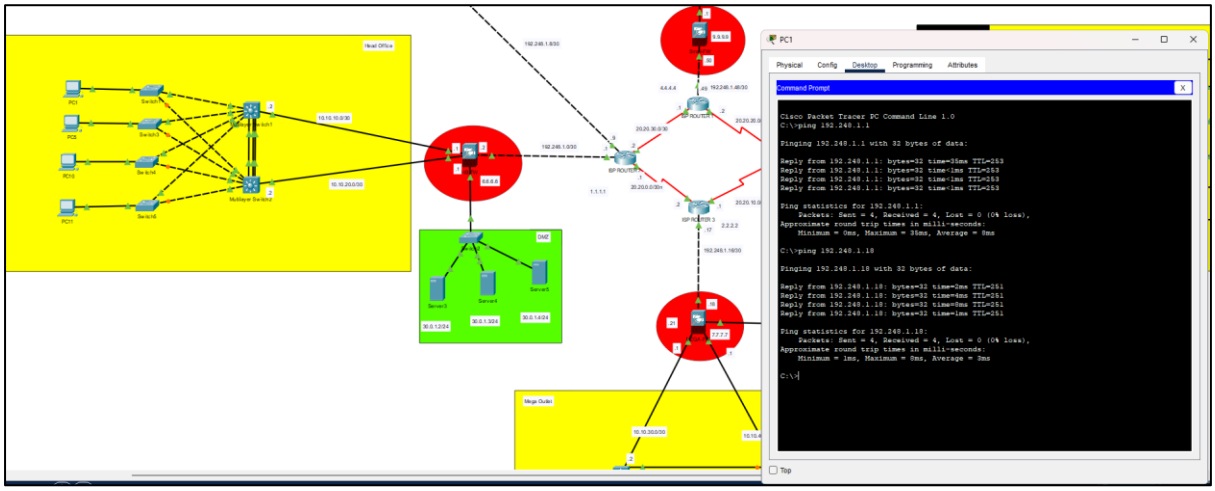
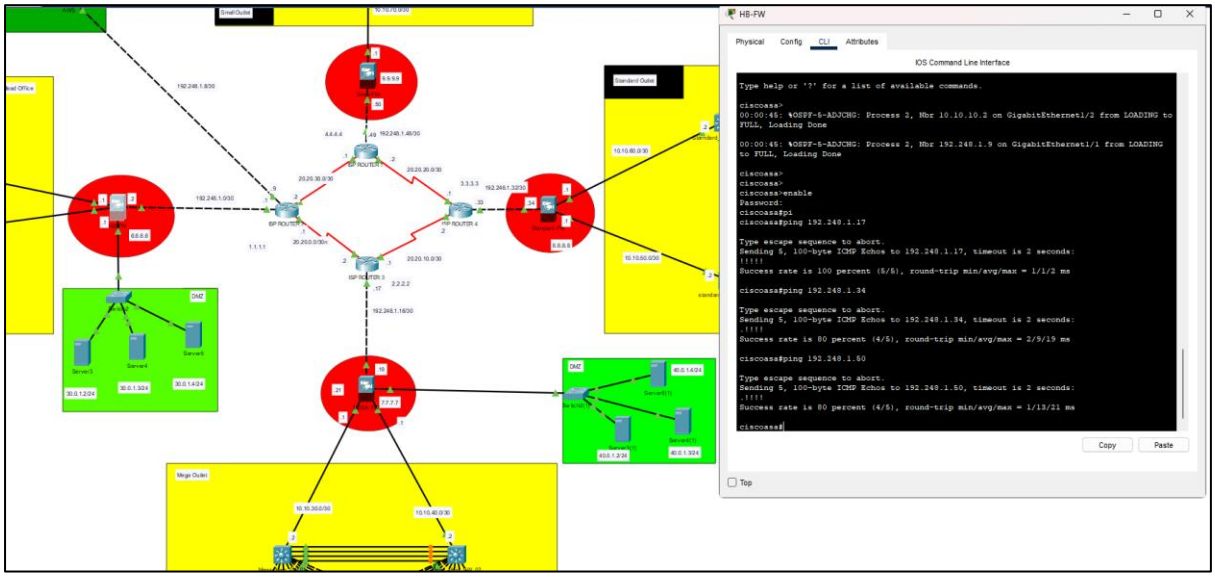
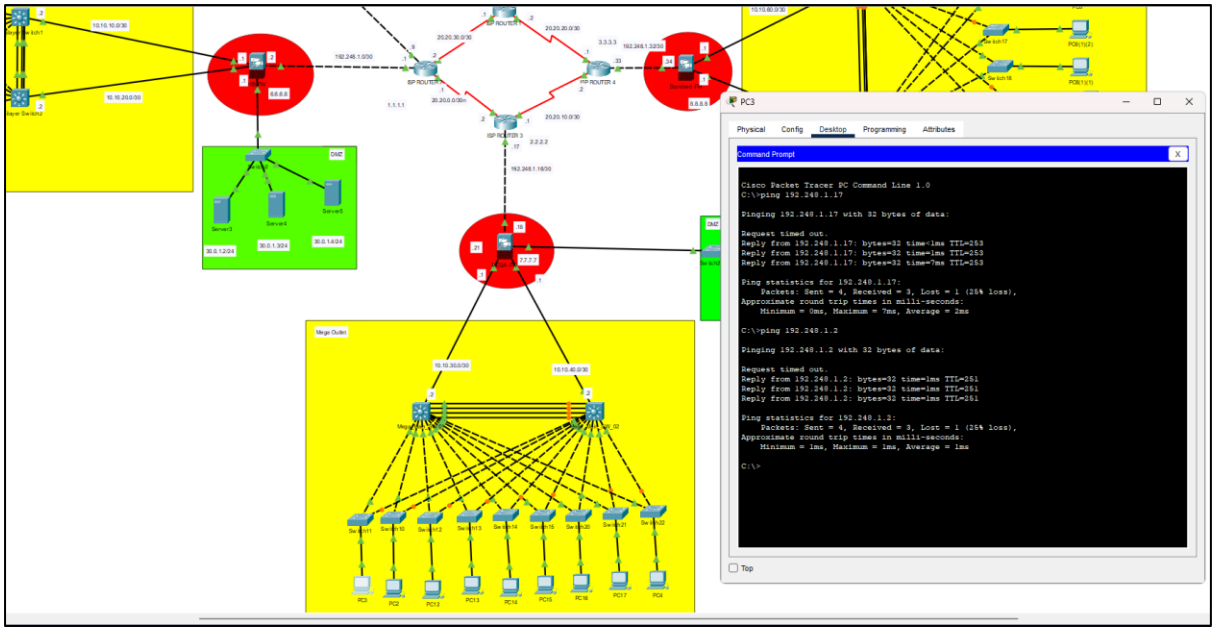
Verification



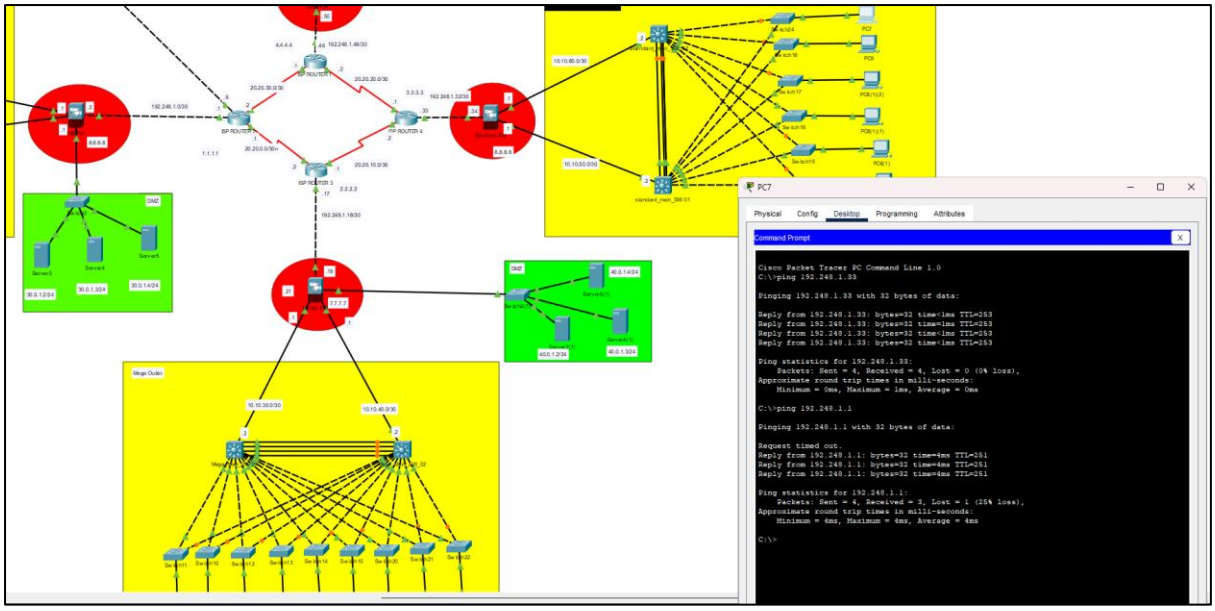
(From Head branch PC to ISP router and Mega branch's Firewall)



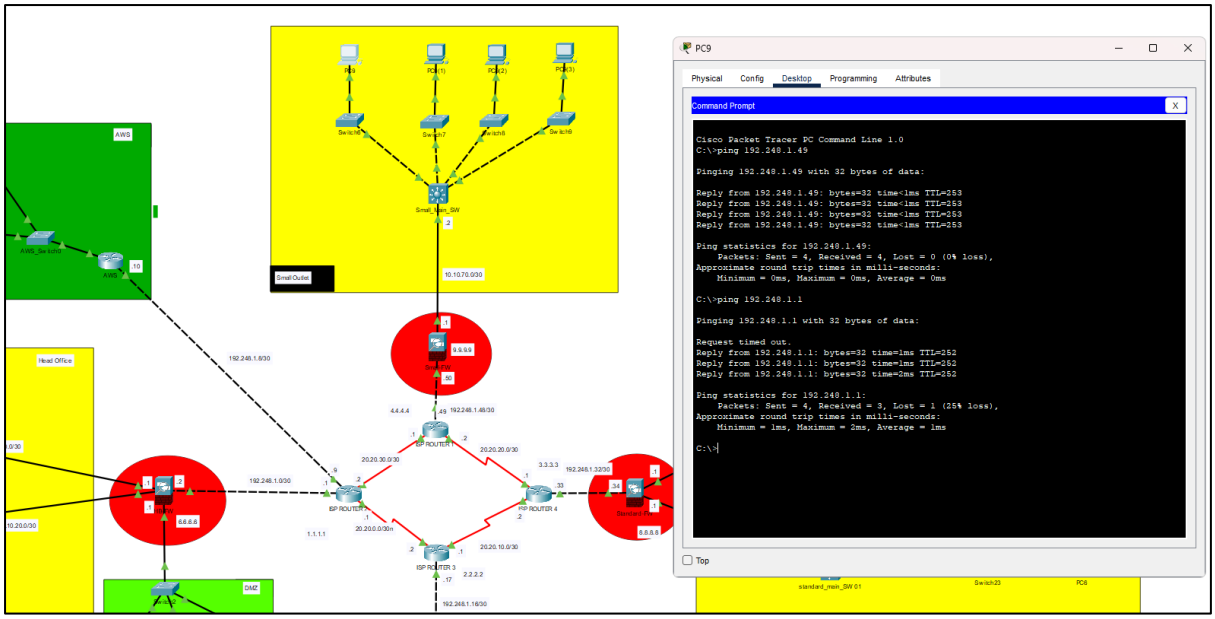
(From Head branch Firewall to Mega branch's Firewall, Standard brand's Firewall, and Small branch's Firewall)



(From Mega branch PC to ISP router and Head branch's Firewall)



(From Standard branch to ISP router and Head branch's Firewall)



(From Small branch to ISP router and Head branch's Firewall)

8. Workload Matrix

Task	Student Name	Contribution
Segmentation Plan	T.V.J.C Bilakshi, G.H.E.H Silva	20%
IP Planning	T.S.D.B.H Kumarage, L.M.L Anuththara	20%
Packet Tracer Implementation	D.M.S.A. Dissanayaka, H.H.G Liyanage	20%
Document Writing	M.A.D.R Kumarathunga	20%
Presentation Slides	R.K.K.D Dilakshi	20%