

SIMULATING SECURE, RESILIENT DUAL- ISP CONNECTIONS FOR ENHANCED BUSINESS COLLABORATION.



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Table of Contents

ACKNOWLEDGEMENTS	5
ABSTRACT	6
Chapter 1: Introduction	8
1.1 Project Introduction	8
1.2 Problem Background	8
1.3 Problem Solution	9
1.4 Project Goals and Objectives	10
1.5 Project Scope	10
1.6 Work Breakdown Structure & Gantt Chart	11
1.6.1 Work Breakdown Structure (WBS):.....	12
1.6.2 Gantt chart.....	14
Chapter 2: Project Analysis	15
2.1 Development Methodology	15
2.2 Hardware Requirements Specification	16
2.3 Software Requirements Specification.....	16
Chapter-3 PROJECT DESIGN	17
3.1 Architecture Design	17
3.1.1 Network Topologies.....	17
3.1.2 Dual-ISP Redundancy.....	19
3.1.3 Networking Devices and Servers.....	19
Chapter-4: Project Implementation and results.....	21
4.1 Service Implementation	21
4.1.1 E-mail Server installation and configuration.....	21
4.1.2 Web Server Installation and Configuration.....	27
4.2 Networks	46
4.2.1 Subnetting and Address Table:	46
4.2.2 Install EVE-NG simulator:	51
4.2.3 Setup of Networking Devices	54
4.2.4 Configuration of Redundancy Protocols.....	59

4.2.5 DHCP Configuration	63
4.2.6 Security Deployment: VPN, DHCP Snooping, and DAI	69
4.2.7 Configuration Network of BlueTech	73
4.2.8 Configuration Network of CyberBooks.....	125
4.2.9 Configuration Network of Monsters, Inc.....	139
4.2.10 Configuration Network of ISP STC.....	154
4.2.11 Configuration Network of ISP Mobily	167
4.2.12 Configuration Network of ISP Zain.....	180
Chapter-5 Conclusion	193
5.1 Summary	193
5.2 Limitations and Future Work.....	194
References:.....	195

Figure 1: WBS Diagram	12
Figure 2: The Gantt Chart.....	14
Figure 3: HLD.....	17
Figure 4: LLD BlueTech.....	18
Figure 5: Monsters, Inc. LLD	18
Figure 6: LLD CyberBooks	19
Figure 7: Download Kali-Linux VirtualBox version.....	21
Figure 8: Prepare VirtualBox and set RAM and CPU cores.	21
Figure 9: Admin dashboard.	23
Figure 10: Server Resources in admin dashboard.....	23
Figure 11: Domain Controller (Admin)	23
Figure 12: MailBox Controller (Admin).....	24
Figure 13: Login Page of Webmail Website.....	24
Figure 14: Login Page of Webmail Website 2.....	24
Figure 15: E-mail Inbox	25
Figure 16: Sending an E-mail for testing.....	25
Figure 17: Testing result. E-mail received.....	26
Figure 18: 2FA QR code Example.....	26
Figure 19: 2FA Testing.....	26
Figure 20: Mobile notification example.	27
Figure 21: XAMPP configuration.....	27
Figure 22: Index Page1.	28
Figure 23: Index Page2.	28
Figure 24: Login Page.....	29
Figure 25: Book List Page.	29
Figure 26: Admin Login Page.....	30
Figure 27: Admin statistics.	30
Figure 28: Add Book Page.....	30
Figure 29: Manage Books Page.	31
Figure 30: List Users Page.....	31
Figure 31: Database entities.....	32
Figure 32: Login Page of EVE-ng in browser.	51
Figure 33: Terminal Login of EVE-ng.	51
Figure 34: WinSCP connection with EVE-ng machine to upload the images.	52
Figure 35: Create new lab in EVE-mg.....	52
Figure 37: Add Node.	53
Figure 36: Choose the node image.....	53
Figure 38: Connect to the router via ssh.	53
Figure 39: Start the node to start configuration.	53
Figure 40: Show ip ospf topology-info command of HM-Core router in BlueTech Company. ..	54

Figure 41: Show ip route command of HM-Core router in BlueTech Company.....	55
Figure 42: Remain result of Figure 37.....	55
Figure 43: Show vlan brief from Switch of Management department.....	56
Figure 44:Show vlan brief from Switch of HR department.....	56
Figure 45: Show interfaces trunk command of MSW1 Multilayer Switches in BlueTech Company.....	57
Figure 46: By using command show vlan brief, shows how to display VLAN information for access ports.	58
Figure 47: Show HSRP configuration in MSW1.....	59
Figure 48: Show standby command MSW1 in BlueTech company.....	60
Figure 49: Show standby command MSW2 in BlueTech company.....	61
Figure 50: EtherChannel Layer 3 with protocol LACP between MSW1 and MSW2.....	62
Figure 51: Multilink between companies and ISPs.	63
Figure 52: PC1 with Win7 getting an IP Address.....	65
Figure 53: PC2 with Win7 getting an IP Address.....	65
Figure 54: DHCP Pool in MSW1 BlueTech.....	66
Figure 55: DHCP binding MSW1 BlueTech.	66
Figure 56: DHCP Pool in RC-Core CyberBooks.	67
Figure 57: DHCP binding RC-Core CyberBooks.....	67
Figure 58: DHCP Pool RB-Core Monsters, Inc.....	68
Figure 59: DHCP Pool RB-Core Monsters, Inc.....	68
Figure 60: DHCP snooping on SW-ACC.	70
Figure 61: DCHP snooping binding SW-ACC.....	71
Figure 62: DHCP snooping SW-HR.....	71
Figure 63: DHCP snooping binding SW-HR.....	71
Figure 64: ARP inspection.....	72

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Your sincere students:

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Saeed Alamoodi

ABSTRACT

This project aims to design and simulate a secure, resilient network infrastructure that connects Company **BlueTech.** with **Monsters, Inc** and **CyberBooks** via dual Internet Service Providers (ISPs). It leverages a combination of three-tier and collapsed core network architectures, implementing networking technologies such as Virtual Local Area Networks (VLANs), redundancy protocols, and Virtual Private Networks (VPNs) to ensure high availability and secure data exchange.

The network simulation will be conducted using EVE-NG, utilizing Cisco network devices and Linux servers to emulate the real-world operations of web and email services. The architecture of **BlueTech.** will be based on a three-tier model, including core, distribution, and access layers, while **Monsters, Inc** and **CyberBooks** will utilize a collapsed core model, suited for smaller-scale operations.

Key objectives include:

1. Establishing a reliable, fault-tolerant network using EtherChannel and Hot Standby Router Protocol (HSRP) for redundancy.
2. Securing network communications between the companies using VPNs and enforcing security policies through Access Control Lists (ACLs).
3. Efficiently routing internal network traffic using Open Shortest Path First (OSPF) and managing external routing between ISPs and companies with Border Gateway Protocol (BGP).
4. Creating separate VLANs to enhance network segmentation and management.
5. Integrating Docker-based email servers to provide reliable internal and external communication services.
6. Configuring Dockerized mail servers to handle SMTP, IMAP, and POP3 protocols securely, ensuring proper authentication and encryption.

The project's scope includes designing a network that connects **BlueTech** with STC and Mobily ISPs, **Monsters, Inc** with STC and Zain ISPs, and **CyberBooks** with Mobily and Zain ISPs. The secure VPN tunnels, ACLs, and DHCP snooping will secure traffic flow between the companies, while HSRP and EtherChannel will provide redundancy. The use of EVE-NG for testing and simulation will ensure that all configurations function correctly.

In addition to enhancing business collaboration between these companies, this project aims to provide a scalable, flexible, and reliable infrastructure, fortified with robust security measures to minimize downtime and protect against cyber threats. The resulting network will deliver operational efficiency, reducing disruptions and operational costs while ensuring continuous connectivity and secure data exchange.

Chapter 1: Introduction

1.1 Project Introduction

The project "Simulating Secure, Resilient Dual-ISP Connections for Enhanced Business Collaboration" focuses on simulating a comprehensive network architecture. It connects Company **BlueTech**, with **Monsters, Inc** and **CyberBooks** via two Internet Service Providers (ISPs) to ensure secure, resilient connectivity. The project involves a three-tier network architecture for **BlueTech**, including core, distribution, and access layers. For **Monsters, Inc** and **CyberBooks**, a collapsed core architecture is employed due to their smaller scale.

Key network technologies include VLANs for segmentation, redundancy protocols for failover, and VPNs for encrypted communications between different organizations. EVE-NG, a network simulation platform, is used to design, implement, and validate the network's topology and configurations. Docker containers will host web and email services, ensuring high service availability. The network is designed to be modular, scalable, and secure, catering to current and future business collaboration requirements.

1.2 Problem Background

Network infrastructures are essential for business operations and seamless communication. However, the following challenges can compromise network performance:

1. Network Complexity: Managing complex network topologies with numerous devices and technologies can lead to configuration errors and complicate troubleshooting.
2. Network Reliability and Fault Tolerance: Redundancy is crucial to ensure continuous service despite hardware failures or ISP downtimes. Without redundancy, companies risk prolonged interruptions.
3. Security Risks: Increased network interconnection exposes sensitive data to cyber threats like malware or unauthorized access, requiring strong security measures.

4. Scalability: As businesses expand, network architecture should accommodate growth while maintaining performance and security.

5. Service Integration: Integrating and maintaining web and email services within a network infrastructure requires careful planning to balance security and reliability.

1.3 Problem Solution

The project aims to overcome the identified challenges using the following solutions:

1. Simulation and Testing: EVE-NG will be used to simulate and test configurations before deployment, minimizing risks and refining network architecture.

2. Dual-ISP Connections: By connecting to two ISPs, network availability is assured even if one ISP experiences downtime.

3. Secure Communication: VPNs and Access Control Lists (ACLs) will be used for secure data transmission, and DHCP snooping will prevent rogue servers.

4. Redundancy Protocols: The use of HSRP and EtherChannel will ensure gateway and link redundancy, maintaining network services during failures.

5. Network Segmentation and Routing: VLANs will segment the network, enhancing security, while OSPF and BGP will provide efficient routing internally and externally.

1.4 Project Goals and Objectives

The project will achieve the following goals and objectives:

1. Network Redundancy: Implement EtherChannel and HSRP for fault tolerance and redundancy.
2. Network Security: Secure inter-company communication through VPNs and enforce security policies via ACLs.
3. Efficient Routing: Implement OSPF internally and BGP externally to optimize traffic flow.
4. Network Segmentation: Create VLANs to enhance security and segregate departments.
5. Mail Server Integration: Use Docker to deploy secure mail servers for SMTP, IMAP, and POP3.
6. Mail Server Security: Ensure encryption and proper authentication of mail protocols.

1.5 Project Scope

The scope of the project includes:

1. Network Design:
 - ❖ Design a three-tier architecture for **BlueTech**.
 - ❖ Implement a collapsed core architecture for **Monsters, Inc** and **CyberBooks**.
 - ❖ Establish dual-ISP connections to ensure network redundancy.
2. Security Implementation:
 - ❖ Configure secure VPN tunnels between companies.
 - ❖ Set up ACLs to control network traffic.
 - ❖ Enable DHCP snooping to prevent unauthorized servers.

3. Redundancy and Reliability:

- ❖ Configure HSRP for gateway redundancy.
- ❖ Use EtherChannel for link redundancy.

4. Routing Protocols:

- ❖ Configure OSPF for internal routing.
- ❖ Implement BGP for external routing between companies and ISPs.

5. Simulation and Testing:

- ❖ Utilize EVE-NG to simulate the entire network.
- ❖ Test all configurations under different scenarios.

6. Documentation:

- ❖ Provide detailed documentation covering all design choices, configurations, and simulation results.

1.6 Work Breakdown Structure & Gantt Chart

Present detailed tasks to be undertaken and their respective timelines, including design, device configuration, server setup, protocol configuration, security deployment, troubleshooting, and documentation.

1.6.1 Work Breakdown Structure (WBS):

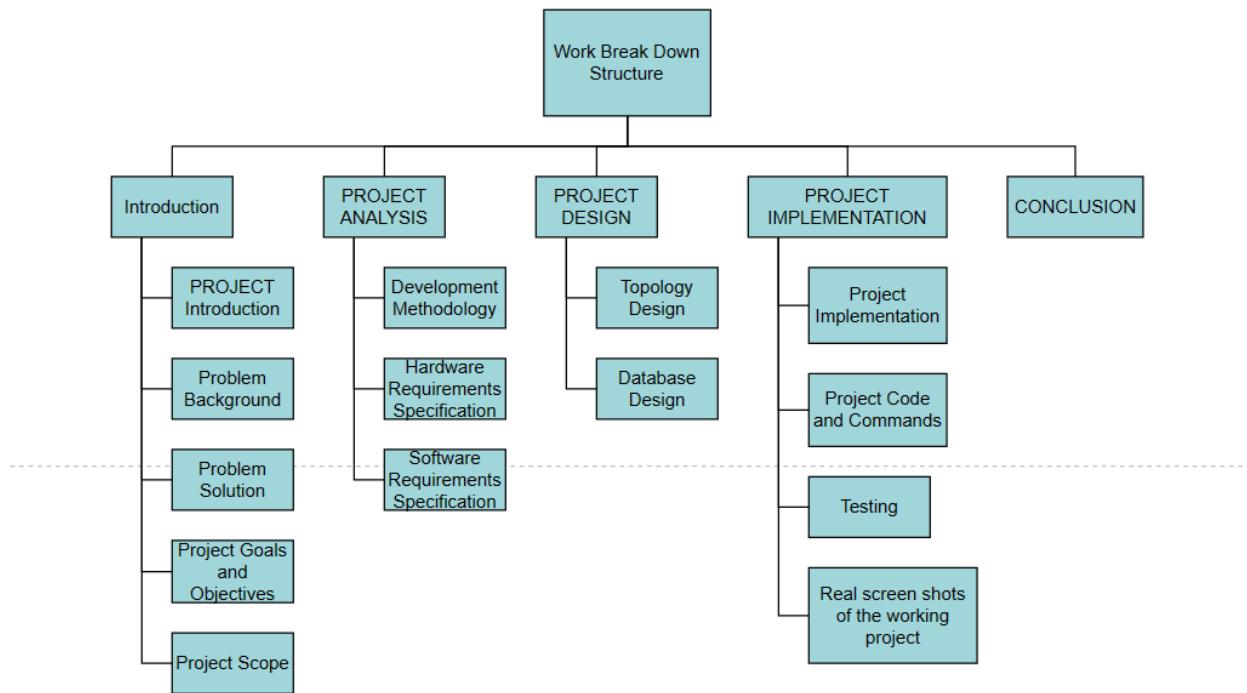


Figure 1: WBS Diagram

1. Topology & Design:

- ❖ Establish overall network design with appropriate architectures.
- ❖ Develop detailed topology diagrams.

2. Install EVE-NG & Devices:

- ❖ Install EVE-NG simulation platform.
- ❖ Import images of network devices.

3. Device Configuration & Addressing:

- ❖ Configure Cisco routers, switches, and other devices.
- ❖ Create and implement IP addressing tables.

4. Install Linux Servers & Configure Email:
 - ❖ Deploy Linux servers for web and email services.
 - ❖ Configure Docker containers for mail services.
5. Routing Protocols (OSPF) & HSRP:
 - ❖ Configure OSPF for internal routing.
 - ❖ Set up HSRP for gateway redundancy.
6. Routing Protocol (BGP):
 - ❖ Establish BGP for external routing.
 - ❖ Test inter-company and ISP routing.
7. Security Deployment:
 - ❖ Implement ACLs and VPNs.
 - ❖ Enable DHCP snooping.
8. Troubleshooting:
 - ❖ Identify configuration issues and fix them.
 - ❖ Fine-tune network design.
9. Documentation:
 - ❖ Document all configurations, testing results, and simulation details.

1.6.2 Gantt chart

TASKS \ WEEKS	1	2	3	4	5	6	7	8	9	10	11	12
Topology & Design												
Install EVE-NG & image devices												
Configuration Devices & Addressing Table												
Install Linux Servers & Configuration E-mail Server												
Routing Protocol (OSPF) & HSRP												
Troubleshooting Edit Configuration and Design												
Prepare Presentation (Midterm Exam)												
Routing Protocol (BGP) Configuration Web server												
Testing & Security deployment												
Documentation												
Final												

Figure 2: The Gantt Chart

Chapter 2: Project Analysis

2.1 Development Methodology

The development methodology for this project adopts an iterative approach that allows for incremental building, testing, and refining of the network infrastructure. The methodology consists of the following key phases:

1. Requirements Gathering: This initial phase involves comprehensive discussions with stakeholders from Company **BlueTech**, **Monsters, Inc**, and **CyberBooks** to define and refine their network needs and security requirements.
2. Design Phase: Utilizing network simulation tools like EVE-NG, a detailed design of the network topology, including the integration of Dockerized mail servers and security configurations such as VPNs and ACLs, will be created.
3. Implementation Phase: During this phase, the network configurations will be implemented in a simulated environment. This includes setting up of Cisco network devices, Linux servers, and configuring routing protocols and redundancy mechanisms.
4. Testing and Evaluation: This phase focuses on rigorous testing to ensure that all elements of the network function seamlessly and meet the predefined criteria. Security tests, redundancy tests, and performance evaluations will be conducted.
5. Documentation: Each step of the process will be meticulously documented. This documentation will include configuration details, issues encountered, and how they were resolved.

2.2 Hardware Requirements Specification

The network simulation and implementation will require the following hardware:

- ❖ EVE-NG Host: A high-performance computer capable of running EVE-NG for network simulations. Minimum requirements include an Intel i7 processor or equivalent, 16 GB RAM, and 200GB SSD storage.
- ❖ Cisco Network Devices: Various Cisco devices, including routers, multilayer switches, and standard switches, will be used to simulate realistic network traffic and topology.
- ❖ Linux Servers: Servers to host and simulate real-world operations of web and email services. These servers will need at least an Intel Xeon processor, 16GB RAM, and 200GB of disk space.
- ❖ Client Devices: Windows 10 and Linux workstations for accessing the network and performing day-to-day operations during the simulation.

2.3 Software Requirements Specification

The project will utilize the following software components:

- ❖ EVE-NG: Network emulation software that will serve as the platform for creating and configuring virtual network topologies.
- ❖ Operating Systems: Windows 10 for client machines, and Linux distributions (e.g., Ubuntu Server) for hosting web and email services.
- ❖ Networking Software: Cisco IOS for routers and switches. This includes software support for OSPF, BGP, VLANs, HSRP, EtherChannel, and security features such as VPNs and ACLs.

Chapter-3 PROJECT DESIGN

3.1 Architecture Design

This section details the architecture design of the network that connects three distinct companies—**BlueTech , Monsters, Inc** and **CyberBooks**—via dual ISPs, ensuring high availability, fault tolerance, and secure communication.

3.1.1 Network Topologies

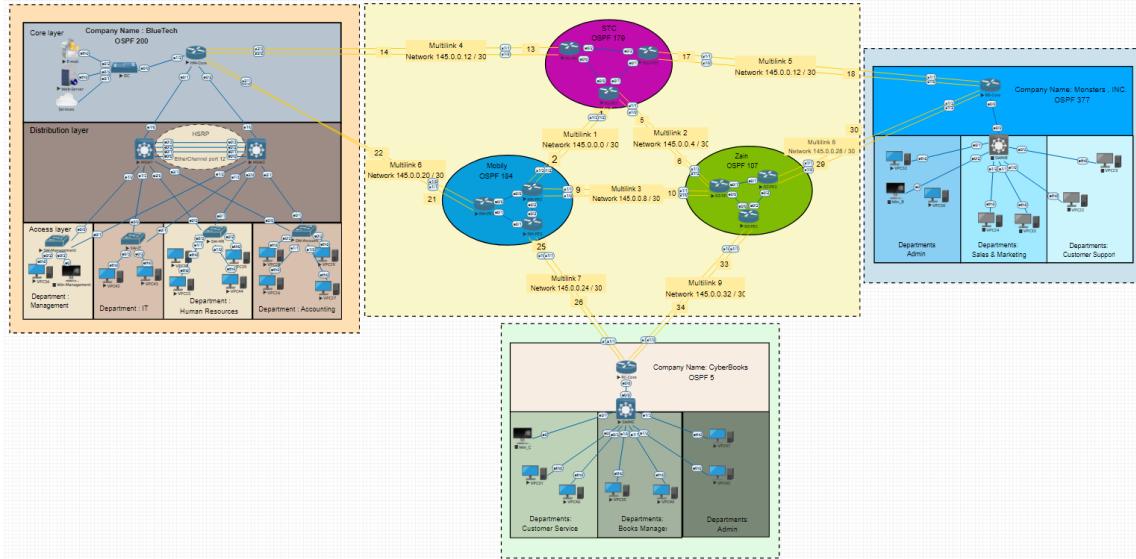


Figure 3: HLD

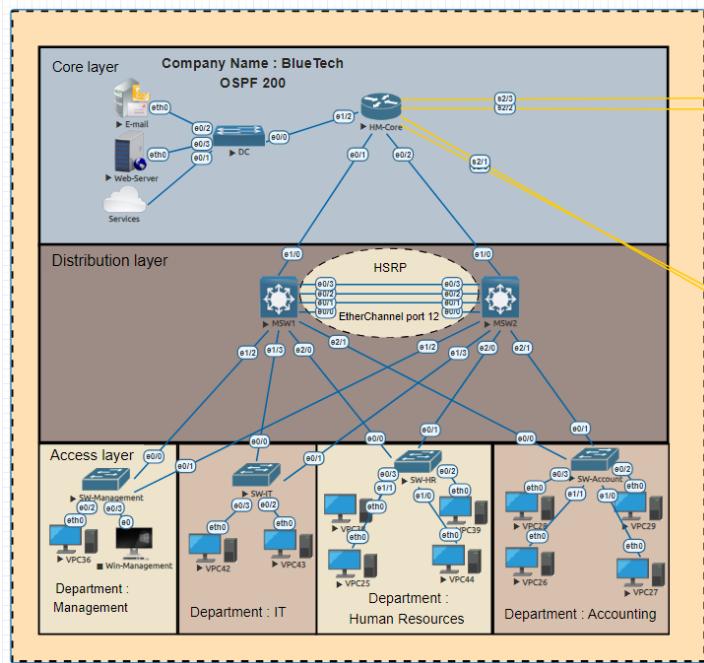


Figure 4: LLD BlueTech.

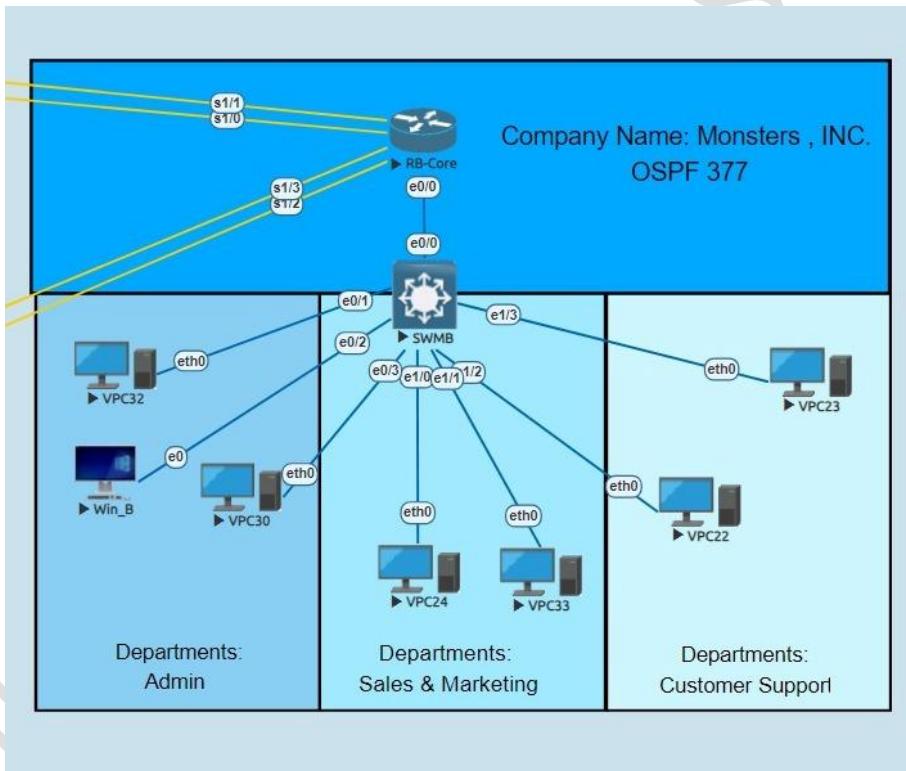


Figure 5: Monsters, Inc. LLD

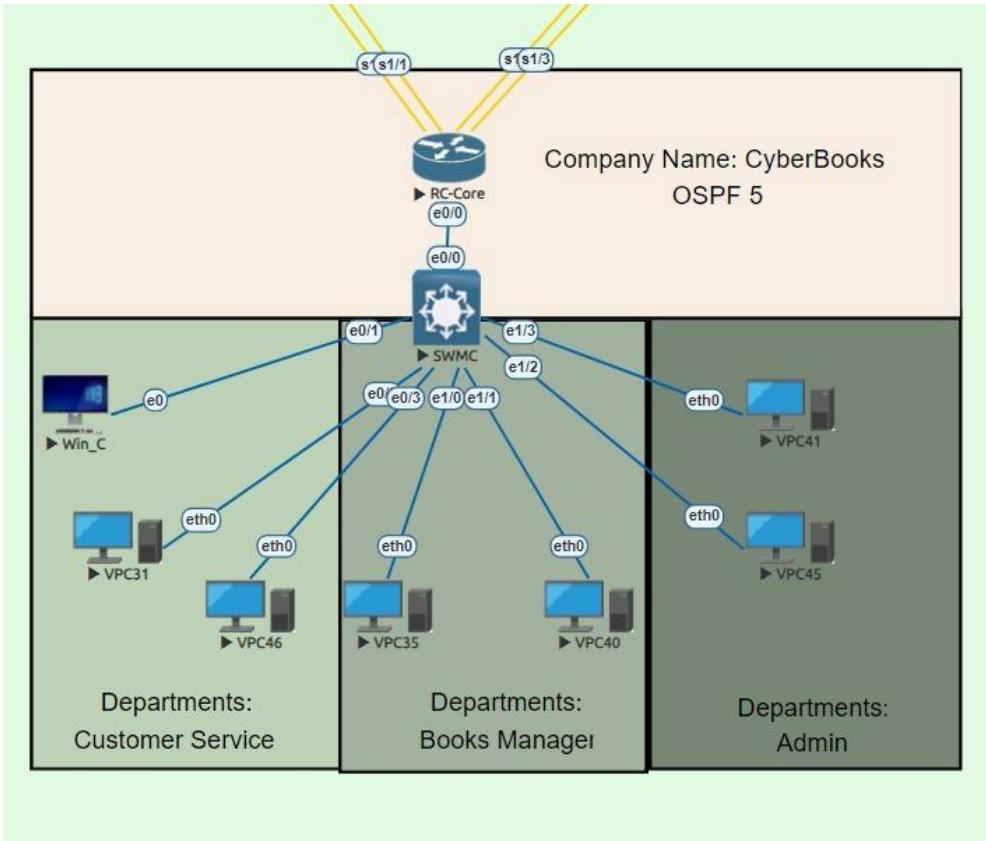


Figure 6: LLD CyberBooks

3.1.2 Dual-ISP Redundancy

- Each company is connected to two ISPs. This redundant connection ensures that if one ISP fails, the other can immediately take over, minimizing downtime and maintaining business operations.
- **ISP Connected:**
 - **BlueTech:** Connected to STC and Mobily.
 - **Monsters, Inc:** Connected to STC and Zain.
 - **CyberBooks:** Connected to Mobily and Zain.

3.1.3 Networking Devices and Servers

- **Cisco Routers and Switches:** These are deployed across all layers of the network to manage traffic, ensure security, and maintain connectivity. High-performance Cisco

routers handle external communications and inter-ISP routing using BGP, while internal routing is managed through OSPF.

- **Linux Servers:** Host essential services such as web and email, simulating real-world operations and ensuring that network services are maintained internally without dependency on external providers.

Chapter-4: Project Implementation and results

4.1 Service Implementation

4.1.1 E-mail Server installation and configuration.

First download kali linux VirtualBox version

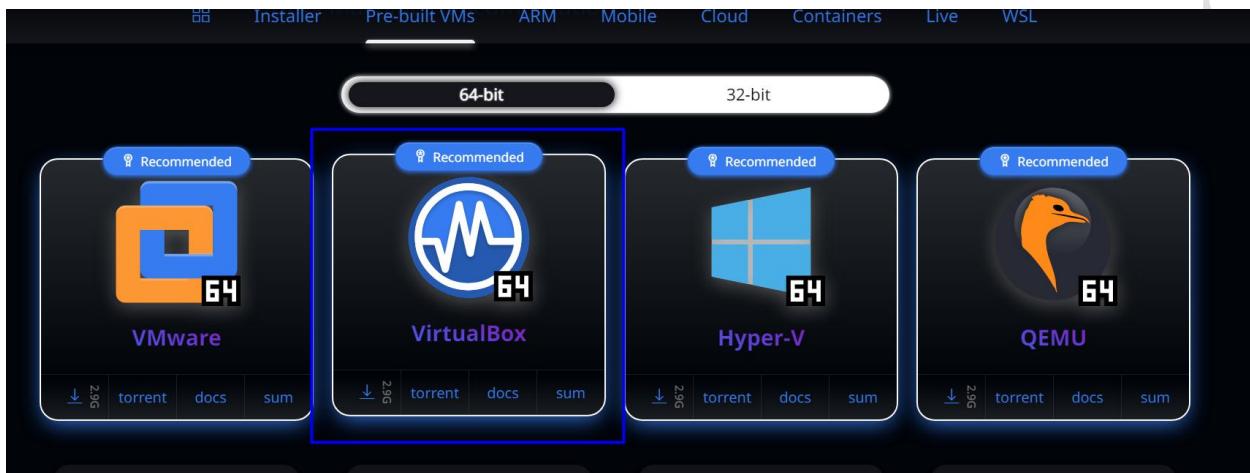


Figure 7: Download Kali-Linux VirtualBox version.

And import the image to Virtual Box

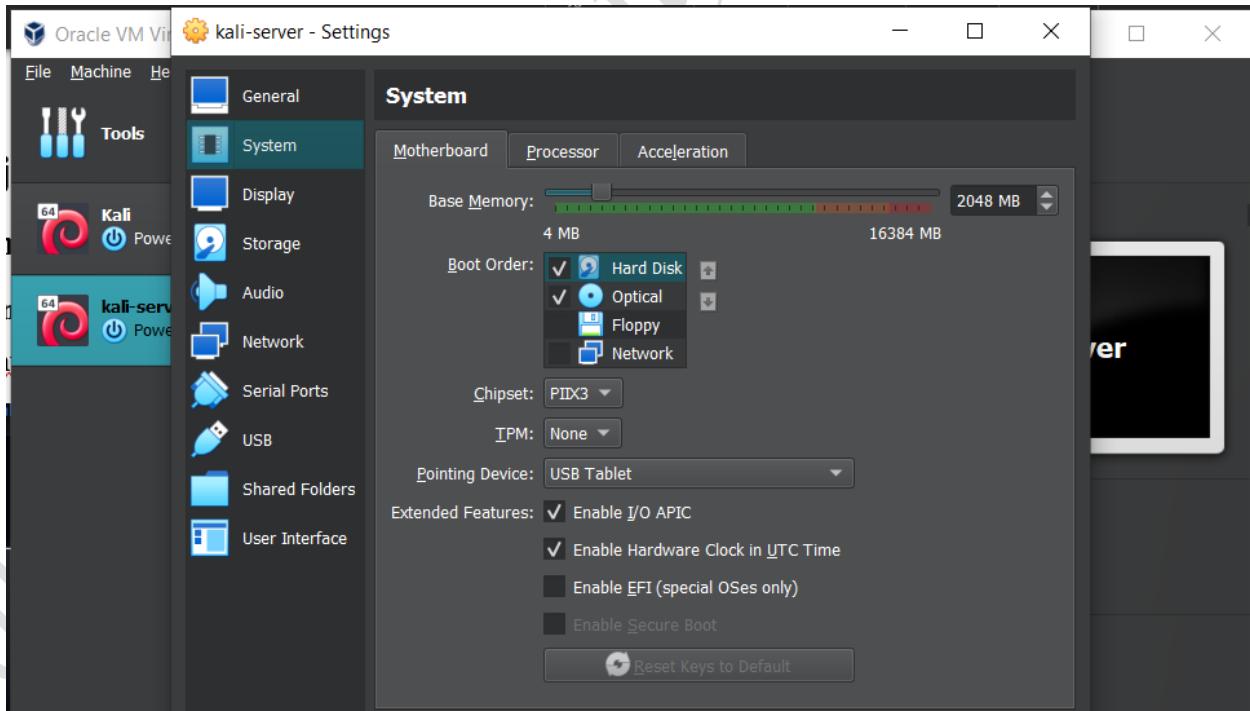


Figure 8: Prepare VirtualBox and set RAM and CPU cores.

In Kali Linux install and configure Docker Container in linux terminal:

```
sudo apt update
```

```
sudo apt install -y docker.io
```

```
sudo systemctl enable docker --now
```

```
docker
```

Installing docker-ce on Kali Linux in linux terminal:

```
echo "deb [arch=amd64 signed-by=/etc/apt/keyrings/docker.gpg]
https://download.docker.com/linux/debian bookworm stable" | \
```

```
sudo tee /etc/apt/sources.list.d/docker.list
```

```
curl -fsSL https://download.docker.com/linux/debian/gpg /
```

```
sudo gpg --dearmor -o /etc/apt/keyrings/docker.gpg
```

```
sudo apt update
```

```
sudo apt install -y docker-ce docker-ce-cli containerd.io
```

Install Docker-Compose

```
sudo curl -L "https://github.com/docker/compose/releases/download/1.25.5/docker-compose-
$(uname -s)-$(uname -m)" -o /usr/local/bin/docker-compose
```

```
sudo chmod +x /usr/local/bin/docker-compose
```

Installing Mail-Server on Kali Linux terminal:

```
cd /opt
```

```
sudo git clone https://github.com/mailcow/mailcow-dockerized
```

```
sudo ./generate_config.sh
```

```
sudo docker-compose up -d
```

Login to admin Dashboard of the E-mail Server:

The screenshot shows the admin dashboard for a server named 'mail.ubuntu.local'. The interface includes a logo for 'Monsters INC' featuring a stylized eye inside a blue circle. Key system details listed include:

- Hostname:** mail.ubuntu.local
- Architecture:** x86_64
- IPs:** IP check is disabled. You can enable it under System > Configuration > Options > Customize.
- Version:** 2024-02
- System Time:** 16.05.2024 20:38:51
- Timezone:** America/New_York
- Uptime:** 7M 46S
- Disk usage:** /dev/sda1 (18.9G / 78.3G [25%])

Figure 9: Admin dashboard.

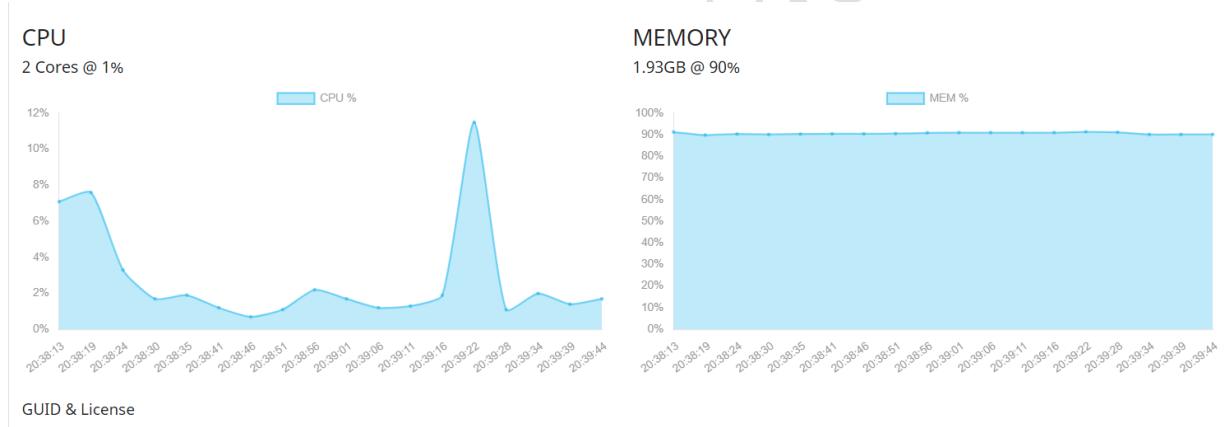


Figure 10: Server Resources in admin dashboard

Domain Controller:

Domains											Refresh
<input type="checkbox"/> Toggle all		Actions		+ Add domain							
Search: <input type="text"/>											
	Domain	Aliases	Mailboxes	Quota	Statistics	Default mailbox size	Max. size of a mailbox	RL	Relay domain	Active	Action
<input type="checkbox"/>	company.local	0 / 400	2 / 10	0 B / 10.0 GiB	<input type="checkbox"/> 25 / 33.9 KiB	3.0 GiB	10.0 GiB	∞	X	✓	<input type="button" value="Edit"/> <input type="button" value="Remove"/> <input type="button" value="DNS"/>
<input type="checkbox"/>	monsters.com	0 / 400	0 / 10	0 B / 10.0 GiB	<input type="checkbox"/> 0 / 0 B	3.0 GiB	10.0 GiB	∞	X	✓	<input type="button" value="Edit"/> <input type="button" value="Remove"/> <input type="button" value="DNS"/>

Showing 1 to 2 of 2 entries

Toggle all Actions + Add domain

Figure 11: Domain Controller (Admin)

MailBoxes Controller:

The screenshot shows a table of mailbox statistics. The columns include Username, Quota, Last mail login, Last password change, In use (%), Message #, Active, and Action. The first mailbox (muhammad@company.local) has a quota of 11.4 KiB, was last used via IMAP on 05/16/2024 at 02:18:41 AM, and has 11 messages. The second mailbox (muhammad@monsters.com) has a quota of 0 B/3.0 GiB, was last used via IMAP on 05/16/2024 at 08:54:44 PM, and has 0 messages. The third mailbox (saeed@company.local) has a quota of 22.5 KiB, was last used via IMAP on 05/10/2024 at 08:26:18 PM, and has 14 messages.

Username	Quota	Last mail login	Last password change	In use (%)	Message #	Active	Action
muhammad@company.local	11.4 KiB/∞	IMAP @ 05/16/2024, 02:18:41 AM POP3 @ x SMTP @ 05/16/2024, 02:18:41 AM	05/15/2024, 07:17:47 PM	0%	11	✓	Edit Remove Login
muhammad@monsters.com	0 B/3.0 GiB	IMAP @ x POP3 @ x SMTP @ x	05/16/2024, 08:54:44 PM	0%	0	✓	Edit Remove Login
saeed@company.local	22.5 KiB/∞	IMAP @ 05/10/2024, 08:26:18 PM POP3 @ x SMTP @ 05/06/2024, 07:26:15 AM	05/05/2024, 01:08:04 PM	0%	14	✓	Edit Remove Login

Figure 12: MailBox Controller (Admin)

Now coming to Web Mail App:

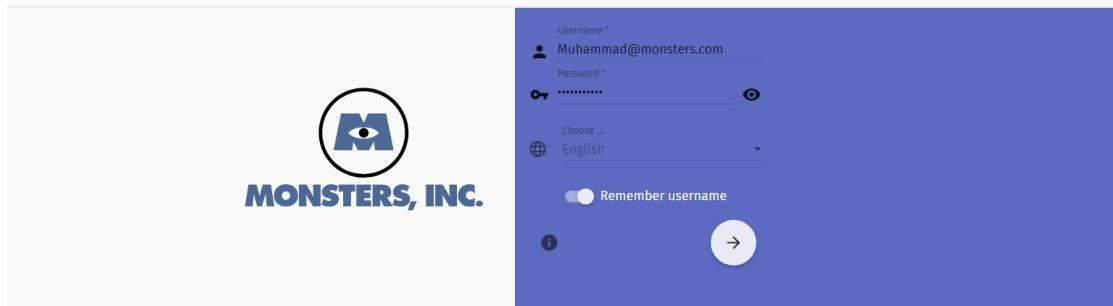


Figure 13: Login Page of Webmail Website

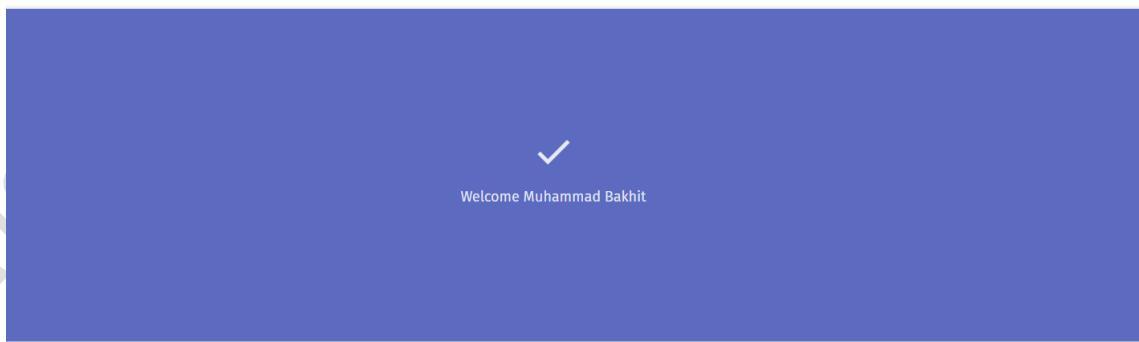


Figure 14: Login Page of Webmail Website 2

Inbox:

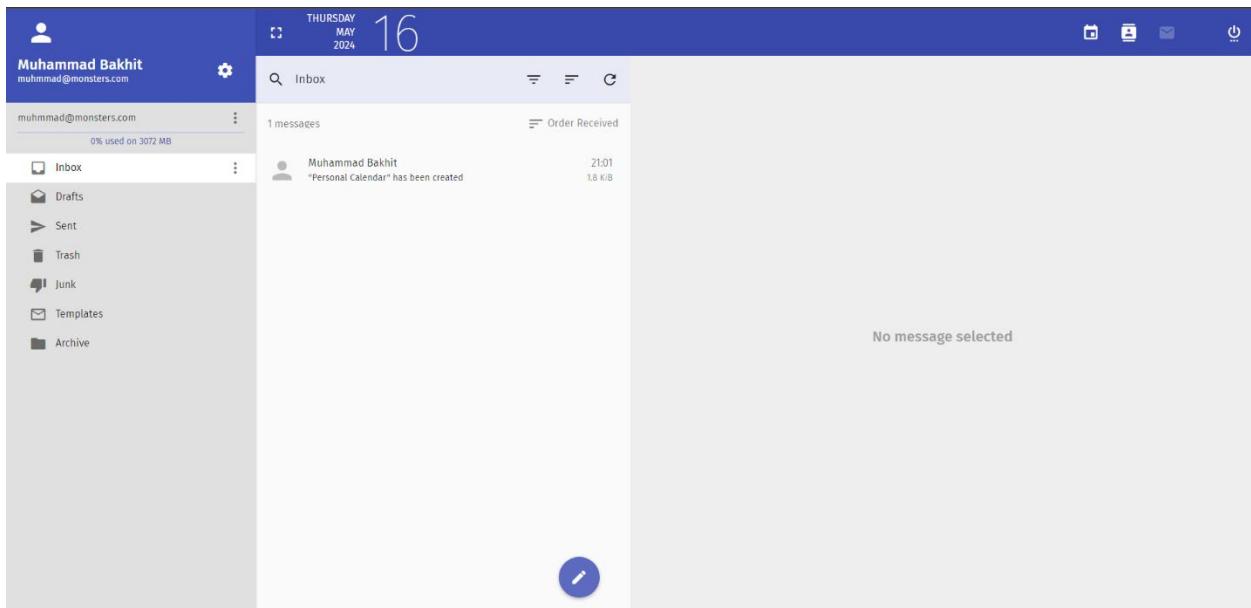


Figure 15: E-mail Inbox

Send an Email for testing:

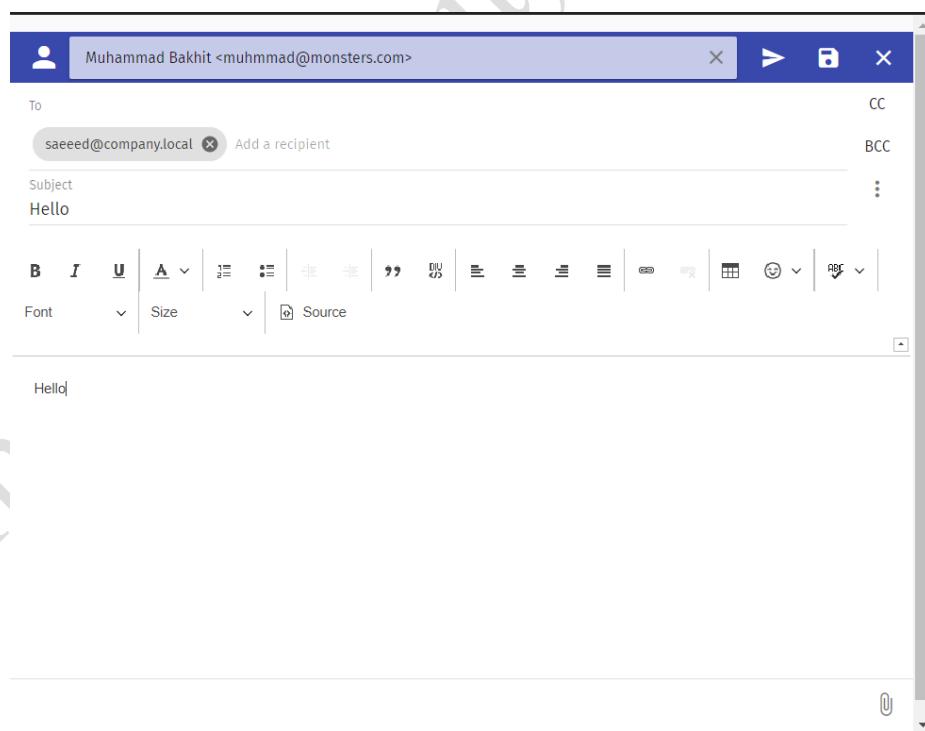


Figure 16: Sending an E-mail for testing.

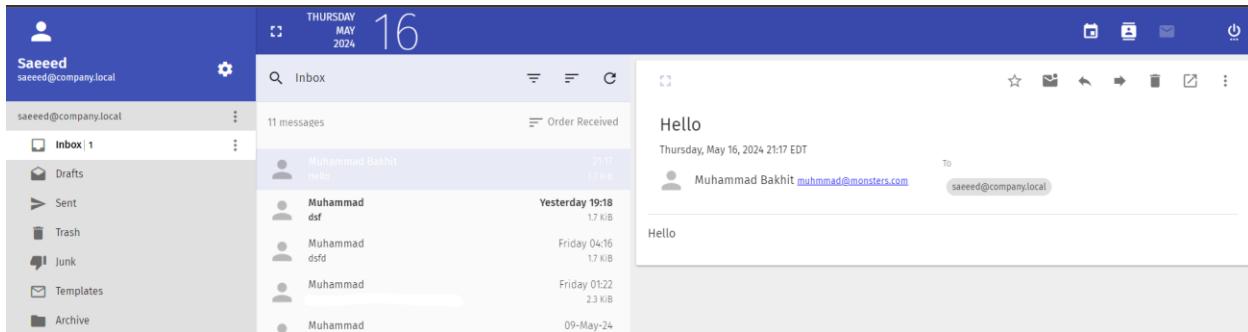


Figure 17: Testing result. E-mail received.

For Security we configure 2FA for users, TOTP gained by any Authenticator app like Google authentication or Microsoft Authenticator.

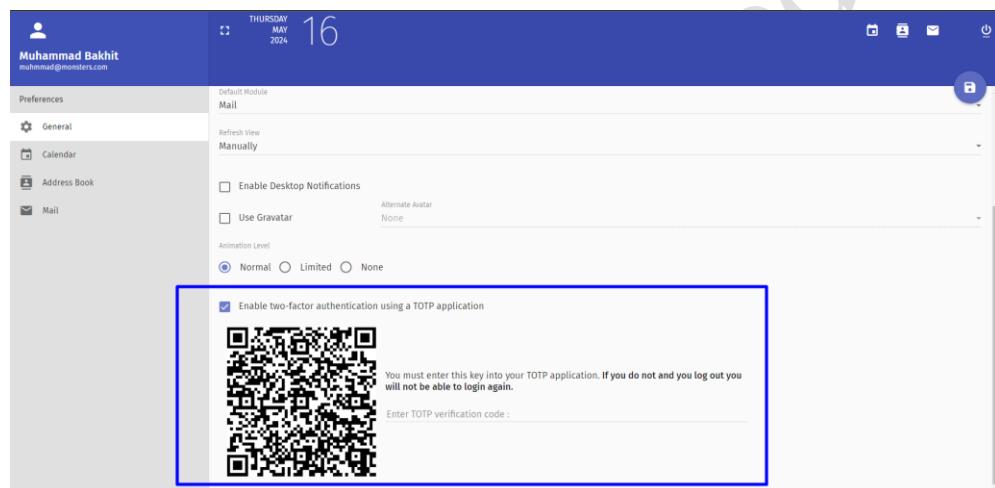


Figure 18: 2FA QR code Example.

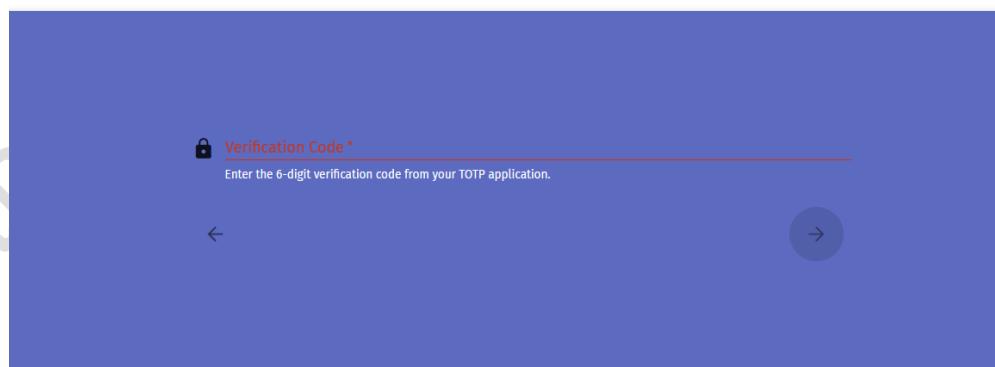


Figure 19: 2FA Testing.

Configuring the E-mail message with Pushover application API, means that any user got an e-mail he will receive a notification on his phone.

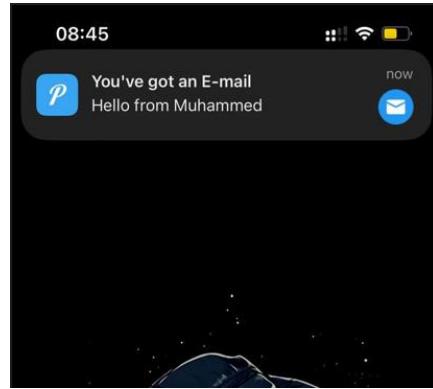


Figure 20: Mobile notification example.

4.1.2 Web Server Installation and Configuration.

The E-Library website is a simple web application that allows users to register, log in, and download books in PDF format. Administrators can manage the book database, view user statistics, and upload new books via an admin dashboard.

System Requirements

- Web Server (e.g., Apache, Nginx)
- PHP 7.4 or higher
- MySQL
- A modern web browser (e.g., Chrome, Firefox)

Using XAMPP and configured it to handle Apache and MySQL.

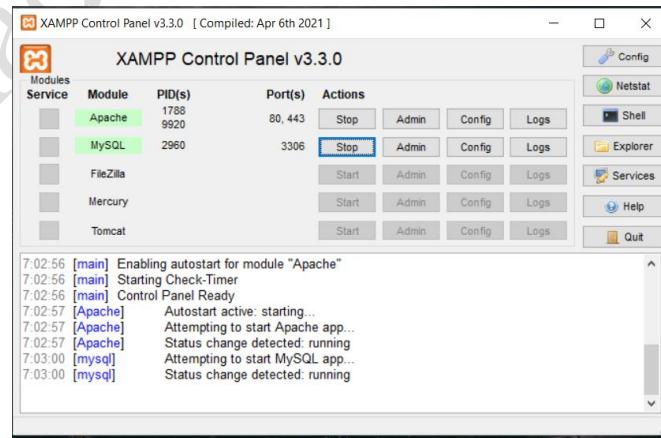


Figure 21: XAMPP configuration.

Web Page Screenshots:

Index page:



Figure 22: Index Page1.

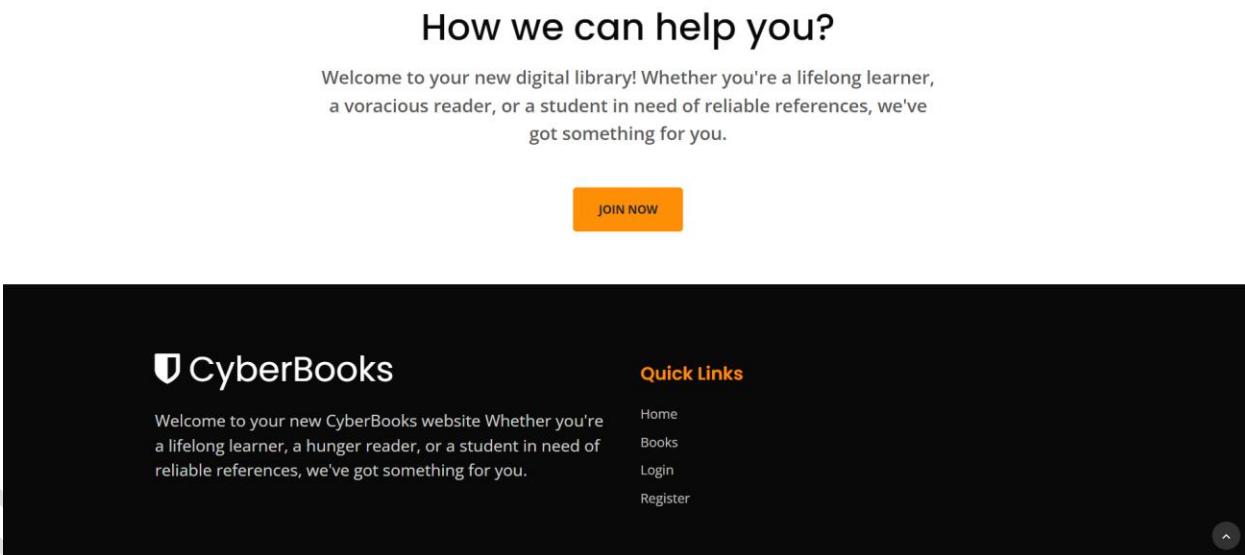


Figure 23: Index Page2.

Login Page:

The screenshot shows the CyberBooks login interface. At the top, there's a navigation bar with links for HOME, BOOKS, LOGIN, and REGISTER. Below the navigation is a breadcrumb trail showing 'Home / Login'. The main area is titled 'Login' and contains two input fields: one for email ('muhammad@gmail.com') and one for password ('.....'). A blue 'LOGIN' button is positioned below the password field.

Figure 24: Login Page.

Book List page:

The screenshot shows the CyberBooks book list page. At the top, there's a navigation bar with links for HOME, BOOKS, LOGIN, and REGISTER. Below the navigation is a breadcrumb trail showing 'Home / Books'. The main title is 'Books List'. A table lists three books with columns for Name, Author, Description, Download, and Reserve.

Name	Author	Description	Download	Reserve
Hacking: The Art of Exploitation	Jon Erickson	This book provides a comprehensive introduction to hacking and cybersecurity. It covers both theoretical concepts and practical applications, including how to exploit software vulnerabilities, write buffer overflow exploits, and perform reverse engineering.	Download	Reserve
Metasploit: The Penetration Tester's Guide	David Kennedy, Jim O'Gorman, Devon Kearns, and Mati Aharoni	This book is a hands-on guide to using the Metasploit Framework, a powerful tool for penetration testing and security research. It walks readers through real-world scenarios, teaching them how to find vulnerabilities, exploit them, and document their findings.	Download	Reserve
The Web Application Hacker's Handbook: Finding and Exploiting Security Flaws	Dafydd Stuttard and Marcus Pinto	This book is essential for anyone interested in web application security. It covers various techniques and tools for finding and exploiting vulnerabilities in web applications, including SQL injection, cross-site scripting (XSS), and more.	Download	Reserve

Figure 25: Book List Page.

Admin Login:

Admin Login

Username:

Password:

Figure 26: Admin Login Page.

Admin home page:

Admin Dashboard Add Book Manage Books List Users Logout

Welcome to the Admin Dashboard

Total Books: 3

Total Users: 4

Total Reservations: 0

Figure 27: Admin statistics.

Add book page:

Admin Dashboard Add Book Manage Books List Users Logout

Add New Book

Book Name:

Author:

Description:

Upload Book File:

No file chosen

Figure 28: Add Book Page.

Manage Books Page:

Books List				
ID	Name	Author	Description	Action
14	Hacking: The Art of Exploitation	Jon Erickson	This book provides a comprehensive introduction to hacking and cybersecurity. It covers both theoretical concepts and practical applications, including how to exploit software vulnerabilities, write buffer overflow exploits, and perform reverse engineering.	<button>Delete</button>
15	Metasploit: The Penetration Tester's Guide	David Kennedy, Jim O'Gorman, Devon Kearns, and Mati Aharoni	This book is a hands-on guide to using the Metasploit Framework, a powerful tool for penetration testing and security research. It walks readers through real-world scenarios, teaching them how to find vulnerabilities, exploit them, and document their findings.	<button>Delete</button>
16	The Web Application Hacker's Handbook: Finding and Exploiting Security Flaws	Dafydd Stuttard and Marcus Pinto	This book is essential for anyone interested in web application security. It covers various techniques and tools for finding and exploiting vulnerabilities in web applications, including SQL injection, cross-site scripting (XSS), and more.	<button>Delete</button>

Figure 29: Manage Books Page.

List Users Page:

List of Users		
ID	Name	Email
8	Ahmed	Ahmed@gmail.com
10	muhammad	muhammad@gmail.com
9	Nu10	nu107842y8@gmail.com
7	saeed	saeed@gmail.com

Figure 30: List Users Page.

DataBase:

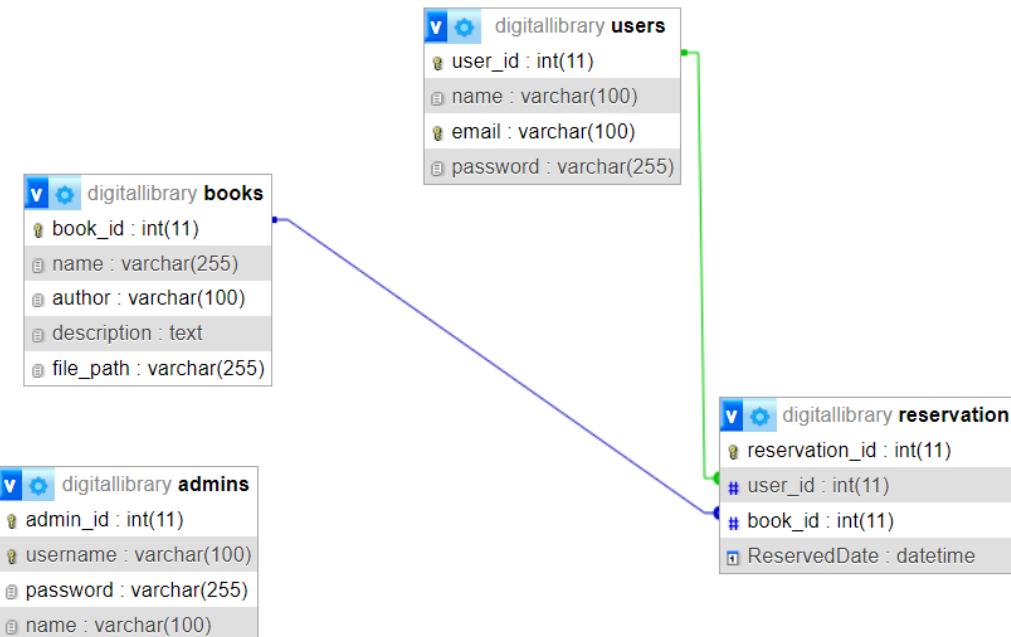


Figure 31: Database entities.

Coding

SQL code:

```
SET SQL_MODE = "NO_AUTO_VALUE_ON_ZERO";
START TRANSACTION;
SET time_zone = "+00:00";

SET @OLD_CHARACTER_SET_CLIENT=@@CHARACTER_SET_CLIENT;
SET @OLD_CHARACTER_SET_RESULTS=@@CHARACTER_SET_RESULTS;
SET @OLD_COLLATION_CONNECTION=@@COLLATION_CONNECTION;
SET NAMES utf8mb4;

CREATE TABLE `admins` (
```

```
`admin_id` int(11) NOT NULL,  
`username` varchar(100) NOT NULL,  
`password` varchar(255) NOT NULL,  
`name` varchar(100) DEFAULT NULL  
) ENGINE=InnoDB DEFAULT CHARSET=utf8mb4 COLLATE=utf8mb4_general_ci;
```

```
INSERT INTO `admins` (`admin_id`, `username`, `password`, `name`) VALUES  
(1, 'admin',  
'$2y$10$EdqUNhpRZ8.C3IWHG8ATSuWdF8eUGN3KPXA65HKtQkJ6RHAcN31Vy',  
'admin');
```

```
CREATE TABLE `books` (  
`book_id` int(11) NOT NULL,  
`name` varchar(255) NOT NULL,  
`author` varchar(100) NOT NULL,  
`description` text DEFAULT NULL,  
`file_path` varchar(255) NOT NULL  
) ENGINE=InnoDB DEFAULT CHARSET=utf8mb4 COLLATE=utf8mb4_general_ci;
```

```
INSERT INTO `books` (`book_id`, `name`, `author`, `description`, `file_path`) VALUES  
(7, 'Test book 1', 'Hannan', 'a test book for the system', '../uploads/TASK 1.pdf'),  
(8, 'Test book 2', 'Rawan', 'best book from Rawan', '../uploads/TASK 2.pdf');
```

```
CREATE TABLE `reservation` (  
`reservation_id` int(11) NOT NULL,  
`user_id` int(11) NOT NULL,  
`book_id` int(11) NOT NULL,
```

```
 `ReservedDate` datetime DEFAULT current_timestamp()
) ENGINE=InnoDB DEFAULT CHARSET=utf8mb4 COLLATE=utf8mb4_general_ci;
```

```
CREATE TABLE `users` (
  `user_id` int(11) NOT NULL,
  `name` varchar(100) NOT NULL,
  `email` varchar(100) NOT NULL,
  `password` varchar(255) NOT NULL
) ENGINE=InnoDB DEFAULT CHARSET=utf8mb4 COLLATE=utf8mb4_general_ci;
```

```
ALTER TABLE `admins`
  ADD PRIMARY KEY (`admin_id`),
  ADD UNIQUE KEY `username` (`username`);
```

```
ALTER TABLE `books`
  ADD PRIMARY KEY (`book_id`);
```

```
ALTER TABLE `reservation`
  ADD PRIMARY KEY (`reservation_id`),
  ADD KEY `user_id` (`user_id`),
  ADD KEY `reservation_ibfk_2` (`book_id`);
```

```
ALTER TABLE `users`
  ADD PRIMARY KEY (`user_id`),
  ADD UNIQUE KEY `email` (`email`);
```

```
ALTER TABLE `admins`
```

```
MODIFY `admin_id` int(11) NOT NULL AUTO_INCREMENT, AUTO_INCREMENT=2;
```

```
ALTER TABLE `books`
```

```
MODIFY `book_id` int(11) NOT NULL AUTO_INCREMENT, AUTO_INCREMENT=9;
```

```
ALTER TABLE `reservation`
```

```
MODIFY `reservation_id` int(11) NOT NULL AUTO_INCREMENT,  
AUTO_INCREMENT=7;
```

```
ALTER TABLE `users`
```

```
MODIFY `user_id` int(11) NOT NULL AUTO_INCREMENT, AUTO_INCREMENT=6;
```

```
ALTER TABLE `reservation`
```

```
ADD CONSTRAINT `reservation_ibfk_1` FOREIGN KEY (`user_id`) REFERENCES `users`  
(`user_id`),
```

```
ADD CONSTRAINT `reservation_ibfk_2` FOREIGN KEY (`book_id`) REFERENCES  
`books` (`book_id`) ON DELETE CASCADE;
```

```
COMMIT;
```

```
SET CHARACTER_SET_CLIENT=@OLD_CHARACTER_SET_CLIENT;
```

```
SET CHARACTER_SET_RESULTS=@OLD_CHARACTER_SET_RESULTS;
```

```
SET COLLATION_CONNECTION=@OLD_COLLATION_CONNECTION;
```

PHP index web page code:

```
<!doctype html>
```

```
<html lang="en">
```

```
<head>
```

```
<meta charset="utf-8">
<meta name="viewport" content="width=device-width, initial-scale=1, shrink-to-fit=no">

<title>Digital Library</title>

<link
  href="//fonts.googleapis.com/css?family=Poppins:100,200,300,400,500,600,700,800,900&display=swap" rel="stylesheet">
<link
  href="//fonts.googleapis.com/css?family=Open+Sans:300,400,600,700,800&display=swap"
  rel="stylesheet">

<link rel="stylesheet" href="assets/css/style-starter.css">
</head>

<body>
<header class="w3l-header">
  <div class="hero-header-11">
    <div class="hero-header-11-content">
      <div class="container">
        <nav class="navbar navbar-expand-lg navbar-light py-md-2 py-0 px-0">
          <a class="navbar-brand" href="index.php"><i class="fa fa-shield" aria-hidden="true"></i></i> CyberBooks </a>
          <button class="navbar-toggler collapsed" type="button" data-toggle="collapse" data-target="#navbarSupportedContent" aria-controls="navbarSupportedContent" aria-expanded="false" aria-label="Toggle navigation">
            <span class="navbar-toggler-icon fa icon-expand fa-bars"></span>
            <span class="navbar-toggler-icon fa icon-close fa-times"></span>

```

```
</button>

<div class="collapse navbar-collapse" id="navbarSupportedContent">
  <ul class="navbar-nav ml-auto">
    <li class="nav-item active">
      <a class="nav-link" href="index.php">Home <span class="sr-only">(current)</span></a>
    </li>
    <li class="nav-item @@about-active">
      <a class="nav-link" href="user/books.php">Books</a>
    </li>
    <li class="nav-item @@services-active">
      <a class="nav-link" href="user/login.php">Login</a>
    </li>
    <li class="nav-item @@contact-active">
      <a class="nav-link" href="user/register.php">Register</a>
    </li>
  </ul>
</div>
</nav>
</div>
</div>
</div>
</header>
<!-- //header -->
<!-- Main banner section -->
<section class="w3l-main-banner">
```



```
<p class="mt-3 mb-5">Welcome to your new digital library! Whether you're a lifelong learner, a voracious reader, or a student in need of reliable references, we've got something for you. </p>
```

```
<a href="user/login.php" class="btn btn-primary theme-button">Join Now</a>
</div>
</div>
</div>
</section>
```

```
<!-- footer -->
```

```
<footer class="w3l-footer-29-main" id="footer">
<div class="footer-29 py-5">
<div class="container pb-lg-3">
<div class="row footer-top-29">
<div class="col-lg-6 col-md-6 footer-list-29 footer-1 mt-md-4">
<a class="footer-logo mb-md-3 mb-2" href="#"><i class="fa fa-shield" aria-hidden="true"></i> CyberBooks</a>
```

```
<p>Welcome to your new CyberBooks website Whether you're a lifelong learner, a hunger reader, or a student in need of reliable references, we've got something for you. </p>
```

```
</div>
```

```
<div class="col-lg-6 col-md-6 footer-list-29 footer-4 mt-5">
<h6 class="footer-title-29">Quick Links</h6>
<ul>
<li><a href="index.php">Home</a></li>
```

```
<li><a href="user/books.php">Books</a></li>
<li><a href="user/login.php">Login</a></li>
<li><a href="user/register.php">Register</a></li>

</ul>
</div>
</div>
</div>
</div>

<div id="footers14-block" class="py-3">
<div class="container">
<div class="footers14-bottom text-center">
<div class="copyright mt-1">
<p>&copy; 2024 CyberBooks. All Rights Reserved to Ubunzu & Saeed</p>
</div>
</div>
</div>
</div>

<!-- move top -->
<button onclick="topFunction()" id="movetop" title="Go to top">
<span class="fa fa-angle-up" aria-hidden="true"></span>
</button>
<script>
// When the user scrolls down 20px from the top of the document, show the button
window.onscroll = function() {
scrollFunction()
```

```
};

function scrollFunction() {
    if (document.body.scrollTop > 20 || document.documentElement.scrollTop > 20) {
        document.getElementById("movetop").style.display = "block";
    } else {
        document.getElementById("movetop").style.display = "none";
    }
}

// When the user clicks on the button, scroll to the top of the document
function topFunction() {
    document.body.scrollTop = 0;
    document.documentElement.scrollTop = 0;
}

```

</script>

<!-- /move top -->

</footer>

<!-- Footer -->

<!-- jQuery and Bootstrap JS -->

<script src="assets/js/jquery-3.3.1.min.js"></script>

<script src="assets/js/bootstrap.min.js"></script>

<!-- Template JavaScript -->

```
<!-- stats number counter-->  
<script src="assets/js/jquery.waypoints.min.js"></script>  
<script src="assets/js/jquery.countup.js"></script>  
<script>  
  $('.counter').countUp();  
</script>  
<!-- //stats number counter -->
```

```
<!-- testimonials owlcarousel -->  
<script src="assets/js/owl.carousel.js"></script>
```

```
<!-- script for owlcarousel -->  
<script>  
$(document).ready(function() {  
  $('.owl-one').owlCarousel({  
    loop: true,  
    margin: 0,  
    nav: false,  
    responsiveClass: true,  
    autoplay: false,  
    autoplayTimeout: 5000,  
    autoplaySpeed: 1000,  
    autoplayHoverPause: false,  
    responsive: {  
      0: {  
        items: 1,
```

```
        nav: false
    },
    480: {
        items: 1,
        nav: false
    },
    667: {
        items: 1,
        nav: false
    },
    1000: {
        items: 1,
        nav: false
    }
}
})
})
}

</script>

<!-- //script for owlcarousel -->
<!-- //testimonials owlcarousel -->

<!-- script for courses -->
<script>

$(document).ready(function() {
    $('.owl-two').owlCarousel({
        loop: true,
        margin: 30,
```

```
nav: false,  
responsiveClass: true,  
autoplay: false,  
autoplayTimeout: 5000,  
autoplaySpeed: 1000,  
autoplayHoverPause: false,  
responsive: {  
    0: {  
        items: 1,  
        nav: false  
    },  
    480: {  
        items: 1,  
        nav: false  
    },  
    667: {  
        items: 2,  
        nav: false  
    },  
    1000: {  
        items: 3,  
        nav: false  
    }  
}  
})  
})  
</script>
```

```
<!-- //script for courses -->

<!-- disable body scroll which navbar is in active -->
<script>
$(function() {
    $('.navbar-toggler').click(function() {
        $('body').toggleClass('noscroll');
    })
});
</script>
<!-- disable body scroll which navbar is in active -->
</body></html>
```

4.2 Networks

4.2.1 Subnetting and Address Table:

Addressing Table for BlueTech.

Dev ice	Description	Interface	IP Address	Network	Subnet Mask	Default Gateway	Switch Port
<i>HM- Core</i>	C-Core to MSW1	E0/1	172.20.0.101	172.20.0.100 /30	255.255.255.252	N/A	E 1/0
	C-Core to MSW2	E0/2	172.20.0.105	172.20.0.104 /30	255.255.255.252	N/A	E 1/0
	C-Core to DC	E 1/2	172.20.0.129	172.20.0.128 /28	255.255.255.240	N/A	eth 0/0
	C-Core to ISP STC	multilink 4	145.0.0.14	145.0.0.12 /30	255.255.255.252	N/A	
	C-Core to ISP Mobily	multilink 6	145.0.0.22	145.0.0.20 /30	255.255.255.252	N/A	
	Loopback 0		200.0.0.1	200.0.0.1 /32	255.255.255.255	N/A	
<i>MS W1</i>	Accounting, vlan 10	E2/1	172.20.0.2	172.20.0.0 /27	255.255.255.224	172.20.0.1	E0/0
	HR , vlan 20	E2/0	172.20.0.34	172.20.0.32 /27	255.255.255.224	172.20.0.33	E0/0
	IT , vlan 30	E1/3	172.20.0.66	172.20.0.64 /28	255.255.255.240	172.20.0.65	E0/0
	Management, vlan40	E1/2	172.20.0.82	172.20.0.80 /28	255.255.255.240	172.20.0.81	E0/0
	MSW1 to MSW2	E0/0-3	172.20.0.97	172.20.0.96 /30	255.255.255.252	N/A	E0/0-3
	MSW1 to HM-Core	E 1/0	172.20.0.102	172.20.0.100 /30	255.255.255.252	N/A	E0/1
<i>MS W2</i>	Accounting, vlan 10	E2/1	172.20.0.3	172.20.0.0 /27	255.255.255.224	172.20.0.1	E0/1
	HR , vlan 20	E2/0	172.20.0.35	172.20.0.32 /27	255.255.255.224	172.20.0.33	E0/1
	IT , vlan 30	E1/3	172.20.0.67	172.20.0.64 /28	255.255.255.240	172.20.0.65	E0/1
	Management, vlan40	E1/2	172.20.0.83	172.20.0.80 /28	255.255.255.240	172.20.0.81	E0/1
	MSW2 to MSW1	E0/0-3	172.20.0.98	172.20.0.96 /30	255.255.255.252	N/A	E0/0-3
	MSW2 to HM-Core	E 1/0	172.20.0.106	172.20.0.104 /30	255.255.255.252	N/A	E0/2
<i>SW- Acc</i>	To MSW1, vlan 10	E0/0	172.20.0.4	172.20.0.0 /27	255.255.255.224	172.20.0.1	E2/1
	To MSW2, vlan 10	E0/1	172.20.0.4	172.20.0.0 /27	255.255.255.224	172.20.0.1	E2/1
<i>SW- HR</i>	To MSW1, vlan 20	E0/0	172.20.0.36	172.20.0.32 /27	255.255.255.224	172.20.0.33	E2/0
	To MSW2, vlan 20	E0/1	172.20.0.36	172.20.0.32 /27	255.255.255.224	172.20.0.33	E2/0

SW-IT	To MSW1, vlan 30	E0/0	172.20.0.68	172.20.0.64 /28	255.255.255.240	172.20.0.65	E1/3
	To MSW2, vlan 30	E0/1	172.20.0.68	172.20.0.64 /28	255.255.255.240	172.20.0.65	E1/3
SW-Manag	To MSW1, vlan 40	E0/0	172.20.0.84	172.20.0.80 /28	255.255.255.240	172.20.0.81	E1/2
	To MSW2, vlan 40	E0/1	172.20.0.84	172.20.0.80 /28	255.255.255.240	172.20.0.81	E1/2
DC	To HM-Core	E0/0	172.20.0.130	172.20.0.128 /28	255.255.255.240	172.20.0.129	E1/2

Addressing Table for Monsters, NC and CyberBooks

Device	Description	Interface	IP Address	Network	Subnet Mask	Default Gateway	Switch Port
RC-Core	<i>RC-Core to Zain</i>	multilink 9	145.0.0.34	145.0.0.32 /30	255.255.255.252	N/A	
	<i>RC-Core to Mobily</i>	multilink 7	145.0.0.26	145.0.0.24 /30	255.255.255.252	N/A	
	<i>RC-Core to SWMC</i>	E 0/0	172.20.1.49	172.20.1.48/30	255.255.255.252	N/A	E 0/0
SWMC	SWMC to RC-Core	E 0/0	172.20.1.50	172.20.1.48/30	255.255.255.252	172.20.1.49	
	Vlan 50	int vlan 50	172.20.1.1	172.20.1.0 / 28	255.255.255.240	N/A	E 0/1-3
	Vlan 60	int vlan 60	172.20.1.17	172.20.1.16 / 28	255.255.255.240	N/A	E 1/0-1
	Vlan 70	int vlan 70	172.20.1.33	172.20.1.32 / 28	255.255.255.240	N/A	E 1/2-3
BC-Core	<i>BC-Core to Zain</i>	multilink 8	145.0.0.34	145.0.0.32 /30	255.255.255.252	N/A	
	<i>RB-Core to STC</i>	multilink 5	145.0.0.26	145.0.0.24 /30	255.255.255.252	N/A	
	<i>RB-Core to SWMB</i>	E 0/0	172.20.2.49	172.20.2.48/30	255.255.255.252	N/A	E 0/0
SWMC	SWMB to RB-Core	E 0/0	172.20.2.50	172.20.2.48/30	255.255.255.252	172.20.2.49	
	Vlan 51	int vlan 51	172.20.2.1	172.20.2.0 / 28	255.255.255.240	N/A	E 0/1-3
	Vlan 61	int vlan 61	172.20.2.17	172.20.2.16 / 28	255.255.255.240	N/A	E 1/0-1
SW-M&S	Vlan 71	int vlan 71	172.20.2.33	172.20.2.32 / 28	255.255.255.240	N/A	E 1/2-3

Addressing Table for ISP STC

Device	Description	Interface	IP Address	Network	Subnet Mask	Default Gateway	Switch Port
<i>STC</i>	<i>STC to HM-core</i>	multilink 4	145.0.0.13	145.0.0.12 /30	255.255.255.252	N/A	
	<i>STC to RB-core</i>	multilink 5	145.0.0.17	145.0.0.16 /30	255.255.255.252	N/A	
	<i>STC to Mobily</i>	multilink 1	145.0.0.1	145.0.0.0 /30	255.255.255.252	N/A	
	<i>STC to Zain</i>	multilink 2	145.0.0.5	145.0.0.4 /30	255.255.255.252	N/A	
	RS-PE 1 to 2	E 0/0	179.0.0.1	179.0.0.0 / 24	255.255.255.0	N/A	E 0/0
	RS-PE 2 to 1	E 0/0	179.0.0.2	179.0.0.0 / 24	255.255.255.0	N/A	E 0/0
	RS-PE 1 to 3	E 0/1	179.0.1.1	179.0.1.0 / 24	255.255.255.0	N/A	E 0/1
	RS-PE 3 to 1	E 0/1	179.0.1.2	179.0.1.0 / 24	255.255.255.0	N/A	E 0/1
	RS-PE 2 to 3	E 0/2	179.0.2.1	179.0.2.0 / 24	255.255.255.0	N/A	E 0/2
	RS-PE 3 to 2	E 0/2	179.0.2.2	179.0.2.0 / 24	255.255.255.0	N/A	E 0/2
	RS-PE 1	loobpack0	179.0.3.1	179.0.3.1/ 32	255.255.255.255	N/A	
	RS-PE 2	loobpack0	179.0.4.1	179.0.4.1/ 32	255.255.255.255		
	RS-PE 3	loobpack0	179.0.5.1	179.0.5.1/ 32	255.255.255.255		

Addressing Table for ISP Mobily

Device	Description	Interface	IP Address	Network	Subnet Mask	Default Gateway	Switch Port
Mobily	<i>Mobily to HM-core</i>	multilink 6	145.0.0.21	145.0.0.20 /30	255.255.255.252	N/A	
	<i>Mobily to RC-core</i>	multilink 7	145.0.0.25	145.0.0.24 /30	255.255.255.252	N/A	
	<i>Mobily to STC</i>	multilink 1	145.0.0.2	145.0.0.0 /30	255.255.255.252	N/A	
	<i>Mobily to Zain</i>	multilink 3	145.0.0.9	145.0.0.8 /30	255.255.255.252	N/A	
	RM-PE 1 to 2	E 0/0	184.0.0.1	184.0.0.0 / 24	255.255.255.0	N/A	E 0/0
	RM-PE 2 to 1	E 0/0	184.0.0.2	184.0.0.0 / 24	255.255.255.0	N/A	E 0/0
	RM-PE 1 to 3	E 0/1	184.0.1.1	184.0.1.0 / 24	255.255.255.0	N/A	E 0/1
	RM-PE 3 to 1	E 0/1	184.0.1.2	184.0.1.0 / 24	255.255.255.0	N/A	E 0/1
	RM-PE 2 to 3	E 0/2	184.0.2.1	184.0.2.0 / 24	255.255.255.0	N/A	E 0/2
	RM-PE 3 to 2	E 0/2	184.0.2.2	184.0.2.0 / 24	255.255.255.0	N/A	E 0/2
	RM-PE 1	loobpack0	184.0.3.1	184.0.3.1/ 32	255.255.255.255	N/A	
	RM-PE 2	loobpack0	184.0.4.1	184.0.4.1/ 32	255.255.255.255		
	RM-PE 3	loobpack0	184.0.5.1	184.0.5.1/ 32	255.255.255.255		

Addressing Table for ISP Zain

Device	Description	Interface	IP Address	Network	Subnet Mask	Default Gateway	Switch Port
Zain	<i>Zain to RB-core</i>	multilink 8	145.0.0.29	145.0.0.28 /30	255.255.255.252	N/A	
	<i>Zain to RC-core</i>	multilink 9	145.0.0.33	145.0.0.32 /30	255.255.255.252	N/A	
	<i>Zain to STC</i>	multilink 2	145.0.0.6	145.0.0.4 /30	255.255.255.252	N/A	
	<i>Zain to Mobily</i>	multilink 3	145.0.0.10	145.0.0.8 /30	255.255.255.252	N/A	
	RZ-PE 1 to 2	E 0/0	107.0.0.1	107.0.0.0 / 24	255.255.255.0	N/A	E 0/0
	RZ-PE 2 to 1	E 0/0	107.0.0.2	107.0.0.0 / 24	255.255.255.0	N/A	E 0/0
	RZ-PE 1 to 3	E 0/1	107.0.1.1	107.0.1.0 / 24	255.255.255.0	N/A	E 0/1
	RZ-PE 3 to 1	E 0/1	107.0.1.2	107.0.1.0 / 24	255.255.255.0	N/A	E 0/1
	RZ-PE 2 to 3	E 0/2	107.0.2.1	107.0.2.0 / 24	255.255.255.0	N/A	E 0/2
	RZ-PE 3 to 2	E 0/2	107.0.2.2	107.0.2.0 / 24	255.255.255.0	N/A	E 0/2
	RZ-PE 1	loobpack0	107.0.3.1	107.0.3.1/ 32	255.255.255.255	N/A	
	RZ-PE 2	loobpack0	107.0.4.1	107.0.4.1/ 32	255.255.255.255		
	RZ-PE 3	loobpack0	107.0.5.1	107.0.5.1/ 32	255.255.255.255		

4.2.2 Install EVE-NG simulator:

Use EVE-NG to simulate the network, ensuring all configurations and integrations function as expected under various scenarios.

Requirements:

- A computer with at least 16GB of RAM (32GB recommended for larger labs).
- At least 4 CPU cores (8 recommended).
- 100GB of free disk space (SSD recommended).

Download EVE-NG:

Download the EVE-NG Community Edition ISO: Visit the EVE-NG download page and download the Community Edition ISO.

Install EVE-NG:

Follow the Installation Steps: Boot from the ISO and follow the on-screen instructions. You will need to:

- Select your language and region.
- Set up the network (choose static or DHCP).
- Partition your disk and install the base system.

Use the IP address to access Login page of EVE-NG:

```
Eve-NG (default root password is 'eve')
Use http://192.168.100.19/
eve-ng login: root
Password:
```

Figure 33: Terminal Login of EVE-ng.



Figure 32: Login Page of EVE-ng in browser.

Upload and Configure Device Images:

Upload Device Images: Using WinSCP, upload your device images to /opt/unetlab addons/qemu/.

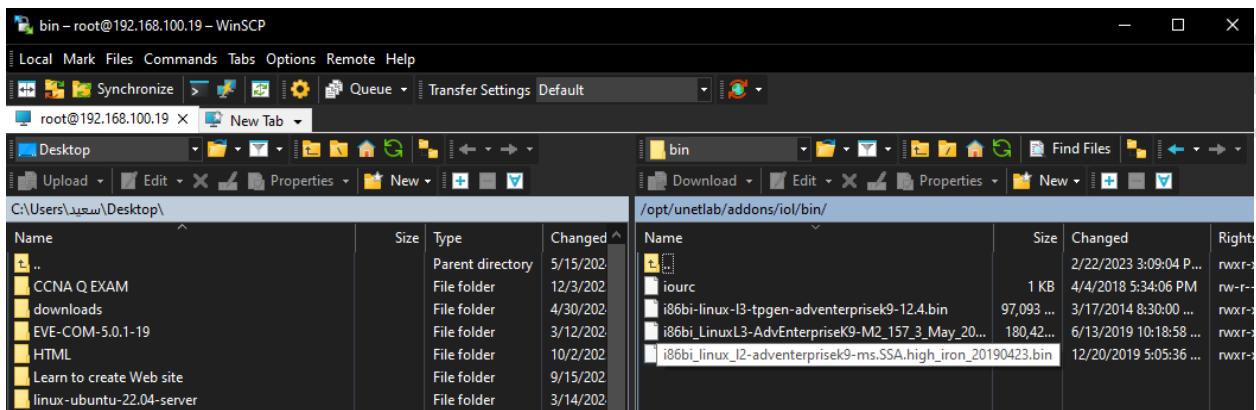


Figure 34: WinSCP connection with EVE-ng machine to upload the images.

Set Up Project Network

- ❖ Create a New Lab:
 - Log into the EVE-NG web interface.
 - Click on + to create a new lab.
 - Name your lab and provide a description if needed.

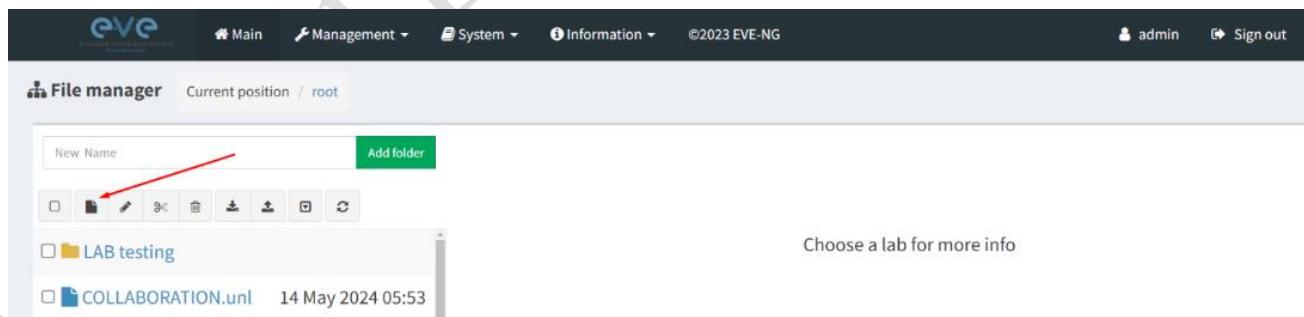


Figure 35: Create new lab in EVE-mg.

❖ Add Nodes:

- In your lab workspace, right-click and select **Add a new node**.
 - Choose the type of device you want to add (e.g., Cisco vIOS).
 - Configure the node settings (name, number of interfaces, etc.).

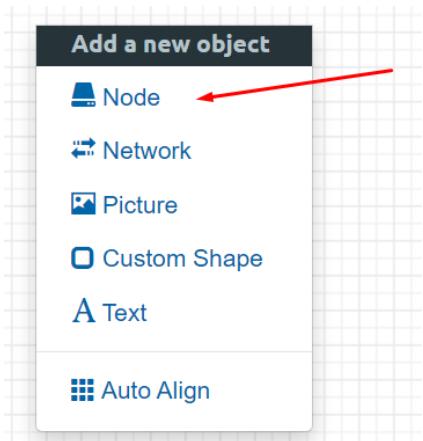


Figure 37: Add Node.

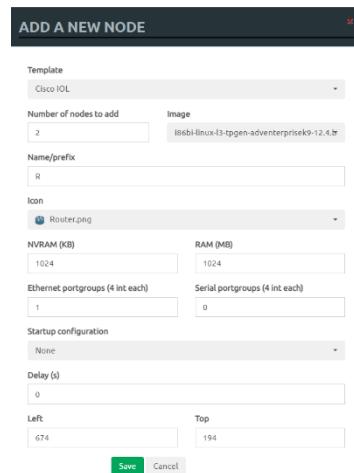


Figure 36: Choose the node image.

❖ Configure Nodes:

- Start the nodes by right-clicking and selecting **Start**.
 - Open the console for each node to configure it as needed for your project.

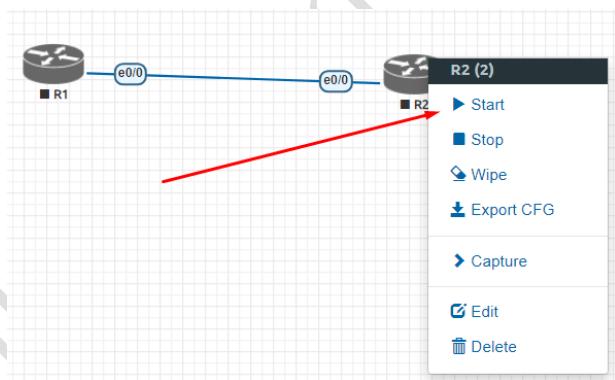


Figure 39: Start the node to start configuration.

Figure 38: Connect to the router via ssh.

4.2.3 Setup of Networking Devices

Setting up networking devices involves configuring routers, switches, and servers to meet the specified architecture and ensure efficient, secure network operations.

1. Routers Configuration:

- ❖ **Interfaces Setup:** Configure each router's interfaces to connect to appropriate network segments, ISPs, and other routers. This involves setting IP addresses, subnet masks, and ensuring interfaces are activated.
- ❖ **Routing Protocols:**
 - **OSPF:** Set up OSPF for internal routing within each company's network.
Configure OSPF areas, network statements, and ensure all routers and multilayer switches participate in OSPF.

```
HM-Core#show ip ospf topology-info

        OSPF Router with ID (200.0.0.1) (Process ID 200)

        Base Topology (MTID 0)

Topology priority is 64
Redistributing External Routes from,
Router is not originating router-LSAs with maximum metric
Number of areas transit capable is 0
Initial SPF schedule delay 5000 msec
Minimum hold time between two consecutive SPFs 10000 msec
Maximum wait time between two consecutive SPFs 10000 msec
Area BACKBONE(0)
    SPF algorithm last executed 00:15:13.794 ago
    SPF algorithm executed 7 times
    Area ranges are
Area 1
    SPF algorithm last executed 00:16:09.550 ago
    SPF algorithm executed 6 times
    Area ranges are
HM-Core#
```

Figure 40: Show ip ospf topology-info command of HM-Core router in BlueTech Company.

```

HM-Core#sh ip route
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
      D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
      N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
      E1 - OSPF external type 1, E2 - OSPF external type 2
      i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
      ia - IS-IS inter area, * - candidate default, U - per-user static route
      o - ODR, P - periodic downloaded static route, H - NHRP, l - LISP
      a - application route
      + - replicated route, % - next hop override, p - overrides from PfR

Gateway of last resort is 145.0.0.13 to network 0.0.0.0

S*   0.0.0.0/0 [1/0] via 145.0.0.13
     37.0.0.0/32 is subnetted, 1 subnets
O IA   37.0.0.1 [110/75] via 145.0.0.13, 00:06:10, Multilink4
     107.0.0.0/8 is variably subnetted, 6 subnets, 2 masks
O     107.0.0.0/24 [110/84] via 145.0.0.13, 00:06:10, Multilink4
O     107.0.0.0/24 [110/94] via 145.0.0.13, 00:06:10, Multilink4
O     107.0.3.1/32 [110/75] via 145.0.0.13, 00:06:20, Multilink4
O     107.0.4.1/32 [110/85] via 145.0.0.13, 00:06:10, Multilink4
O     107.0.5.1/32 [110/85] via 145.0.0.13, 00:06:10, Multilink4
145.0.0.0/16 is variably subnetted, 13 subnets, 2 masks
O     145.0.0.0/30 [110/74] via 145.0.0.13, 00:06:20, Multilink4
O     145.0.0.4/30 [110/74] via 145.0.0.13, 00:06:20, Multilink4
O     145.0.0.8/30 [110/106] via 145.0.0.21, 00:06:20, Multilink4
          [110/106] via 145.0.0.13, 00:06:20, Multilink4
C     145.0.0.12/30 is directly connected, Multilink4
C     145.0.0.13/32 is directly connected, Multilink4
L     145.0.0.14/32 is directly connected, Multilink4
O     145.0.0.16/30 [110/74] via 145.0.0.13, 00:06:10, Multilink4
C     145.0.0.20/30 is directly connected, Multilink6
C     145.0.0.21/32 is directly connected, Multilink6
L     145.0.0.22/32 is directly connected, Multilink6
O     145.0.0.24/30 [110/106] via 145.0.0.21, 00:06:20, Multilink6
O     145.0.0.28/30 [110/106] via 145.0.0.13, 00:06:10, Multilink4
O     145.0.0.32/30 [110/116] via 145.0.0.13, 00:06:10, Multilink4
172.20.0.0/16 is variably subnetted, 19 subnets, 4 masks
O     172.20.0.0/27 [110/11] via 172.20.0.102, 00:07:16, Ethernets0/1
O     172.20.0.32/27 [110/11] via 172.20.0.102, 00:07:16, Ethernets0/1
O     172.20.0.64/28 [110/11] via 172.20.0.102, 00:07:16, Ethernets0/1
O     172.20.0.80/28 [110/11] via 172.20.0.102, 00:07:16, Ethernets0/1
O     172.20.0.96/30 [110/12] via 172.20.0.106, 00:07:16, Ethernets0/2
          [110/12] via 172.20.0.102, 00:07:16, Ethernets0/1
C     172.20.0.100/30 is directly connected, Ethernets0/1
L     172.20.0.101/32 is directly connected, Ethernets0/1
C     172.20.0.104/30 is directly connected, Ethernets0/2
L     172.20.0.105/32 is directly connected, Ethernets0/2
C     172.20.0.128/28 is directly connected, Ethernets1/2
L     172.20.0.129/32 is directly connected, Ethernets1/2
O IA   172.20.1.0/28 [110/117] via 145.0.0.21, 00:05:56, Multilink6
O IA   172.20.1.16/28 [110/117] via 145.0.0.21, 00:05:56, Multilink6
O IA   172.20.1.32/28 [110/117] via 145.0.0.21, 00:05:56, Multilink6
O IA   172.20.1.48/30 [110/116] via 145.0.0.21, 00:06:20, Multilink6

```

Figure 41: Show ip route command of HM-Core router in BlueTech Company.

```

O IA   172.20.1.48/30 [110/116] via 145.0.0.21, 00:06:20, Multilink6
O IA   172.20.2.0/28 [110/85] via 145.0.0.13, 00:05:58, Multilink4
O IA   172.20.2.16/28 [110/85] via 145.0.0.13, 00:05:58, Multilink4
O IA   172.20.2.32/28 [110/85] via 145.0.0.13, 00:05:58, Multilink4
O IA   172.20.2.48/30 [110/84] via 145.0.0.13, 00:06:10, Multilink4
179.0.0.0/16 is variably subnetted, 6 subnets, 2 masks
O     179.0.0.0/24 [110/42] via 145.0.0.13, 00:06:56, Multilink4
O     179.0.1.0/24 [110/52] via 145.0.0.13, 00:06:20, Multilink4
O     179.0.2.0/24 [110/42] via 145.0.0.13, 00:06:20, Multilink4
O     179.0.3.1/32 [110/43] via 145.0.0.13, 00:06:20, Multilink4
O     179.0.4.1/32 [110/33] via 145.0.0.13, 00:06:56, Multilink4
O     179.0.5.1/32 [110/43] via 145.0.0.13, 00:06:10, Multilink4
184.0.0.0/16 is variably subnetted, 6 subnets, 2 masks
O     184.0.0.0/24 [110/74] via 145.0.0.21, 00:06:20, Multilink6
O     184.0.1.0/24 [110/74] via 145.0.0.21, 00:06:30, Multilink6
O     184.0.2.0/24 [110/84] via 145.0.0.21, 00:06:20, Multilink6
          [110/84] via 145.0.0.13, 00:06:20, Multilink4
O     184.0.3.1/32 [110/65] via 145.0.0.21, 00:07:06, Multilink6
O     184.0.4.1/32 [110/75] via 145.0.0.21, 00:06:20, Multilink6
          [110/75] via 145.0.0.13, 00:06:20, Multilink4
O     184.0.5.1/32 [110/75] via 145.0.0.21, 00:06:20, Multilink6
200.0.0.0/32 is subnetted, 1 subnets
C     200.0.0.1 is directly connected, Loopback0

```

Figure 42: Remain result of Figure 37.

2. Switches Configuration

Configuring switches is a crucial step in setting up a network. Here's a more detailed breakdown of how switches should be configured, including settings for access ports:

❖ VLAN Setup:

- **Definition:** Create VLANs on switches to segment the network logically according to departmental or functional requirements. This helps in managing broadcast domains effectively and enhances security.
- **Configuration:** Assign VLAN IDs and names for easier management. For example, VLAN 10 for the Accounting department, VLAN 20 for HR, etc.

```
SW-Management#show vlan brief
VLAN Name                               Status    Ports
---- -----
1   default                             active
40  Management                          active   Et0/2, Et0/3
999 Block                             active   Et1/0, Et1/1, Et1/2, Et1/3
                                         Et2/0, Et2/1, Et2/2, Et2/3
                                         Et3/0, Et3/1, Et3/2, Et3/3
                                         Et4/0, Et4/1, Et4/2, Et4/3
                                         Et5/0, Et5/1, Et5/2, Et5/3
1002 fddi-default                      act/unsup
1003 token-ring-default                act/unsup
1004 fddinet-default                  act/unsup
1005 trnet-default                    act/unsup
SW-Management#
```

Figure 43: Show vlan brief from Switch of Management department.

```
SW-HR#show vlan brief
VLAN Name                               Status    Ports
---- -----
1   default                             active
20  HR                                 active   Et0/2, Et0/3, Et1/0, Et1/1
                                         Et1/2, Et1/3, Et2/0, Et2/1
                                         Et2/2, Et2/3, Et3/0, Et3/1
                                         Et3/2, Et3/3, Et4/0, Et4/1
                                         Et4/2, Et4/3, Et5/0, Et5/1
                                         Et5/2, Et5/3
1002 fddi-default                      act/unsup
1003 token-ring-default                act/unsup
1004 fddinet-default                  act/unsup
1005 trnet-default                    act/unsup
SW-HR#
SW-HR#
```

Figure 44: Show vlan brief from Switch of HR department.

Trunking:

Purpose: Trunks carry traffic from multiple VLANs across a single physical link between switches or between switches and routers using tagging protocols like IEEE 802.1Q.

Configuration: Enable trunking on ports connected to other switches or to routers. Set the native VLAN and allowed VLANs list to control which VLANs can pass through the trunk.

```
MSW1#show interfaces trunk

  Port      Mode        Encapsulation  Status      Native vlan
  Etl/2     on          802.1q        trunking    1
  Etl/3     on          802.1q        trunking    1
  Et2/0     on          802.1q        trunking    1
  Et2/1     on          802.1q        trunking    1

  Port      Vlans allowed on trunk
  Etl/2     1-4094
  Etl/3     1-4094
  Et2/0     1-4094
  Et2/1     1-4094

  Port      Vlans allowed and active in management domain
  Etl/2     1,10,20,30,40
  Etl/3     1,10,20,30,40
  Et2/0     1,10,20,30,40
  Et2/1     1,10,20,30,40

  Port      Vlans in spanning tree forwarding state and not pruned
  Etl/2     1,10,20,30,40
  Etl/3     1,10,20,30,40
  Et2/0     1,10,20,30,40
  Et2/1     1,10,20,30,40
MSW1#
```

Figure 45: Show interfaces trunk command of MSW1 Multilayer Switches in BlueTech Company.

Access Ports:

- **Purpose:** Access ports connect end devices like computers, printers, and VoIP phones to the network. Each access port carries traffic for a single VLAN.

Configuration:

- Set each access port to a specific VLAN based on the connected device's location and role in the organization.
- Configure the port mode to "access" to ensure it belongs to only one VLAN at a time.

```
SWMC#show vlan brief

VLAN Name          Status    Ports
---- -----
1    default        active
50   Customer_Service active    Et0/1, Et0/2, Et0/3
60   Book_Manager   active    Et1/0, Et1/1
70   Admin          active    Et1/2, Et1/3
999  Block          active    Et2/0, Et2/1, Et2/2, Et2/3
1002 fddi-default  act/unsup
1003 token-ring-default act/unsup
1004 fddinet-default act/unsup
1005 trnet-default  act/unsup
SWMC#
SWMC#
```

Figure 46: By using command `show vlan brief`, shows how to display VLAN information for access ports.

Interconnections:

- Use Ethernet cables to interconnect switches and routers within the company.
- Connect end devices to access switches and ensure they are part of the appropriate VLANs for segregation and security.
- Use Serial cables that encapsulated two link as one link (Multilink) to interconnect Core layer device of company to routers of ISP.

4.2.4 Configuration of Redundancy Protocols.

Redundancy protocols are essential in a network to ensure continuous operation and high availability by providing alternative paths and failover mechanisms. Here's how to configure HSRP, EtherChannel, and Multilink:

HSRP (Hot Standby Router Protocol)

- **Purpose:** Provides network redundancy for IP hosts on an Ethernet network by maintaining a standby router ready to take over if the primary router fails.
- **Configuration:**
 - **Virtual IP Assignment:** Assign a virtual IP address that all client devices will use as their default gateway. This IP does not belong to a real interface but to the virtual router created by HSRP.
 - **Router Participation:** Configure two or more routers in each critical subnet to participate in HSRP. Designate one as the active router and at least one as the standby router.
 - **Priority Settings:** Set priorities to determine which router acts as the active router and which one as standby. Typically, a higher priority value indicates a preferred active router.
 - **Preemption:** Enable preemption to allow a higher priority router to reclaim the role of the active router when it comes online after a failure.

```
MSW1#
MSW1#show standby brief
                  P indicates configured to preempt.
|
Interface  Grp  Pri  P State   Active          Standby           Virtual IP
V110       10   120  P Active local      172.20.0.3    172.20.0.1
V120       20   120  P Active local      172.20.0.35   172.20.0.33
V130       30   120  P Active local      172.20.0.67   172.20.0.65
V140       40   120  P Active local      172.20.0.83   172.20.0.81
MSW1#
MSW1#
```

Figure 47: Show HSRP configuration in MSW1.

Show standby command MSW1 Multilayer Switches (Active) in BlueTech Company

MSW1 is Active to all vlans (vlan 10 , 20 , 30 , and 40).

```
MSW1#
MSW1#show standby
Vlan10 - Group 10 (version 2)
  State is Active
    2 state changes, last state change 00:20:22
  Virtual IP address is 172.20.0.1
  Active virtual MAC address is 0000.0c9f.f00a (MAC In Use)
    Local virtual MAC address is 0000.0c9f.f00a (v2 default)
  Hello time 3 sec, hold time 10 sec
    Next hello sent in 1.280 secs
  Preemption enabled
  Active router is local
  Standby router is 172.20.0.3, priority 90 (expires in 9.904 sec)
    Priority 120 (configured 120)
    Group name is "hsrp-V110-10" (default)
Vlan20 - Group 20 (version 2)
  State is Active
    2 state changes, last state change 00:20:21
  Virtual IP address is 172.20.0.33
  Active virtual MAC address is 0000.0c9f.f014 (MAC In Use)
    Local virtual MAC address is 0000.0c9f.f014 (v2 default)
  Hello time 3 sec, hold time 10 sec
    Next hello sent in 2.464 secs
  Preemption enabled
  Active router is local
  Standby router is 172.20.0.35, priority 90 (expires in 11.040 sec)
    Priority 120 (configured 120)
    Group name is "hsrp-V120-20" (default)
Vlan30 - Group 30 (version 2)
  State is Active
    2 state changes, last state change 00:20:21
  Virtual IP address is 172.20.0.65
  Active virtual MAC address is 0000.0c9f.f01e (MAC In Use)
    Local virtual MAC address is 0000.0c9f.f01e (v2 default)
  Hello time 3 sec, hold time 10 sec
    Next hello sent in 1.040 secs
  Preemption enabled
  Active router is local
  Standby router is 172.20.0.67, priority 90 (expires in 9.280 sec)
    Priority 120 (configured 120)
    Group name is "hsrp-V130-30" (default)
Vlan40 - Group 40 (version 2)
  State is Active
    2 state changes, last state change 00:20:21
  Virtual IP address is 172.20.0.81
  Active virtual MAC address is 0000.0c9f.f028 (MAC In Use)
    Local virtual MAC address is 0000.0c9f.f028 (v2 default)
  Hello time 3 sec, hold time 10 sec
    Next hello sent in 0.352 secs
  Preemption enabled
  Active router is local
  Standby router is 172.20.0.83, priority 90 (expires in 8.752 sec)
    Priority 120 (configured 120)
    Group name is "hsrp-V140-40" (default)
MSW1#
```

Figure 48: Show standby command MSW1 in BlueTech company.

Show standby command MSW2 Multilayer Switches (Standby) in BlueTech Company

MSW1 is Standby to all vlans (vlan 10 , 20 , 30 , and 40).

```
MSW2#show standby
Vlan10 - Group 10 (version 2)
  State is Standby
    4 state changes, last state change 00:07:15
  Virtual IP address is 172.20.0.1
  Active virtual MAC address is 0000.0c9f.f00a (MAC Not In Use)
    Local virtual MAC address is 0000.0c9f.f00a (v2 default)
  Hello time 3 sec, hold time 10 sec
    Next hello sent in 1.232 secs
  Preemption enabled
  Active router is 172.20.0.2, priority 120 (expires in 10.224 sec)
    MAC address is aabb.cc80.1000
  Standby router is local
  Priority 90 (configured 90)
  Group name is "hsrp-Vl10-10" (default)
Vlan20 - Group 20 (version 2)
  State is Standby
    4 state changes, last state change 00:07:15
  Virtual IP address is 172.20.0.33
  Active virtual MAC address is 0000.0c9f.f014 (MAC Not In Use)
    Local virtual MAC address is 0000.0c9f.f014 (v2 default)
  Hello time 3 sec, hold time 10 sec
    Next hello sent in 0.976 secs
  Preemption enabled
  Active router is 172.20.0.34, priority 120 (expires in 9.712 sec)
    MAC address is aabb.cc80.1000
  Standby router is local
  Priority 90 (configured 90)
  Group name is "hsrp-Vl20-20" (default)
Vlan30 - Group 30 (version 2)
  State is Standby
    4 state changes, last state change 00:07:17
  Virtual IP address is 172.20.0.65
  Active virtual MAC address is 0000.0c9f.f01e (MAC Not In Use)
    Local virtual MAC address is 0000.0c9f.f01e (v2 default)
  Hello time 3 sec, hold time 10 sec
    Next hello sent in 1.616 secs
  Preemption enabled
  Active router is 172.20.0.66, priority 120 (expires in 9.776 sec)
    MAC address is aabb.cc80.1000
  Standby router is local
  Priority 90 (configured 90)
  Group name is "hsrp-Vl30-30" (default)
Vlan40 - Group 40 (version 2)
  State is Standby
    4 state changes, last state change 00:07:21
  Virtual IP address is 172.20.0.81
  Active virtual MAC address is 0000.0c9f.f028 (MAC Not In Use)
    Local virtual MAC address is 0000.0c9f.f028 (v2 default)
  Hello time 3 sec, hold time 10 sec
    Next hello sent in 1.296 secs
  Preemption enabled
  Active router is 172.20.0.82, priority 120 (expires in 9.968 sec)
    MAC address is aabb.cc80.1000
  Standby router is local
  Priority 90 (configured 90)
  Group name is "hsrp-Vl40-40" (default)
MSW2#
MSW2#
```

Figure 49: Show standby command MSW2 in BlueTech company.

EtherChannel

- **Purpose:** Combines multiple physical Ethernet links into a single logical link to provide increased bandwidth and fault tolerance.
- **Configuration:**
 - **Interface Selection:** Select the interfaces on Cisco switches that will be grouped into an EtherChannel.
 - **Mode Configuration:** Configure the EtherChannel mode, choosing between LACP (Link Aggregation Control Protocol) or PAgP (Port Aggregation Protocol) depending on your network equipment and requirements. We selected LACP
 - **Consistent Settings:** Ensure all interfaces in the EtherChannel have identical configurations for speed, duplex, VLANs, and other switchport settings to prevent issues and ensure a seamless flow of traffic.

```
MSW1#
MSW1#
MSW1#show etherchannel summary
Flags:  D - down      P - bundled in port-channel
        I - stand-alone S - suspended
        H - Hot-standby (LACP only)
        R - Layer3      S - Layer2
        U - in use      N - not in use, no aggregation
        f - failed to allocate aggregator

        M - not in use, minimum links not met
        m - not in use, port not aggregated due to minimum links not met
        u - unsuitable for bundling
        w - waiting to be aggregated
        d - default port

        A - formed by Auto LAG

Number of channel-groups in use: 1
Number of aggregators:          1

Group  Port-channel  Protocol    Ports
-----+-----+-----+
  12    Po12 (RU)    LACP        Et0/0 (P)    Et0/1 (P)    Et0/2 (P)
                                         Et0/3 (P)
```

Figure 50: EtherChannel Layer 3 with protocol LACP between MSW1 and MSW2.

Multilink PPP (Point-to-Point Protocol)

- ❖ **Purpose:** Multilink PPP is used to aggregate multiple WAN links into a single logical link, providing increased bandwidth and redundancy.
- ❖ **Configuration:**
 - **Link Grouping:** Identify the interfaces that will be included in the Multilink bundle. These could be serial interfaces connecting to different ISPs or different routers.
 - **Bundle Creation:** Configure a virtual Multilink interface on the router that represents the aggregated links.
 - **Interface Association:** Associate each physical interface with the Multilink interface. This configuration aggregates the bandwidth and shares the load across the physical links.
 - **PPP Configuration:** Apply PPP encapsulation to the Multilink interface to ensure all links in the bundle can transport packets as a single connection. This setup also allows for more advanced configurations, such as dynamic bandwidth allocation and load balancing.
 - We use Multilink between companies and ISPs, and also between different ISPs.

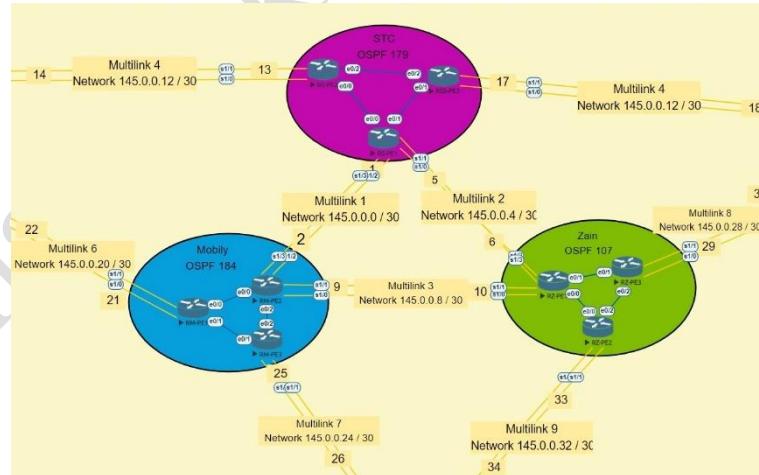


Figure 51: Multilink between companies and ISPs.

4.2.5 DHCP Configuration.

Dynamic Host Configuration Protocol (DHCP) is crucial for managing IP address allocation efficiently in large networks. In a network where DHCP services are implemented on different

layers—either on a multilayer switch at the distribution layer for some companies or directly on routers at the core layer for others—the approach focuses on leveraging the capabilities of these devices to manage IP address allocation efficiently.

Scalability and Flexibility: DHCP simplifies the process of adding new devices to the network and adjusting to changes in network topology or size.

1. DHCP Implementation on Network Devices:

- ❖ **DHCP on Multilayer Switches (Distribution Layer):**
 - Deployment: Implement DHCP directly on multilayer switches in the distribution layer for companies where centralized control over IP management is less critical or where rapid deployment is prioritized. This setup benefits environments with high density of end devices and direct switch-to-device connections.
- ❖ **DHCP on Routers (Core Layer):**
 - Deployment: For companies requiring robust centralized control and higher reliability, deploying DHCP on routers at the core layer is advantageous. This is particularly effective in networks with multiple VLANs that span broad geographic locations.

2. Scope Configuration:

- **Define Scopes:** Create DHCP scopes for each VLAN or subnet. A scope is a range of IP addresses that the DHCP server can allocate to clients. Each scope should correspond to a different segment of the network, typically defined by VLANs.
- **Scope Options:** Configure options for each scope, including:
- **Default Gateway:** Typically, the IP address of the router interface on the VLAN.
- **Subnet Mask:** Appropriate subnet mask for the VLAN.
- **DNS Servers:** IP addresses of the internal or external DNS servers that the clients should use.

- PC's get IP Address from DHCP

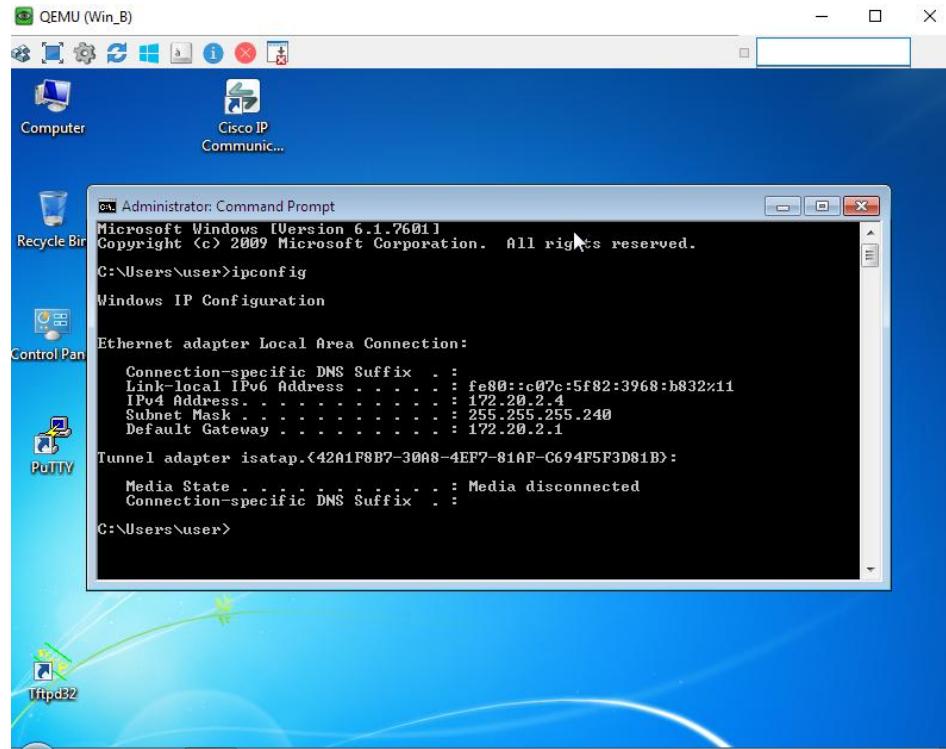


Figure 52: PC1 with Win7 getting an IP Address.

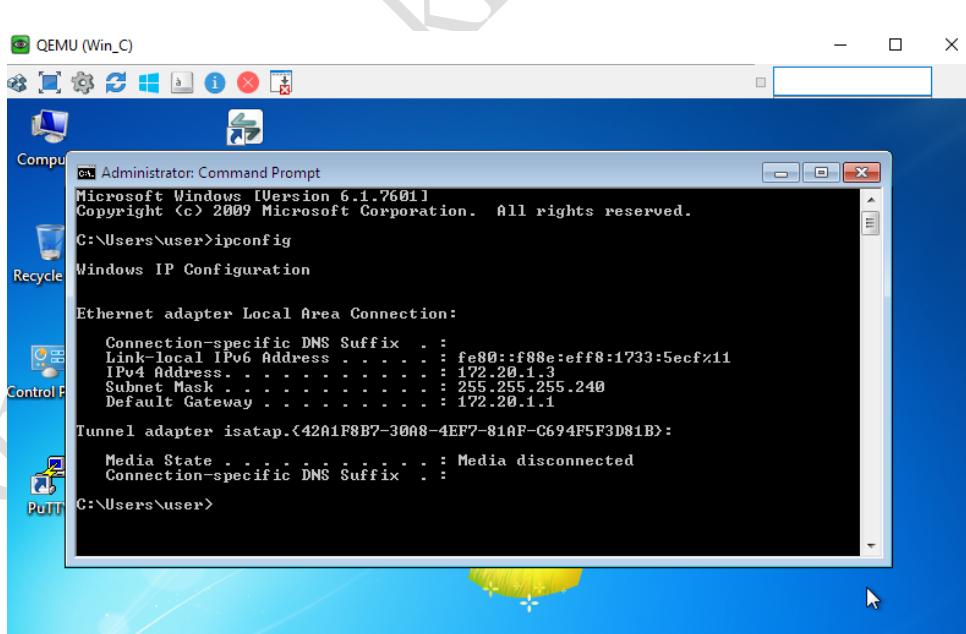


Figure 53: PC2 with Win7 getting an IP Address.

- All DHCP Pool on MSW1 of BlueTech Company

```

MSW1#
MSW1#sh ip dhcp pool

Pool Accounting :
  Utilization mark (high/low)      : 100 / 0
  Subnet size (first/next)        : 0 / 0
  Total addresses                 : 30
  Leased addresses                : 3
  Excluded addresses              : 4
  Pending event                   : none
  1 subnet is currently in the pool :
    Current index      IP address range           Leased/Excluded/Total
    172.20.0.9          172.20.0.1      - 172.20.0.30      3      / 4      / 30

Pool HR :
  Utilization mark (high/low)      : 100 / 0
  Subnet size (first/next)        : 0 / 0
  Total addresses                 : 30
  Leased addresses                : 3
  Excluded addresses              : 3
  Pending event                   : none
  1 subnet is currently in the pool :
    Current index      IP address range           Leased/Excluded/Total
    172.20.0.40         172.20.0.33      - 172.20.0.62      3      / 3      / 30

Pool IT :
  Utilization mark (high/low)      : 100 / 0
  Subnet size (first/next)        : 0 / 0
  Total addresses                 : 14
  Leased addresses                : 2
  Excluded addresses              : 3
  Pending event                   : none
  1 subnet is currently in the pool :
    Current index      IP address range           Leased/Excluded/Total
    172.20.0.70         172.20.0.65      - 172.20.0.78      2      / 3      / 14

Pool Management :
  Utilization mark (high/low)      : 100 / 0
  Subnet size (first/next)        : 0 / 0
  Total addresses                 : 14
  Leased addresses                : 1
  Excluded addresses              : 3
  Pending event                   : none
  1 subnet is currently in the pool :
    Current index      IP address range           Leased/Excluded/Total
    172.20.0.85         172.20.0.81      - 172.20.0.94      1      / 3      / 14
MSW1#
MSW1#

```

Figure 54: DHCP Pool in MSW1 BlueTech.

```

MSW1#sh ip dhcp binding
Bindings from all pools not associated with VRF:
IP address      Client-ID/          Lease expiration       Type      State       Interface
                  Hardware address/
                  User name
172.20.0.5      0100.5079.6668.1c   May 20 2024 05:05 PM  Automatic  Active     Vlan10
172.20.0.8      0100.5079.6668.1a   May 20 2024 05:07 PM  Automatic  Active     Vlan10
172.20.0.37     0100.5079.6668.27   May 20 2024 05:04 PM  Automatic  Active     Vlan20
172.20.0.40     0100.5079.6668.2c   May 19 2024 05:20 PM  Automatic  Selecting  Vlan20
172.20.0.70     0100.5079.6668.2b   May 19 2024 05:20 PM  Automatic  Selecting  Vlan30
172.20.0.71     0100.5079.6668.2a   May 19 2024 05:20 PM  Automatic  Selecting  Vlan30
172.20.0.84     0100.5079.6668.24   May 20 2024 05:02 PM  Automatic  Active     Vlan40
MSW1#
MSW1#

```

Figure 55: DHCP binding MSW1 BlueTech.

- All DHCP pool on RC-Core of **CyberBooks** Company.

```

RC-Core#
RC-Core#show ip dhcp pool

Pool VLAN50 :
  Utilization mark (high/low)      : 100 / 0
  Subnet size (first/next)        : 0 / 0
  Total addresses                 : 14
  Leased addresses                : 2
  Pending event                  : none
  1 subnet is currently in the pool :
    Current index          IP address range           Leased addresses
    172.20.1.4            172.20.1.1       - 172.20.1.14      2

Pool VLAN60 :
  Utilization mark (high/low)      : 100 / 0
  Subnet size (first/next)        : 0 / 0
  Total addresses                 : 14
  Leased addresses                : 2
  Pending event                  : none
  1 subnet is currently in the pool :
    Current index          IP address range           Leased addresses
    172.20.1.20           172.20.1.17       - 172.20.1.30      2

Pool VLAN70 :
  Utilization mark (high/low)      : 100 / 0
  Subnet size (first/next)        : 0 / 0
  Total addresses                 : 14
  Leased addresses                : 2
  Pending event                  : none
  1 subnet is currently in the pool :
    Current index          IP address range           Leased addresses
    172.20.1.36           172.20.1.33       - 172.20.1.46      2
RC-Core#
RC-Core#

```

Figure 56: DHCP Pool in RC-Core CyberBooks.

```

RC-Core#
RC-Core#show ip dhcp binding
Bindings from all pools not associated with VRF:
IP address      Client-ID/
                           Hardware address/
                           User name
172.20.1.2      0100.5079.6668.1f
172.20.1.3      0100.5079.6668.2e
172.20.1.18     0100.5079.6668.23
172.20.1.19     0100.5079.6668.28
172.20.1.34     0100.5079.6668.2d
172.20.1.35     0100.5079.6668.29
RC-Core#

```

Figure 57: DHCP binding RC-Core CyberBooks.

- All DHCP pool on RB-Core of Monsters, Inc Company

```

RB-Core#
RB-Core#show ip dhcp pool

Pool VLAN55 :
  Utilization mark (high/low)      : 100 / 0
  Subnet size (first/next)        : 0 / 0
  Total addresses                 : 14
  Leased addresses                : 2
  Pending event                  : none
  1 subnet is currently in the pool :
    Current index          IP address range           Leased addresses
    172.20.2.4            172.20.2.1      - 172.20.2.14      2

Pool VLAN66 :
  Utilization mark (high/low)      : 100 / 0
  Subnet size (first/next)        : 0 / 0
  Total addresses                 : 14
  Leased addresses                : 2
  Pending event                  : none
  1 subnet is currently in the pool :
    Current index          IP address range           Leased addresses
    172.20.2.20           172.20.2.17      - 172.20.2.30      2

Pool VLAN77 :
  Utilization mark (high/low)      : 100 / 0
  Subnet size (first/next)        : 0 / 0
  Total addresses                 : 14
  Leased addresses                : 2
  Pending event                  : none
  1 subnet is currently in the pool :
    Current index          IP address range           Leased addresses
    172.20.2.36           172.20.2.33      - 172.20.2.46      2
RB-Core#
RB-Core#

```

Figure 58: DHCP Pool RB-Core Monsters, Inc.

```

RB-Core#
RB-Core#show ip dhcp binding
Bindings from all pools not associated with VRF:
IP address      Client-ID/             Lease expiration       Type
               Hardware address/
               User name
172.20.2.2      0100.5079.6668.1e   May 20 2024 06:00 PM  Automatic
172.20.2.3      0100.5079.6668.20   May 20 2024 06:00 PM  Automatic
172.20.2.18     0100.5079.6668.18   May 20 2024 06:00 PM  Automatic
172.20.2.19     0100.5079.6668.21   May 20 2024 06:01 PM  Automatic
172.20.2.34     0100.5079.6668.16   May 20 2024 06:01 PM  Automatic
172.20.2.35     0100.5079.6668.17   May 20 2024 06:01 PM  Automatic
RB-Core#

```

Figure 59: DHCP Pool RB-Core Monsters, Inc.

4.2.6 Security Deployment: VPN, DHCP Snooping, and DAI.

Implementing robust security measures is crucial for maintaining the integrity, confidentiality, and availability of network resources. Below is an outline detailing the deployment of VPNs for site-to-site connectivity, DHCP Snooping for network integrity, and Dynamic ARP Inspection (DAI).

1. VPN Site-to-Site

- Purpose: VPN site-to-site connections allow secure communication between different geographic locations of the same company or between business partners. This setup encrypts data transmitted over the internet, safeguarding sensitive information against interception.
 - ❖ Configuration:
- Device Selection: Choose network devices (typically routers or dedicated VPN appliances) that support VPN functionality at both sites.
- Tunnel Setup: Configure the VPN tunnel parameters on both ends. This includes setting up IPsec (Internet Protocol Security) policies, specifying encryption and authentication methods, and defining the tunnel endpoints (public IP addresses).
- Routing Configuration: Adjust the routing tables or use routing protocols to direct traffic destined for the remote network through the VPN tunnel.
- Security Policies: Define security associations that determine how traffic is secured across the tunnel, including key management and the negotiation of encryption protocols.

2. DHCP Snooping

- Purpose: DHCP Snooping is a security feature that acts as a firewall between untrusted hosts and trusted DHCP servers. It prevents unauthorized (rogue) DHCP servers from sending malicious or incorrect DHCP responses to clients.

Configuration:

- Enable DHCP Snooping: Activate DHCP Snooping on the switch that connects to user segments where DHCP messages are received.
- Trust Configuration: Designate which ports connect to legitimate DHCP servers as "trusted" and mark all other ports as "untrusted". This controls where DHCP responses are accepted from.
- Rate Limiting: Configure rate limiting on untrusted ports to prevent DHCP flooding attacks.
- Binding Database: DHCP Snooping builds a binding database that maps client MAC addresses to leased IP addresses and associated VLAN information, which helps in tracking and controlling network access.
- We make two links trust to request DHCP from MSW1 or MSW2

```
SW-ACC#  
SW-ACC#show ip dhcp snooping  
Switch DHCP snooping is enabled  
Switch DHCP gleaning is disabled  
DHCP snooping is configured on following VLANs:  
1,10  
DHCP snooping is operational on following VLANs:  
1,10  
DHCP snooping is configured on the following L3 Interfaces:  
  
Insertion of option 82 is disabled  
    circuit-id default format: vlan-mod-port  
    remote-id: aabb.cc00.7000 (MAC)  
Option 82 on untrusted port is not allowed  
Verification of hwaddr field is enabled  
Verification of giaddr field is enabled  
DHCP snooping trust/rate is configured on the following Interfaces:  
  
Interface          Trusted      Allow option     Rate limit (pps)  
-----  
Ethernet0/0        yes         yes             10  
    Custom circuit-ids:  
Ethernet0/1        yes         yes             10  
    Custom circuit-ids:  
SW-ACC#  
SW-ACC#
```

Figure 60: DHCP snooping on SW-ACC.

```

SW-ACC#
SW-ACC#show ip dhcp snooping binding
MacAddress          IPAddress        Lease(sec)   Type        VLAN    Interface
-----
00:50:79:66:68:1C  172.20.0.5      85873       dhcp-snooping 10      Ethernet0/3
00:50:79:66:68:1B  172.20.0.7      85922       dhcp-snooping 10      Ethernet1/0
00:50:79:66:68:1D  172.20.0.6      85884       dhcp-snooping 10      Ethernet0/2
00:50:79:66:68:1A  172.20.0.4      85901       dhcp-snooping 10      Ethernet1/1
Total number of bindings: 4

SW-ACC#
SW-ACC#

```

Figure 61: DHCP snooping binding SW-ACC.

```

SW-HR#
SW-HR#show ip dhcp snooping
Switch DHCP snooping is enabled
Switch DHCP gleaning is disabled
DHCP snooping is configured on following VLANs:
1,20
DHCP snooping is operational on following VLANs:
1,20
DHCP snooping is configured on the following L3 Interfaces:

Insertion of option 82 is disabled
  circuit-id default format: vlan-mod-port
  remote-id: aabb.cc00.6000 (MAC)
Option 82 on untrusted port is not allowed
Verification of hwaddr field is enabled
Verification of giaddr field is enabled
DHCP snooping trust/rate is configured on the following Interfaces:

Interface           Trusted     Allow option   Rate limit (pps)
-----
Ethernet0/0         yes        yes            10
  Custom circuit-ids:
Ethernet0/1         yes        yes            10
  Custom circuit-ids:
SW-HR#
SW-HR#

```

Figure 62: DHCP snooping SW-HR.

```

SW-HR#
SW-HR#show ip dhcp snooping binding
MacAddress          IPAddress        Lease(sec)   Type        VLAN    Interface
-----
00:50:79:66:68:2C  172.20.0.39    85685       dhcp-snooping 20      Ethernet1/0
00:50:79:66:68:27  172.20.0.38    85672       dhcp-snooping 20      Ethernet0/2
00:50:79:66:68:26  172.20.0.36    85419       dhcp-snooping 20      Ethernet0/3
00:50:79:66:68:19  172.20.0.37    85657       dhcp-snooping 20      Ethernet1/1
Total number of bindings: 4

SW-HR#

```

Figure 63: DHCP snooping binding SW-HR.

3. Dynamic ARP Inspection (DAI)

Purpose: DAI enhances network security by ensuring that only valid ARP requests and responses are processed, based on a trusted binding database usually built by DHCP Snooping. This prevents ARP poisoning, a common attack where malicious ARP messages redirect traffic to an attacker's machine.

Configuration:

Enable DAI: Activate Dynamic ARP Inspection on the switches to protect against ARP spoofing, particularly those with user or untrusted host connections.

Binding Database Integration: Use the DHCP Snooping binding database to validate ARP packets, which associates IP addresses with MAC addresses and VLAN numbers.

Trust Settings: Configure trust settings on the ports connected to legitimate devices or servers to ensure that their ARP packets are not dropped.

```
SW-HR#sh ip arp inspection

Source Mac Validation      : Disabled
Destination Mac Validation : Disabled
IP Address Validation     : Disabled

Vlan      Configuration      Operation      ACL Match      Static ACL
-----  -----
  1        Enabled            Active
  20       Enabled            Active
```

Figure 64: ARP inspection.

4.2.7 Configuration Network of BlueTech

- SW-Acc

version 15.2

service timestamps debug datetime msec

service timestamps log datetime msec

no service password-encryption

service compress-config

!

hostname SW-ACC

!

boot-start-marker

boot-end-marker

!

no aaa new-model

!

ip arp inspection vlan 1,10

!

ip dhcp snooping vlan 1,10

no ip dhcp snooping information option

ip dhcp snooping

ip cef

no ipv6 cef

!

spanning-tree mode pvst

spanning-tree extend system-id

!

interface Ethernet0/0

```
no shutdown  
switchport trunk encapsulation dot1q  
switchport mode trunk  
ip arp inspection trust  
ip arp inspection limit rate 10  
ip dhcp snooping limit rate 10  
ip dhcp snooping trust  
!  
interface Ethernet0/1  
no shutdown  
switchport trunk encapsulation dot1q  
switchport mode trunk  
ip arp inspection trust  
ip arp inspection limit rate 10  
ip dhcp snooping limit rate 10  
ip dhcp snooping trust  
!  
interface Ethernet0/2  
no shutdown  
switchport access vlan 10  
switchport mode access  
!  
interface Ethernet0/3  
no shutdown  
switchport access vlan 10  
switchport mode access  
!
```

```
interface Ethernet1/0
no shutdown
switchport access vlan 10
switchport mode access
!
interface Ethernet1/1
no shutdown
switchport access vlan 10
switchport mode access
!
interface Ethernet1/2
no shutdown
switchport access vlan 999
switchport mode access
shutdown
!
interface Ethernet1/3
no shutdown
switchport access vlan 999
switchport mode access
shutdown
!
interface Ethernet2/0
no shutdown
switchport access vlan 999
switchport mode access
shutdown
```

```
!  
interface Ethernet2/1  
no shutdown  
switchport access vlan 999  
switchport mode access  
shutdown  
!  
interface Ethernet2/2  
no shutdown  
switchport access vlan 999  
switchport mode access  
shutdown  
!  
interface Ethernet2/3  
no shutdown  
switchport access vlan 999  
switchport mode access  
shutdown  
!  
interface Ethernet3/0  
no shutdown  
switchport access vlan 999  
switchport mode access  
shutdown  
!  
interface Ethernet3/1  
no shutdown
```

```
switchport access vlan 999
```

```
switchport mode access
```

```
shutdown
```

```
!
```

```
interface Ethernet3/2
```

```
no shutdown
```

```
switchport access vlan 999
```

```
switchport mode access
```

```
shutdown
```

```
!
```

```
interface Ethernet3/3
```

```
no shutdown
```

```
switchport access vlan 999
```

```
switchport mode access
```

```
shutdown
```

```
!
```

```
interface Ethernet4/0
```

```
no shutdown
```

```
switchport access vlan 999
```

```
switchport mode access
```

```
shutdown
```

```
!
```

```
interface Ethernet4/1
```

```
no shutdown
```

```
switchport access vlan 999
```

```
switchport mode access
```

```
shutdown
```

```
!  
interface Ethernet4/2  
no shutdown  
switchport access vlan 999  
switchport mode access  
shutdown  
!  
interface Ethernet4/3  
no shutdown  
switchport access vlan 999  
switchport mode access  
shutdown  
!  
interface Ethernet5/0  
no shutdown  
switchport access vlan 999  
switchport mode access  
shutdown  
!  
interface Ethernet5/1  
no shutdown  
switchport access vlan 999  
switchport mode access  
shutdown  
!  
interface Ethernet5/2  
no shutdown
```

```
switchport access vlan 999
switchport mode access
shutdown
!
interface Ethernet5/3
no shutdown
switchport access vlan 999
switchport mode access
shutdown
!
ip forward-protocol nd
!
ip http server
ip http secure-server
!
ip ssh server algorithm encryption aes128-ctr aes192-ctr aes256-ctr
ip ssh client algorithm encryption aes128-ctr aes192-ctr aes256-ctr
!
control-plane
!
line con 0
logging synchronous
line aux 0
line vty 0 4
login
!
end
```

- SW-HR

version 15.2

service timestamps debug datetime msec

service timestamps log datetime msec

no service password-encryption

service compress-config

!

hostname SW-HR

!

boot-start-marker

boot-end-marker

!

no aaa new-model

!

ip arp inspection vlan 1,20

!

ip dhcp snooping vlan 1,20

no ip dhcp snooping information option

ip dhcp snooping

ip cef

no ipv6 cef

!

spanning-tree mode pvst

spanning-tree extend system-id

!

interface Ethernet0/0

no shutdown

```
switchport trunk encapsulation dot1q
switchport mode trunk
ip arp inspection trust
ip arp inspection limit rate 10
ip dhcp snooping limit rate 10
ip dhcp snooping trust
!
interface Ethernet0/1
no shutdown
switchport trunk encapsulation dot1q
switchport mode trunk
ip arp inspection trust
ip arp inspection limit rate 10
ip dhcp snooping limit rate 10
ip dhcp snooping trust
!
interface Ethernet0/2
no shutdown
switchport access vlan 20
switchport mode access
!
interface Ethernet0/3
no shutdown
switchport access vlan 20
switchport mode access
!
interface Ethernet1/0
```

```
no shutdown  
switchport access vlan 20  
switchport mode access  
!  
interface Ethernet1/1  
no shutdown  
switchport access vlan 20  
switchport mode access  
!  
interface Ethernet1/2  
no shutdown  
switchport access vlan 999  
switchport mode access  
shutdown  
!  
interface Ethernet1/3  
no shutdown  
switchport access vlan 999  
switchport mode access  
shutdown  
!  
interface Ethernet2/0  
no shutdown  
switchport access vlan 999  
switchport mode access  
shutdown  
!
```

```
interface Ethernet2/1
no shutdown
switchport access vlan 999
switchport mode access
shutdown
!
interface Ethernet2/2
no shutdown
switchport access vlan 999
switchport mode access
shutdown
!
interface Ethernet2/3
no shutdown
switchport access vlan 999
switchport mode access
shutdown
!
interface Ethernet3/0
no shutdown
switchport access vlan 999
switchport mode access
shutdown
!
interface Ethernet3/1
no shutdown
switchport access vlan 999
```

```
switchport mode access  
shutdown  
!  
interface Ethernet3/2  
no shutdown  
switchport access vlan 999  
switchport mode access  
shutdown  
!  
interface Ethernet3/3  
no shutdown  
switchport access vlan 999  
switchport mode access  
shutdown  
!  
interface Ethernet4/0  
no shutdown  
switchport access vlan 999  
switchport mode access  
shutdown  
!  
interface Ethernet4/1  
no shutdown  
switchport access vlan 999  
switchport mode access  
shutdown  
!
```

```
interface Ethernet4/2
no shutdown
switchport access vlan 999
switchport mode access
shutdown
!
interface Ethernet4/3
no shutdown
switchport access vlan 999
switchport mode access
shutdown
!
interface Ethernet5/0
no shutdown
switchport access vlan 999
switchport mode access
shutdown
!
interface Ethernet5/1
no shutdown
switchport access vlan 999
switchport mode access
shutdown
!
interface Ethernet5/2
no shutdown
switchport access vlan 999
```

```
switchport mode access
shutdown
!
interface Ethernet5/3
no shutdown
switchport access vlan 999
switchport mode access
shutdown
!
ip forward-protocol nd
!
ip http server
ip http secure-server
!
ip ssh server algorithm encryption aes128-ctr aes192-ctr aes256-ctr
ip ssh client algorithm encryption aes128-ctr aes192-ctr aes256-ctr
!
control-plane
!
line con 0
logging synchronous
line aux 0
line vty 0 4
login
!
end
```

- SW-IT

version 15.2

service timestamps debug datetime msec

service timestamps log datetime msec

no service password-encryption

service compress-config

!

hostname SW-IT

!

boot-start-marker

boot-end-marker

!

no aaa new-model

!

ip arp inspection vlan 1,30

!

ip dhcp snooping vlan 1,30

no ip dhcp snooping information option

ip dhcp snooping

ip cef

no ipv6 cef

!

spanning-tree mode pvst

spanning-tree extend system-id

!

interface Ethernet0/0

no shutdown

```
switchport trunk encapsulation dot1q
switchport mode trunk
ip arp inspection trust
ip arp inspection limit rate 10
ip dhcp snooping limit rate 10
ip dhcp snooping trust
!
interface Ethernet0/1
no shutdown
switchport trunk encapsulation dot1q
switchport mode trunk
ip arp inspection trust
ip arp inspection limit rate 10
ip dhcp snooping limit rate 10
ip dhcp snooping trust
!
interface Ethernet0/2
no shutdown
switchport access vlan 30
switchport mode access
!
interface Ethernet0/3
no shutdown
switchport access vlan 30
switchport mode access
!
interface Ethernet1/0
```

```
switchport access vlan 999
switchport mode access
shutdown
!
interface Ethernet1/1
switchport access vlan 999
switchport mode access
shutdown
!
interface Ethernet1/2
switchport access vlan 999
switchport mode access
shutdown
!
interface Ethernet1/3
switchport access vlan 999
switchport mode access
shutdown
!
interface Ethernet2/0
switchport access vlan 999
switchport mode access
shutdown
!
interface Ethernet2/1
switchport access vlan 999
switchport mode access
```

```
shutdown
!
interface Ethernet2/2
switchport access vlan 999
switchport mode access
shutdown
!
interface Ethernet2/3
switchport access vlan 999
switchport mode access
shutdown
!
interface Ethernet3/0
switchport access vlan 999
switchport mode access
shutdown
!
interface Ethernet3/1
switchport access vlan 999
switchport mode access
shutdown
!
interface Ethernet3/2
switchport access vlan 999
switchport mode access
shutdown
!
```

```
interface Ethernet3/3
switchport access vlan 999
switchport mode access
shutdown
!
interface Ethernet4/0
switchport access vlan 999
switchport mode access
shutdown
!
interface Ethernet4/1
switchport access vlan 999
switchport mode access
shutdown
!
interface Ethernet4/2
switchport access vlan 999
switchport mode access
shutdown
!
interface Ethernet4/3
switchport access vlan 999
switchport mode access
shutdown
!
interface Ethernet5/0
switchport access vlan 999
```

```
switchport mode access
shutdown
!
interface Ethernet5/1
switchport access vlan 999
switchport mode access
shutdown
!
interface Ethernet5/2
switchport access vlan 999
switchport mode access
shutdown
!
interface Ethernet5/3
switchport access vlan 999
switchport mode access
shutdown
!
ip forward-protocol nd
!
ip http server
ip http secure-server
!
ip ssh server algorithm encryption aes128-ctr aes192-ctr aes256-ctr
ip ssh client algorithm encryption aes128-ctr aes192-ctr aes256-ctr
```

```
!  
control-plane  
!  
line con 0  
logging synchronous  
line aux 0  
line vty 0 4  
login  
!  
end
```

- SW-Management

version 15.2

service timestamps debug datetime msec

service timestamps log datetime msec

no service password-encryption

service compress-config

!

hostname SW-Management

!

boot-start-marker

boot-end-marker

!

no aaa new-model

!

ip arp inspection vlan 1,40

!

ip dhcp snooping vlan 1,40

no ip dhcp snooping information option

ip dhcp snooping

ip cef

no ipv6 cef

!

spanning-tree mode pvst

spanning-tree extend system-id

!

interface Ethernet0/0

no shutdown

```
switchport trunk encapsulation dot1q
switchport mode trunk
ip arp inspection trust
ip arp inspection limit rate 10
ip dhcp snooping limit rate 10
ip dhcp snooping trust
!
interface Ethernet0/1
no shutdown
switchport trunk encapsulation dot1q
switchport mode trunk
ip arp inspection trust
ip arp inspection limit rate 10
ip dhcp snooping limit rate 10
ip dhcp snooping trust
!
interface Ethernet0/2
no shutdown
switchport access vlan 40
switchport mode access
!
interface Ethernet0/3
no shutdown
switchport access vlan 40
switchport mode access
!
interface Ethernet1/0
```

```
switchport access vlan 999
switchport mode access
shutdown
!
interface Ethernet1/1
switchport access vlan 999
switchport mode access
shutdown
!
interface Ethernet1/2
switchport access vlan 999
switchport mode access
shutdown
!
interface Ethernet1/3
switchport access vlan 999
switchport mode access
shutdown
!
interface Ethernet2/0
switchport access vlan 999
switchport mode access
shutdown
!
interface Ethernet2/1
switchport access vlan 999
switchport mode access
```

```
shutdown
!
interface Ethernet2/2
switchport access vlan 999
switchport mode access
shutdown
!
interface Ethernet2/3
switchport access vlan 999
switchport mode access
shutdown
!
interface Ethernet3/0
switchport access vlan 999
switchport mode access
shutdown
!
interface Ethernet3/1
switchport access vlan 999
switchport mode access
shutdown
!
interface Ethernet3/2
switchport access vlan 999
switchport mode access
shutdown
!
```

```
interface Ethernet3/3
switchport access vlan 999
switchport mode access
shutdown
!
interface Ethernet4/0
switchport access vlan 999
switchport mode access
shutdown
!
interface Ethernet4/1
switchport access vlan 999
switchport mode access
shutdown
!
interface Ethernet4/2
switchport access vlan 999
switchport mode access
shutdown
!
interface Ethernet4/3
switchport access vlan 999
switchport mode access
shutdown
!
interface Ethernet5/0
switchport access vlan 999
```

```
switchport mode access
shutdown
!
interface Ethernet5/1
switchport access vlan 999
switchport mode access
shutdown
!
interface Ethernet5/2
switchport access vlan 999
switchport mode access
shutdown
!
interface Ethernet5/3
switchport access vlan 999
switchport mode access
shutdown
!
ip forward-protocol nd
!
ip http server
ip http secure-server
!
ip ssh server algorithm encryption aes128-ctr aes192-ctr aes256-ctr
ip ssh client algorithm encryption aes128-ctr aes192-ctr aes256-ctr
!
control-plane
```

```
!  
line con 0  
logging synchronous  
line aux 0  
line vty 0 4  
login  
!  
end
```

- Multilayer Switches : MAW1

version 15.2

service timestamps debug datetime msec

service timestamps log datetime msec

no service password-encryption

service compress-config

!

hostname MSW1

!

boot-start-marker

boot-end-marker

!

no aaa new-model

!

ip dhcp excluded-address 172.20.0.1

ip dhcp excluded-address 172.20.0.1 172.20.0.3

ip dhcp excluded-address 172.20.0.33 172.20.0.35

ip dhcp excluded-address 172.20.0.65 172.20.0.67

ip dhcp excluded-address 172.20.0.81 172.20.0.83

!

ip dhcp pool Accounting

network 172.20.0.0 255.255.255.224

default-router 172.20.0.1

dns-server 8.8.8.8

!

ip dhcp pool HR

network 172.20.0.32 255.255.255.224

```
default-router 172.20.0.33
dns-server 8.8.8.8
!
ip dhcp pool IT
network 172.20.0.64 255.255.255.240
default-router 172.20.0.65
dns-server 8.8.8.8
!
ip dhcp pool Management
network 172.20.0.80 255.255.255.240
default-router 172.20.0.81
dns-server 8.8.8.8
!
no ip dhcp snooping information option
ip cef
no ipv6 cef
!
spanning-tree mode pvst
spanning-tree extend system-id
!
interface Port-channel12
no shutdown
no switchport
ip address 172.20.0.97 255.255.255.252
!
interface Ethernet0/0
no shutdown
```

```
description "point to point etherchannel"
no switchport
no ip address
channel-protocol lacp
channel-group 12 mode active
!
interface Ethernet0/1
no shutdown
description "point to point etherchannel"
no switchport
no ip address
channel-protocol lacp
channel-group 12 mode active
!
interface Ethernet0/2
no shutdown
description "point to point etherchannel"
no switchport
no ip address
channel-protocol lacp
channel-group 12 mode active
!
interface Ethernet0/3
no shutdown
description "point to point etherchannel"
no switchport
no ip address
```

```
channel-protocol lacp
channel-group 12 mode active
!
interface Ethernet1/0
no shutdown
no switchport
ip address 172.20.0.102 255.255.255.252
!
interface Ethernet1/1
switchport access vlan 999
switchport mode access
shutdown
!
interface Ethernet1/2
no shutdown
switchport trunk encapsulation dot1q
switchport mode trunk
!
interface Ethernet1/3
no shutdown
switchport trunk encapsulation dot1q
switchport mode trunk
!
interface Ethernet2/0
no shutdown
switchport trunk encapsulation dot1q
switchport mode trunk
```

```
!  
interface Ethernet2/1  
no shutdown  
switchport trunk encapsulation dot1q  
switchport mode trunk  
!  
interface Ethernet2/2  
switchport access vlan 999  
switchport mode access  
shutdown  
!  
interface Ethernet2/3  
switchport access vlan 999  
switchport mode access  
shutdown  
!  
interface Vlan10  
no shutdown  
ip address 172.20.0.2 255.255.255.224  
standby version 2  
standby 10 ip 172.20.0.1  
standby 10 priority 120  
standby 10 preempt  
!  
interface Vlan20  
no shutdown  
ip address 172.20.0.34 255.255.255.224
```

```
standby version 2
standby 20 ip 172.20.0.33
standby 20 priority 120
standby 20 preempt
!
interface Vlan30
no shutdown
ip address 172.20.0.66 255.255.255.240
standby version 2
standby 30 ip 172.20.0.65
standby 30 priority 120
standby 30 preempt
!
interface Vlan40
no shutdown
ip address 172.20.0.82 255.255.255.240
standby version 2
standby 40 ip 172.20.0.81
standby 40 priority 120
standby 40 preempt
!
router ospf 200
network 172.20.0.0 0.0.0.31 area 1
network 172.20.0.32 0.0.0.31 area 1
network 172.20.0.64 0.0.0.15 area 1
network 172.20.0.80 0.0.0.15 area 1
network 172.20.0.96 0.0.0.3 area 1
```

```
network 172.20.0.100 0.0.0.3 area 1
!
ip forward-protocol nd
!
ip http server
ip http secure-server
!
ip ssh server algorithm encryption aes128-ctr aes192-ctr aes256-ctr
ip ssh client algorithm encryption aes128-ctr aes192-ctr aes256-ctr
!
control-plane
!
line con 0
logging synchronous
line aux 0
line vty 0 4
login
!
end
```

- Multilayer Switches : MAW2

version 15.2

service timestamps debug datetime msec

service timestamps log datetime msec

no service password-encryption

service compress-config

!

hostname MSW2

!

boot-start-marker

boot-end-marker

!

no aaa new-model

!

ip dhcp excluded-address 172.20.0.1

ip dhcp excluded-address 172.20.0.1 172.20.0.3

ip dhcp excluded-address 172.20.0.33 172.20.0.35

ip dhcp excluded-address 172.20.0.65 172.20.0.67

ip dhcp excluded-address 172.20.0.81 172.20.0.83

!

ip dhcp pool Accounting

network 172.20.0.0 255.255.255.224

default-router 172.20.0.1

dns-server 8.8.8.8

!

ip dhcp pool HR

network 172.20.0.32 255.255.255.224

```
default-router 172.20.0.33
dns-server 8.8.8.8
!
ip dhcp pool IT
network 172.20.0.64 255.255.255.240
default-router 172.20.0.65
dns-server 8.8.8.8
!
ip dhcp pool Management
network 172.20.0.80 255.255.255.240
default-router 172.20.0.81
dns-server 8.8.8.8
!
no ip dhcp snooping information option
ip cef
no ipv6 cef
!
spanning-tree mode pvst
spanning-tree extend system-id
!
interface Port-channel12
no shutdown
no switchport
ip address 172.20.0.98 255.255.255.252
!
interface Ethernet0/0
no shutdown
```

```
description "point to point etherchannel"
no switchport
no ip address
channel-protocol lacp
channel-group 12 mode active
!
interface Ethernet0/1
no shutdown
description "point to point etherchannel"
no switchport
no ip address
channel-protocol lacp
channel-group 12 mode active
!
interface Ethernet0/2
no shutdown
description "point to point etherchannel"
no switchport
no ip address
channel-protocol lacp
channel-group 12 mode active
!
interface Ethernet0/3
no shutdown
description "point to point etherchannel"
no switchport
no ip address
```

```
channel-protocol lacp
channel-group 12 mode active
!
interface Ethernet1/0
no shutdown
no switchport
ip address 172.20.0.106 255.255.255.252
!
interface Ethernet1/1
no switchport
no ip address
shutdown
!
interface Ethernet1/2
no shutdown
switchport trunk encapsulation dot1q
switchport mode trunk
!
interface Ethernet1/3
no shutdown
switchport trunk encapsulation dot1q
switchport mode trunk
!
interface Ethernet2/0
no shutdown
switchport trunk encapsulation dot1q
switchport mode trunk
```

```
!  
interface Ethernet2/1  
no shutdown  
switchport trunk encapsulation dot1q  
switchport mode trunk  
!  
interface Ethernet2/2  
switchport access vlan 999  
switchport mode access  
shutdown  
!  
interface Ethernet2/3  
switchport access vlan 999  
switchport mode access  
shutdown  
!  
interface Vlan10  
no shutdown  
ip address 172.20.0.3 255.255.255.224  
standby version 2  
standby 10 ip 172.20.0.1  
standby 10 priority 90  
standby 10 preempt  
!  
interface Vlan20  
no shutdown  
ip address 172.20.0.35 255.255.255.224
```

```
standby version 2
standby 20 ip 172.20.0.33
standby 20 priority 90
standby 20 preempt
!
interface Vlan30
no shutdown
ip address 172.20.0.67 255.255.255.240
standby version 2
standby 30 ip 172.20.0.65
standby 30 priority 90
standby 30 preempt
!
interface Vlan40
no shutdown
ip address 172.20.0.83 255.255.255.240
standby version 2
standby 40 ip 172.20.0.81
standby 40 priority 90
standby 40 preempt
!
router ospf 200
network 172.20.0.0 0.0.0.31 area 1
network 172.20.0.32 0.0.0.31 area 1
network 172.20.0.64 0.0.0.15 area 1
network 172.20.0.80 0.0.0.15 area 1
network 172.20.0.96 0.0.0.3 area 1
```

```
network 172.20.0.104 0.0.0.3 area 1
!
ip forward-protocol nd
!
ip http server
ip http secure-server
!
ip ssh server algorithm encryption aes128-ctr aes192-ctr aes256-ctr
ip ssh client algorithm encryption aes128-ctr aes192-ctr aes256-ctr
!
control-plane
!
line con 0
logging synchronous
line aux 0
line vty 0 4
login
!
end
```

- HM-Core

version 15.7

service timestamps debug datetime msec

service timestamps log datetime msec

no service password-encryption

service compress-config

!

hostname HM-Core

!

boot-start-marker

boot-end-marker

!

no aaa new-model

!

mmi polling-interval 60

no mmi auto-configure

no mmi pvc

mmi snmp-timeout 180

!

ip cef

no ipv6 cef

!

multilink bundle-name authenticated

!

redundancy

!

track 1 interface Multilink4 ip routing

!

crypto isakmp policy 10

encr aes 256

authentication pre-share

group 5

!

crypto isakmp policy 20

encr aes 256

authentication pre-share

group 5

!

crypto isakmp policy 25

encr aes 256

authentication pre-share

group 5

!

crypto isakmp policy 26

encr aes 256

authentication pre-share

group 5

!

crypto isakmp policy 30

encr aes 256

authentication pre-share

group 5

!

crypto isakmp policy 35

```
encr aes 256
authentication pre-share
group 5
!
crypto isakmp policy 40
encr aes 256
authentication pre-share
group 5
!
crypto isakmp policy 45
encr aes 256
authentication pre-share
group 5
crypto isakmp key AdminVpn address 145.0.0.30
crypto isakmp key AdminVpn address 145.0.0.18
crypto isakmp key AdminVpn3 address 145.0.0.34
crypto isakmp key AdminVpn35 address 145.0.0.26
!
crypto ipsec transform-set VPN-SET esp-aes esp-sha-hmac
mode tunnel
!
crypto map VPN-MAP 10 ipsec-isakmp
description connection to State Monster
set peer 145.0.0.30
set transform-set VPN-SET
match address 110
crypto map VPN-MAP 20 ipsec-isakmp
```

```
description connection to State Monster
set peer 145.0.0.18
set transform-set VPN-SET
match address 120
crypto map VPN-MAP 25 ipsec-isakmp
description connection to State Monster
set peer 145.0.0.30
set transform-set VPN-SET
match address 125
crypto map VPN-MAP 26 ipsec-isakmp
description connection to State Monster
set peer 145.0.0.18
set transform-set VPN-SET
match address 126
crypto map VPN-MAP 30 ipsec-isakmp
description connection to State CyberBook
set peer 145.0.0.34
set transform-set VPN-SET
match address 130
crypto map VPN-MAP 35 ipsec-isakmp
description connection to State Monster
set peer 145.0.0.26
set transform-set VPN-SET
match address 135
crypto map VPN-MAP 40 ipsec-isakmp
description connection to State CyberBook
set peer 145.0.0.34
```

```
set transform-set VPN-SET
match address 140
crypto map VPN-MAP 45 ipsec-isakmp
description connection to State Blue
set peer 145.0.0.26
set transform-set VPN-SET
match address 145
!
interface Loopback0
no shutdown
ip address 200.0.0.1 255.255.255.255
!
interface Multilink4
no shutdown
ip address 145.0.0.14 255.255.255.252
ip nat outside
ip virtual-reassembly in
ppp multilink
ppp multilink group 4
crypto map VPN-MAP
!
interface Multilink6
no shutdown
ip address 145.0.0.22 255.255.255.252
ip nat outside
ip virtual-reassembly in
ppp multilink
```

```
ppp multilink group 6
crypto map VPN-MAP
!
interface Ethernet0/0
no shutdown
no ip address
shutdown
duplex auto
!
interface Ethernet0/1
no shutdown
ip address 172.20.0.101 255.255.255.252
ip nat inside
ip virtual-reassembly in
duplex auto
!
interface Ethernet0/2
no shutdown
description "point to point etherchannel To MSW2"
ip address 172.20.0.105 255.255.255.252
duplex auto
!
interface Ethernet0/3
no shutdown
no ip address
shutdown
duplex auto
```

```
!  
interface Ethernet1/0  
no shutdown  
no ip address  
shutdown  
duplex auto  
!  
interface Ethernet1/1  
no shutdown  
no ip address  
shutdown  
duplex auto  
!  
interface Ethernet1/2  
no shutdown  
ip address 172.20.0.129 255.255.255.240  
duplex auto  
!  
interface Ethernet1/3  
no shutdown  
no ip address  
shutdown  
duplex auto  
!  
interface Serial2/0  
no shutdown  
no ip address
```

```
serial restart-delay 0
```

```
!
```

```
interface Serial2/1
```

```
no shutdown
```

```
no ip address
```

```
encapsulation ppp
```

```
ppp multilink
```

```
ppp multilink group 6
```

```
serial restart-delay 0
```

```
!
```

```
interface Serial2/2
```

```
no shutdown
```

```
no ip address
```

```
encapsulation ppp
```

```
ppp multilink
```

```
ppp multilink group 4
```

```
serial restart-delay 0
```

```
!
```

```
interface Serial2/3
```

```
no shutdown
```

```
no ip address
```

```
encapsulation ppp
```

```
ppp multilink
```

```
ppp multilink group 4
```

```
serial restart-delay 0
```

```
!
```

```
router ospf 200
```

```
network 145.0.0.12 0.0.0.3 area 0
network 145.0.0.20 0.0.0.3 area 0
network 172.20.0.100 0.0.0.3 area 1
network 172.20.0.104 0.0.0.3 area 1
network 172.20.0.112 0.0.0.15 area 1
network 172.20.0.128 0.0.0.15 area 1
network 200.0.0.1 0.0.0.0 area 1
default-information originate
!
ip forward-protocol nd
!
ip http server
ip http secure-server
ip nat inside source route-map NAT-ISPM interface Multilink6 overload
ip nat inside source route-map NAT-ISPS interface Multilink4 overload
ip route 0.0.0.0 0.0.0.0 145.0.0.13 track 1
ip route 0.0.0.0 0.0.0.0 145.0.0.21 10
!
ip access-list extended NAT
deny ip 172.20.2.0 0.0.0.63 172.20.0.0 0.0.0.127
permit ip 172.20.2.0 0.0.0.63 any
!
ip sla 1
icmp-echo 145.0.0.13 source-interface Multilink4
frequency 5
ip sla schedule 1 life forever start-time now
ipv6 ioam timestamp !
```

```
route-map NAT-ISPS permit 10
  match ip address NAT
  match interface Multilink4
!
route-map NAT-ISPM permit 10
  match ip address NAT
  match interface Multilink6
!
access-list 110 permit ip 172.20.0.0 0.0.0.127 172.20.2.0 0.0.0.63
access-list 120 permit ip 172.20.0.0 0.0.0.127 172.20.2.0 0.0.0.63
access-list 125 permit ip 172.20.0.0 0.0.0.127 172.20.2.0 0.0.0.63
access-list 126 permit ip 172.20.0.0 0.0.0.127 172.20.2.0 0.0.0.63
access-list 130 permit ip 172.20.0.0 0.0.0.127 172.20.1.0 0.0.0.63
access-list 135 permit ip 172.20.0.0 0.0.0.127 172.20.1.0 0.0.0.63
access-list 140 permit ip 172.20.0.0 0.0.0.127 172.20.1.0 0.0.0.63
access-list 145 permit ip 172.20.0.0 0.0.0.127 172.20.1.0 0.0.0.63
!
control-plane
!
line con 0
  logging synchronous
line aux 0
line vty 0 4
  login
  transport input none
!
end
```

4.2.8 Configuration Network of CyberBooks

- Multilayer Switches : SWMC

version 15.2

service timestamps debug datetime msec

service timestamps log datetime msec

no service password-encryption

service compress-config

!

hostname SWMC

!

boot-start-marker

boot-end-marker

!

no aaa new-model

!

ip arp inspection vlan 1,50,60,70

!

ip dhcp snooping vlan 1,50,60,70

no ip dhcp snooping information option

ip dhcp snooping

ip cef

no ipv6 cef

!

spanning-tree mode pvst

spanning-tree extend system-id

!

```
interface Ethernet0/0
no shutdown
switchport trunk encapsulation dot1q
switchport mode trunk
ip arp inspection trust
ip arp inspection limit rate 10
ip dhcp snooping limit rate 10
ip dhcp snooping trust
!

interface Ethernet0/1
no shutdown
switchport access vlan 50
switchport mode access
!

interface Ethernet0/2
no shutdown
switchport access vlan 50
switchport mode access
!

interface Ethernet0/3
no shutdown
switchport access vlan 50
switchport mode access
!

interface Ethernet1/0
no shutdown
switchport access vlan 60
```

```
switchport mode access
!
interface Ethernet1/1
no shutdown
switchport access vlan 60
switchport mode access
!
interface Ethernet1/2
no shutdown
switchport access vlan 70
switchport mode access
!
interface Ethernet1/3
no shutdown
switchport access vlan 70
switchport mode access
!
interface Ethernet2/0
switchport access vlan 999
switchport mode access
shutdown
!
interface Ethernet2/1
switchport access vlan 999
switchport mode access
shutdown
!
```

```
interface Ethernet2/2
switchport access vlan 999
switchport mode access
shutdown
!
interface Ethernet2/3
switchport access vlan 999
switchport mode access
shutdown
!
interface Vlan50
no shutdown
ip address 172.20.1.2 255.255.255.240
!
interface Vlan60
no shutdown
ip address 172.20.1.18 255.255.255.240
!
interface Vlan70
no shutdown
ip address 172.20.1.34 255.255.255.240
!
router ospf 5
network 172.20.1.0 0.0.0.15 area 5
network 172.20.1.16 0.0.0.15 area 5
network 172.20.1.32 0.0.0.15 area 5
network 172.20.1.48 0.0.0.3 area 5
```

```
!
ip forward-protocol nd
!
ip http server
ip http secure-server
!
ip ssh server algorithm encryption aes128-ctr aes192-ctr aes256-ctr
ip ssh client algorithm encryption aes128-ctr aes192-ctr aes256-ctr
!
control-plane
!
line con 0
logging synchronous
line aux 0
line vty 0 4
login
!
end
```

- RC-Core

version 15.7

```
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
```

hostname RC-Core

```
!
boot-start-marker
boot-end-marker
!
```

no aaa new-model

```
!
mmi polling-interval 60
no mmi auto-configure
no mmi pvc
mmi snmp-timeout 180
!
```

ip dhcp excluded-address 172.20.1.33 172.20.1.34
ip dhcp excluded-address 172.20.1.17 172.20.1.18
ip dhcp excluded-address 172.20.1.1 172.20.1.2
!

ip dhcp pool VLAN50
network 172.20.1.0 255.255.255.240
default-router 172.20.1.1
dns-server 8.8.8.8
!

```
ip dhcp pool VLAN60
network 172.20.1.16 255.255.255.240
default-router 172.20.1.17
dns-server 8.8.8.8
!
ip dhcp pool VLAN70
network 172.20.1.32 255.255.255.240
default-router 172.20.1.33
dns-server 8.8.8.8
!
ip cef
no ipv6 cef
!
multilink bundle-name authenticated
!
redundancy
!
track 1 interface Multilink7 ip routing
!
crypto isakmp policy 30
encr aes 256
authentication pre-share
group 5
!
crypto isakmp policy 35
encr aes 256
authentication pre-share
```

```
group 5
!
crypto isakmp policy 40
    encr aes 256
    authentication pre-share
group 5
!
crypto isakmp policy 45
    encr aes 256
    authentication pre-share
group 5
crypto isakmp key AdminVpn address 145.0.0.14
crypto isakmp key AdminVpn40 address 145.0.0.22
!
crypto ipsec transform-set VPN-SET esp-aes esp-sha-hmac
mode tunnel
!
crypto map VPN-MAP 30 ipsec-isakmp
    description connection to State Blue
    set peer 145.0.0.14
    set transform-set VPN-SET
    match address 130
crypto map VPN-MAP 35 ipsec-isakmp
    description connection to State Blue
    set peer 145.0.0.14
    set transform-set VPN-SET
    match address 135
```

```
crypto map VPN-MAP 40 ipsec-isakmp
description connection to State CyberBook
set peer 145.0.0.22
set transform-set VPN-SET
match address 140

crypto map VPN-MAP 45 ipsec-isakmp
description connection to State blue
set peer 145.0.0.22
set transform-set VPN-SET
match address 145

!

interface Multilink7
no shutdown
ip address 145.0.0.26 255.255.255.252
ip nat outside
ip virtual-reassembly in
ppp multilink
ppp multilink group 7
crypto map VPN-MAP
!

interface Multilink9
no shutdown
ip address 145.0.0.34 255.255.255.252
ip nat outside
ip virtual-reassembly in
ppp multilink
ppp multilink group 9
```

```
crypto map VPN-MAP
!
interface Ethernet0/0
no shutdown
no ip address
ip nat inside
ip virtual-reassembly in
duplex auto
!
interface Ethernet0/0.50
no shutdown
encapsulation dot1Q 50
ip address 172.20.1.1 255.255.255.240
ip nat inside
ip virtual-reassembly in
!
interface Ethernet0/0.60
no shutdown
encapsulation dot1Q 60
ip address 172.20.1.17 255.255.255.240
ip nat inside
ip virtual-reassembly in
!
interface Ethernet0/0.70
no shutdown
encapsulation dot1Q 70
ip address 172.20.1.33 255.255.255.240
```

```
ip nat inside  
ip virtual-reassembly in  
!  
interface Ethernet0/1  
no shutdown  
no ip address  
shutdown  
duplex auto  
!  
interface Ethernet0/2  
no shutdown  
no ip address  
shutdown  
duplex auto  
!  
interface Ethernet0/3  
no shutdown  
no ip address  
shutdown  
duplex auto  
!  
interface Serial1/0  
no shutdown  
no ip address  
encapsulation ppp  
ppp multilink  
ppp multilink group 7
```

```
serial restart-delay 0
```

```
!
```

```
interface Serial1/1
```

```
no shutdown
```

```
no ip address
```

```
encapsulation ppp
```

```
ppp multilink
```

```
ppp multilink group 7
```

```
serial restart-delay 0
```

```
!
```

```
interface Serial1/2
```

```
no shutdown
```

```
no ip address
```

```
encapsulation ppp
```

```
ppp multilink
```

```
ppp multilink group 9
```

```
serial restart-delay 0
```

```
!
```

```
interface Serial1/3
```

```
no shutdown
```

```
no ip address
```

```
encapsulation ppp
```

```
ppp multilink
```

```
ppp multilink group 9
```

```
serial restart-delay 0
```

```
!
```

```
router ospf 5
```

```
network 145.0.0.24 0.0.0.3 area 0
network 145.0.0.32 0.0.0.3 area 0
network 172.20.1.48 0.0.0.3 area 5
default-information originate
!
ip forward-protocol nd
!
no ip http server
no ip http secure-server
ip nat inside source route-map NAT-ISPM interface Multilink7 overload
ip nat inside source route-map NAT-ISPZ interface Multilink9 overload
ip route 0.0.0.0 0.0.0.0 145.0.0.25 track 1
ip route 0.0.0.0 0.0.0.0 145.0.0.33 10
!
ip access-list extended NAT
permit ip 172.20.1.0 0.0.0.63 any
!
ip sla 1
icmp-echo 145.0.0.25 source-interface Multilink7
frequency 5
ip sla schedule 1 life forever start-time now
ipv6 ioam timestamp
!
route-map NAT-ISPZ permit 10
match ip address NAT
match interface Multilink9
!
```

```
route-map NAT-ISPM permit 10
  match ip address NAT
  match interface Multilink7
!
access-list 130 permit ip 172.20.1.0 0.0.0.63 172.20.0.0 0.0.0.127
access-list 135 permit ip 172.20.1.0 0.0.0.63 172.20.0.0 0.0.0.127
access-list 140 permit ip 172.20.1.0 0.0.0.63 172.20.0.0 0.0.0.127
access-list 145 permit ip 172.20.1.0 0.0.0.63 172.20.0.0 0.0.0.127
!
control-plane
!
line con 0
  logging synchronous
line aux 0
line vty 0 4
  login
  transport input none
!
end
```

4.2.9 Configuration Network of Monsters, Inc

- Multilayer Switches : SWMB

version 15.2

service timestamps debug datetime msec

service timestamps log datetime msec

no service password-encryption

service compress-config

!

hostname SWMB

!

boot-start-marker

boot-end-marker

!

no aaa new-model

!

ip arp inspection vlan 1,55,66,77

!

ip dhcp snooping vlan 1,55,66,77

no ip dhcp snooping information option

ip dhcp snooping

ip cef

no ipv6 cef

!

spanning-tree mode pvst

spanning-tree extend system-id

!

interface Ethernet0/0

```
no shutdown  
switchport trunk encapsulation dot1q  
switchport mode trunk  
ip arp inspection trust  
ip arp inspection limit rate 10  
ip dhcp snooping limit rate 10  
ip dhcp snooping trust  
!  
interface Ethernet0/1  
no shutdown  
switchport access vlan 55  
switchport mode access  
!  
interface Ethernet0/2  
no shutdown  
switchport access vlan 55  
switchport mode access  
!  
interface Ethernet0/3  
no shutdown  
switchport access vlan 55  
switchport mode access  
!  
interface Ethernet1/0  
no shutdown  
switchport access vlan 66  
switchport mode access
```

```
!  
interface Ethernet1/1  
no shutdown  
switchport access vlan 66  
switchport mode access  
!  
interface Ethernet1/2  
no shutdown  
switchport access vlan 77  
switchport mode access  
!  
interface Ethernet1/3  
no shutdown  
switchport access vlan 77  
switchport mode access  
!  
interface Ethernet2/0  
no shutdown  
switchport access vlan 999  
switchport mode access  
shutdown  
!  
interface Ethernet2/1  
no shutdown  
switchport access vlan 999  
switchport mode access  
shutdown
```

```
!  
interface Ethernet2/2  
no shutdown  
switchport access vlan 999  
switchport mode access  
shutdown  
!  
interface Ethernet2/3  
no shutdown  
switchport access vlan 999  
switchport mode access  
shutdown  
!  
interface Vlan55  
no shutdown  
ip address 172.20.2.2 255.255.255.240  
!  
interface Vlan66  
no shutdown  
ip address 172.20.2.18 255.255.255.240  
!  
interface Vlan77  
no shutdown  
ip address 172.20.2.34 255.255.255.240  
!  
router ospf 377  
network 172.20.2.0 0.0.0.15 area 3
```

```
network 172.20.2.16 0.0.0.15 area 3
network 172.20.2.32 0.0.0.15 area 3
!
ip forward-protocol nd
!
ip http server
ip http secure-server
!
ip ssh server algorithm encryption aes128-ctr aes192-ctr aes256-ctr
ip ssh client algorithm encryption aes128-ctr aes192-ctr aes256-ctr
!
control-plane
!
line con 0
logging synchronous
line aux 0
line vty 0 4
login
!
end
```

- RB-Core

version 15.7

service timestamps debug datetime msec

service timestamps log datetime msec

no service password-encryption

!

hostname RB-Core

!

boot-start-marker

boot-end-marker

!

no aaa new-model

!

mmi polling-interval 60

no mmi auto-configure

no mmi pvc

mmi snmp-timeout 180

!

ip dhcp excluded-address 172.20.2.1 172.20.2.2

ip dhcp excluded-address 172.20.2.17 172.20.2.18

ip dhcp excluded-address 172.20.2.33 172.20.2.34

!

ip dhcp pool VLAN55

network 172.20.2.0 255.255.255.240

default-router 172.20.2.1

dns-server 8.8.8.8

!

```
ip dhcp pool VLAN66
network 172.20.2.16 255.255.255.240
default-router 172.20.2.17
dns-server 8.8.8.8
!
ip dhcp pool VLAN77
network 172.20.2.32 255.255.255.240
default-router 172.20.2.33
dns-server 8.8.8.8
!
ip cef
no ipv6 cef
!
multilink bundle-name authenticated
!
redundancy
!
track 1 interface Multilink8 ip routing
!
crypto isakmp policy 10
encr aes 256
authentication pre-share
group 5
!
crypto isakmp policy 20
encr aes 256
authentication pre-share
```

```
group 5
!
crypto isakmp policy 25
    encr aes 256
    authentication pre-share
group 5
!
crypto isakmp policy 26
    encr aes 256
    authentication pre-share
group 5
crypto isakmp key AdminVpn address 145.0.0.14
crypto isakmp key AdminVpn address 145.0.0.22
!
!
crypto ipsec transform-set VPN-SET esp-aes esp-sha-hmac
mode tunnel
!
crypto map VPN-MAP 10 ipsec-isakmp
    description connection to State Monster
    set peer 145.0.0.14
    set transform-set VPN-SET
    match address 110
crypto map VPN-MAP 20 ipsec-isakmp
    description connection to State Blue
    set peer 145.0.0.14
    set transform-set VPN-SET
```

```
match address 120
crypto map VPN-MAP 25 ipsec-isakmp
description connection to State Monster
set peer 145.0.0.22
set transform-set VPN-SET
match address 125
crypto map VPN-MAP 26 ipsec-isakmp
description connection to State Monster
set peer 145.0.0.22
set transform-set VPN-SET
match address 126
!
interface Loopback0
no shutdown
ip address 37.0.0.1 255.255.255.255
!
interface Multilink5
no shutdown
ip address 145.0.0.18 255.255.255.252
ip access-group 100 in
ip nat outside
ip virtual-reassembly in
ppp multilink
ppp multilink group 5
crypto map VPN-MAP
!
interface Multilink8
```

```
no shutdown
ip address 145.0.0.30 255.255.255.252
ip access-group 100 in
ip nat outside
ip virtual-reassembly in
ppp multilink
ppp multilink group 8
crypto map VPN-MAP
!
interface Ethernet0/0
no shutdown
no ip address
ip nat inside
ip virtual-reassembly in
duplex auto
!
interface Ethernet0/0.55
no shutdown
encapsulation dot1Q 55
ip address 172.20.2.1 255.255.255.240
ip nat inside
ip virtual-reassembly in
!
interface Ethernet0/0.66
no shutdown
encapsulation dot1Q 66
ip address 172.20.2.17 255.255.255.240
```

```
ip nat inside  
ip virtual-reassembly in  
!  
interface Ethernet0/0.77  
no shutdown  
encapsulation dot1Q 77  
ip address 172.20.2.33 255.255.255.240  
ip nat inside  
ip virtual-reassembly in  
!  
interface Ethernet0/1  
no shutdown  
no ip address  
shutdown  
duplex auto  
!  
interface Ethernet0/2  
no shutdown  
no ip address  
shutdown  
duplex auto  
!  
interface Ethernet0/3  
no shutdown  
no ip address  
shutdown  
duplex auto
```

!

interface Serial1/0

no shutdown

no ip address

encapsulation ppp

ppp multilink

ppp multilink group 5

serial restart-delay 0

!

interface Serial1/1

no shutdown

no ip address

encapsulation ppp

ppp multilink

ppp multilink group 5

serial restart-delay 0

!

interface Serial1/2

no shutdown

no ip address

encapsulation ppp

ppp multilink

ppp multilink group 8

serial restart-delay 0

!

interface Serial1/3

no shutdown

```
no ip address  
encapsulation ppp  
ppp multilink  
ppp multilink group 8  
serial restart-delay 0  
!  
router ospf 377  
network 37.0.0.1 0.0.0.0 area 3  
network 145.0.0.16 0.0.0.3 area 0  
network 145.0.0.28 0.0.0.3 area 0  
network 172.20.2.0 0.0.0.15 area 3  
network 172.20.2.16 0.0.0.15 area 3  
network 172.20.2.32 0.0.0.15 area 3  
default-information originate  
!  
ip forward-protocol nd  
!  
no ip http server  
no ip http secure-server  
ip nat inside source route-map NAT-ISPS interface Multilink5 overload  
ip nat inside source route-map NAT-ISPZ interface Multilink8 overload  
ip route 0.0.0.0 0.0.0.0 145.0.0.29 track 1  
ip route 0.0.0.0 0.0.0.0 145.0.0.17 10  
!  
ip access-list extended NAT  
permit ip 172.20.2.0 0.0.0.63 any  
!
```

```
ip sla 1
  icmp-echo 145.0.0.29 source-interface Multilink8
  frequency 5
ip sla schedule 1 life forever start-time now
ipv6 ioam timestamp
!
route-map NAT-ISPZ permit 10
  match ip address NAT
  match interface Multilink8
!
route-map NAT-ISPS permit 10
  match ip address NAT
  match interface Multilink5
!
access-list 110 permit ip 172.20.2.0 0.0.0.63 172.20.0.0 0.0.0.127
access-list 120 permit ip 172.20.2.0 0.0.0.63 172.20.0.0 0.0.0.127
access-list 125 permit ip 172.20.2.0 0.0.0.63 172.20.0.0 0.0.0.127
access-list 126 permit ip 172.20.2.0 0.0.0.63 172.20.0.0 0.0.0.127
!
control-plane
!
line con 0
logging synchronous
line aux 0
line vty 0 4
login
transport input none
```

!

end

4.2.10 Configuration Network of ISP STC

- RS-PE1

version 12.4

service timestamps debug datetime msec

service timestamps log datetime msec

no service password-encryption

!

hostname RS-PE1

!

boot-start-marker

boot-end-marker

!

no aaa new-model

mmi polling-interval 60

no mmi auto-configure

no mmi pvc

mmi snmp-timeout 180

ip source-route

!

ip cef

no ipv6 traffic interface-statistics

no ipv6 cef

!

multilink bundle-name authenticated

!

redundancy

!

```
interface Loopback0
no shutdown
ip address 179.0.3.1 255.255.255.255
!
interface Multilink1
no shutdown
ip address 145.0.0.1 255.255.255.252
ppp multilink
ppp multilink group 1
!
interface Multilink2
no shutdown
ip address 145.0.0.5 255.255.255.252
ppp multilink
ppp multilink group 2
!
interface Ethernet0/0
no shutdown
ip address 179.0.0.1 255.255.255.0
!
interface Ethernet0/1
no shutdown
ip address 179.0.1.1 255.255.255.0
!
interface Ethernet0/2
no shutdown
no ip address
```

```
shutdown
!
interface Ethernet0/3
    no shutdown
    no ip address
    shutdown
!
interface Serial1/0
    no shutdown
    no ip address
    encapsulation ppp
    ppp multilink
    ppp multilink group 2
    no fair-queue
    serial restart-delay 0
!
interface Serial1/1
    no shutdown
    no ip address
    encapsulation ppp
    ppp multilink
    ppp multilink group 2
    serial restart-delay 0
!
interface Serial1/2
    no shutdown
    no ip address
```

```
encapsulation ppp
ppp multilink
ppp multilink group 1
serial restart-delay 0
!
interface Serial1/3
no shutdown
no ip address
encapsulation ppp
ppp multilink
ppp multilink group 1
serial restart-delay 0
!
router ospf 179
log-adjacency-changes
redistribute bgp 179 subnets
network 145.0.0.0 0.0.0.3 area 0
network 145.0.0.4 0.0.0.3 area 0
network 179.0.0.0 0.0.0.255 area 0
network 179.0.1.0 0.0.0.255 area 0
network 179.0.3.1 0.0.0.0 area 0
!
ip forward-protocol nd
!
!
no ip http server
no ip http secure-server
```

```
!  
control-plane  
!  
line con 0  
exec-timeout 0 0  
logging synchronous  
line aux 0  
line vty 0 4  
login  
!  
exception data-corruption buffer truncate  
end
```

- RS-PE2

version 12.4

service timestamps debug datetime msec

service timestamps log datetime msec

no service password-encryption

!

hostname RS-PE2

!

boot-start-marker

boot-end-marker

!

no aaa new-model

mmi polling-interval 60

no mmi auto-configure

no mmi pvc

mmi snmp-timeout 180

ip source-route

!

ip cef

no ipv6 traffic interface-statistics

no ipv6 cef

!

multilink bundle-name authenticated

!

redundancy

!

interface Loopback0

```
no shutdown  
ip address 179.0.4.1 255.255.255.255  
!  
interface Multilink4  
no shutdown  
ip address 145.0.0.13 255.255.255.252  
ppp multilink  
ppp multilink group 4  
!  
interface Ethernet0/0  
no shutdown  
ip address 179.0.0.2 255.255.255.0  
!  
interface Ethernet0/1  
no shutdown  
no ip address  
shutdown  
!  
interface Ethernet0/2  
no shutdown  
ip address 179.0.2.1 255.255.255.0  
!  
interface Ethernet0/3  
no shutdown  
no ip address  
shutdown  
!
```

```
interface Serial1/0
```

```
  no shutdown
```

```
  no ip address
```

```
  encapsulation ppp
```

```
  ppp multilink
```

```
  ppp multilink group 4
```

```
  no fair-queue
```

```
  serial restart-delay 0
```

```
!
```

```
interface Serial1/1
```

```
  no shutdown
```

```
  no ip address
```

```
  encapsulation ppp
```

```
  ppp multilink
```

```
  ppp multilink group 4
```

```
  serial restart-delay 0
```

```
!
```

```
interface Serial1/2
```

```
  no shutdown
```

```
  no ip address
```

```
  shutdown
```

```
  serial restart-delay 0
```

```
!
```

```
interface Serial1/3
```

```
  no shutdown
```

```
  no ip address
```

```
  shutdown
```

```
serial restart-delay 0
!
router ospf 179
log-adjacency-changes
network 145.0.0.12 0.0.0.3 area 0
network 179.0.0.0 0.0.0.255 area 0
network 179.0.2.0 0.0.0.255 area 0
network 179.0.4.1 0.0.0.0 area 0
!
ip forward-protocol nd
!
!
no ip http server
no ip http secure-server
!
control-plane
!
line con 0
exec-timeout 0 0
logging synchronous
line aux 0
line vty 0 4
login
!
exception data-corruption buffer truncate
end
```

- RS-PE3

version 15.7

service timestamps debug datetime msec

service timestamps log datetime msec

no service password-encryption

!

hostname RS-PE3

!

boot-start-marker

boot-end-marker

!

no aaa new-model

!

mmi polling-interval 60

no mmi auto-configure

no mmi pvc

mmi snmp-timeout 180

!

ip cef

no ipv6 traffic interface-statistics

no ipv6 cef

!

multilink bundle-name authenticated

!

redundancy

!

interface Loopback0

```
no shutdown  
ip address 179.0.5.1 255.255.255.0  
!  
interface Multilink5  
no shutdown  
ip address 145.0.0.17 255.255.255.252  
ppp multilink  
ppp multilink group 5  
!  
interface Ethernet0/0  
no shutdown  
no ip address  
shutdown  
duplex auto  
!  
interface Ethernet0/1  
no shutdown  
ip address 179.0.1.2 255.255.255.0  
duplex auto  
!  
interface Ethernet0/2  
no shutdown  
ip address 179.0.2.2 255.255.255.0  
duplex auto  
!  
interface Ethernet0/3  
no shutdown
```

no ip address

shutdown

duplex auto

!

interface Serial1/0

no shutdown

no ip address

encapsulation ppp

ppp multilink

ppp multilink group 5

serial restart-delay 0

!

interface Serial1/1

no shutdown

no ip address

encapsulation ppp

ppp multilink

ppp multilink group 5

serial restart-delay 0

!

interface Serial1/2

no shutdown

no ip address

shutdown

serial restart-delay 0

!

interface Serial1/3

```
no shutdown  
no ip address  
shutdown  
serial restart-delay 0  
!  
router ospf 179  
network 145.0.0.16 0.0.0.3 area 0  
network 179.0.1.0 0.0.0.255 area 0  
network 179.0.2.0 0.0.0.255 area 0  
network 179.0.5.1 0.0.0.0 area 0  
!  
ip forward-protocol nd  
!  
no ip http server  
no ip http secure-server  
!  
ipv6 ioam timestamp  
!  
control-plane  
!  
line con 0  
exec-timeout 0 0  
logging synchronous  
line aux 0  
line vty 0 4  
login  
transport input none
```

4.2.11 Configuration Network of ISP Mobily

- RM-PE1

version 12.4

service timestamps debug datetime msec

service timestamps log datetime msec

no service password-encryption

!

hostname RM-PE1

!

boot-start-marker

boot-end-marker

!

no aaa new-model

mmi polling-interval 60

no mmi auto-configure

no mmi pvc

mmi snmp-timeout 180

ip source-route

!

ip cef

no ipv6 traffic interface-statistics

no ipv6 cef

!

multilink bundle-name authenticated

!

redundancy

!

```
interface Loopback0
no shutdown
ip address 184.0.3.1 255.255.255.255
!
interface Multilink6
no shutdown
ip address 145.0.0.21 255.255.255.252
ppp multilink
ppp multilink group 6
!
interface Ethernet0/0
no shutdown
ip address 184.0.0.1 255.255.255.0
!
interface Ethernet0/1
no shutdown
ip address 184.0.1.1 255.255.255.0
!
interface Ethernet0/2
no shutdown
no ip address
shutdown
!
interface Ethernet0/3
no shutdown
no ip address
shutdown
```

!

interface Serial1/0

no shutdown

no ip address

encapsulation ppp

ppp multilink

ppp multilink group 6

no fair-queue

serial restart-delay 0

!

interface Serial1/1

no shutdown

no ip address

encapsulation ppp

ppp multilink

ppp multilink group 6

serial restart-delay 0

!

interface Serial1/2

no shutdown

no ip address

shutdown

serial restart-delay 0

!

interface Serial1/3

no shutdown

no ip address

```
shutdown
serial restart-delay 0
!
router ospf 184
log-adjacency-changes
network 145.0.0.20 0.0.0.3 area 0
network 184.0.0.0 0.0.0.255 area 0
network 184.0.1.0 0.0.0.255 area 0
network 184.0.3.1 0.0.0.0 area 0
!
ip forward-protocol nd
!
no ip http server
no ip http secure-server
!
control-plane
!
line con 0
exec-timeout 0 0
logging synchronous
line aux 0
line vty 0 4
login
!
exception data-corruption buffer truncate
end
```

- RM-PE2

version 12.4

service timestamps debug datetime msec

service timestamps log datetime msec

no service password-encryption

!

hostname RM-PE2

!

boot-start-marker

boot-end-marker

!

no aaa new-model

mmi polling-interval 60

no mmi auto-configure

no mmi pvc

mmi snmp-timeout 180

ip source-route

!

ip cef

no ipv6 traffic interface-statistics

no ipv6 cef

!

multilink bundle-name authenticated

!

redundancy

!

interface Loopback0

```
no shutdown  
ip address 184.0.4.1 255.255.255.255  
!  
interface Multilink1  
no shutdown  
ip address 145.0.0.2 255.255.255.252  
ppp multilink  
ppp multilink group 1  
!  
interface Multilink3  
no shutdown  
ip address 145.0.0.9 255.255.255.252  
ppp multilink  
ppp multilink group 3  
!  
interface Ethernet0/0  
no shutdown  
ip address 184.0.0.2 255.255.255.0  
!  
interface Ethernet0/1  
no shutdown  
no ip address  
shutdown  
!  
interface Ethernet0/2  
no shutdown  
ip address 184.0.2.1 255.255.255.0
```

```
!  
interface Ethernet0/3  
no shutdown  
no ip address  
shutdown  
!  
interface Serial1/0  
no shutdown  
no ip address  
encapsulation ppp  
ppp multilink  
ppp multilink group 3  
no fair-queue  
serial restart-delay 0  
!  
interface Serial1/1  
no shutdown  
no ip address  
encapsulation ppp  
ppp multilink  
ppp multilink group 3  
serial restart-delay 0  
!  
interface Serial1/2  
no shutdown  
no ip address  
encapsulation ppp
```

```
ppp multilink
ppp multilink group 1
serial restart-delay 0
!
interface Serial1/3
no shutdown
no ip address
encapsulation ppp
ppp multilink
ppp multilink group 1
serial restart-delay 0
!
router ospf 184
log-adjacency-changes
network 145.0.0.0 0.0.0.3 area 0
network 145.0.0.8 0.0.0.3 area 0
network 184.0.0.0 0.0.0.255 area 0
network 184.0.2.0 0.0.0.255 area 0
network 184.0.4.1 0.0.0.0 area 0
!
ip forward-protocol nd
!
no ip http server
no ip http secure-server
!
control-plane
!
```

```
line con 0
exec-timeout 0 0
logging synchronous
line aux 0
line vty 0 4
login
!
exception data-corruption buffer truncate
end
```

- RM-PE3

version 12.4

service timestamps debug datetime msec

service timestamps log datetime msec

no service password-encryption

!

hostname RM-PE3

!

boot-start-marker

boot-end-marker

!

no aaa new-model

mmi polling-interval 60

no mmi auto-configure

no mmi pvc

mmi snmp-timeout 180

ip source-route

!

ip cef

no ipv6 traffic interface-statistics

no ipv6 cef

!

multilink bundle-name authenticated

!

redundancy

!

interface Loopback0

```
no shutdown  
ip address 184.0.5.1 255.255.255.0  
!  
interface Multilink7  
no shutdown  
ip address 145.0.0.25 255.255.255.252  
ppp multilink  
ppp multilink group 7  
!  
interface Ethernet0/0  
no shutdown  
no ip address  
shutdown  
!  
interface Ethernet0/1  
no shutdown  
ip address 184.0.1.2 255.255.255.0  
!  
interface Ethernet0/2  
no shutdown  
ip address 184.0.2.2 255.255.255.0  
!  
interface Ethernet0/3  
no shutdown  
no ip address  
shutdown  
!
```

```
interface Serial1/0
```

```
  no shutdown
```

```
  no ip address
```

```
  encapsulation ppp
```

```
  ppp multilink
```

```
  ppp multilink group 7
```

```
  no fair-queue
```

```
  serial restart-delay 0
```

```
!
```

```
interface Serial1/1
```

```
  no shutdown
```

```
  no ip address
```

```
  encapsulation ppp
```

```
  ppp multilink
```

```
  ppp multilink group 7
```

```
  serial restart-delay 0
```

```
!
```

```
interface Serial1/2
```

```
  no shutdown
```

```
  no ip address
```

```
  shutdown
```

```
  serial restart-delay 0
```

```
!
```

```
interface Serial1/3
```

```
  no shutdown
```

```
  no ip address
```

```
  shutdown
```

```
serial restart-delay 0
!
router ospf 184
    log-adjacency-changes
    network 145.0.0.24 0.0.0.3 area 0
    network 184.0.1.0 0.0.0.255 area 0
    network 184.0.2.0 0.0.0.255 area 0
    network 184.0.5.1 0.0.0.0 area 0
!
ip forward-protocol nd
!
no ip http server
no ip http secure-server
!
control-plane
!
line con 0
exec-timeout 0 0
logging synchronous
line aux 0
line vty 0 4
login
!
exception data-corruption buffer truncate
end
```

4.2.12 Configuration Network of ISP Zain

- RZ-PE1

version 12.4

service timestamps debug datetime msec

service timestamps log datetime msec

no service password-encryption

!

hostname RZ-PE1

!

boot-start-marker

boot-end-marker

!

no aaa new-model

mmi polling-interval 60

no mmi auto-configure

no mmi pvc

mmi snmp-timeout 180

ip source-route

!

ip cef

no ipv6 traffic interface-statistics

no ipv6 cef

!

multilink bundle-name authenticated

!

redundancy

!

```
interface Loopback0
no shutdown
ip address 107.0.3.1 255.255.255.255
!
interface Multilink2
no shutdown
ip address 145.0.0.6 255.255.255.252
ppp multilink
ppp multilink group 2
!
interface Multilink3
no shutdown
ip address 145.0.0.10 255.255.255.252
ppp multilink
ppp multilink group 3
!
interface Ethernet0/0
no shutdown
ip address 107.0.0.1 255.255.255.0
!
interface Ethernet0/1
no shutdown
ip address 107.0.1.1 255.255.255.0
!
interface Ethernet0/2
no shutdown
no ip address
```

```
shutdown
!
interface Ethernet0/3
    no shutdown
    no ip address
    shutdown
!
interface Serial1/0
    no shutdown
    no ip address
    encapsulation ppp
    ppp multilink
    ppp multilink group 3
    no fair-queue
    serial restart-delay 0
!
interface Serial1/1
    no shutdown
    no ip address
    encapsulation ppp
    ppp multilink
    ppp multilink group 3
    serial restart-delay 0
!
interface Serial1/2
    no shutdown
    no ip address
```

```
encapsulation ppp
ppp multilink
ppp multilink group 2
serial restart-delay 0
!
interface Serial1/3
no shutdown
no ip address
encapsulation ppp
ppp multilink
ppp multilink group 2
serial restart-delay 0
!
router ospf 107
log-adjacency-changes
network 107.0.0.0 0.0.0.255 area 0
network 107.0.1.0 0.0.0.255 area 0
network 107.0.3.1 0.0.0.0 area 0
network 145.0.0.4 0.0.0.3 area 0
network 145.0.0.8 0.0.0.3 area 0
!
ip forward-protocol nd
!
no ip http server
no ip http secure-server
!
control-plane
```

```
!  
line con 0  
exec-timeout 0 0  
logging synchronous  
line aux 0  
line vty 0 4  
login  
!  
exception data-corruption buffer truncate  
end
```

- RZ-PE2

version 12.4

service timestamps debug datetime msec

service timestamps log datetime msec

no service password-encryption

!

hostname RZ-PE2

!

boot-start-marker

boot-end-marker

!

no aaa new-model

mmi polling-interval 60

no mmi auto-configure

no mmi pvc

mmi snmp-timeout 180

ip source-route

!

ip cef

no ipv6 traffic interface-statistics

no ipv6 cef

!

multilink bundle-name authenticated

!

redundancy

!

interface Loopback0

```
no shutdown  
ip address 107.0.4.1 255.255.255.255  
!  
interface Multilink9  
no shutdown  
ip address 145.0.0.33 255.255.255.252  
ppp multilink  
ppp multilink group 9  
!  
interface Ethernet0/0  
no shutdown  
ip address 107.0.0.2 255.255.255.0  
!  
interface Ethernet0/1  
no shutdown  
no ip address  
shutdown  
!  
interface Ethernet0/2  
no shutdown  
ip address 107.0.2.1 255.255.255.0  
!  
interface Ethernet0/3  
no shutdown  
no ip address  
shutdown  
!
```

```
interface Serial1/0
```

```
  no shutdown
```

```
  no ip address
```

```
  encapsulation ppp
```

```
  ppp multilink
```

```
  ppp multilink group 9
```

```
  no fair-queue
```

```
  serial restart-delay 0
```

```
!
```

```
interface Serial1/1
```

```
  no shutdown
```

```
  no ip address
```

```
  encapsulation ppp
```

```
  ppp multilink
```

```
  ppp multilink group 9
```

```
  serial restart-delay 0
```

```
!
```

```
interface Serial1/2
```

```
  no shutdown
```

```
  no ip address
```

```
  shutdown
```

```
  serial restart-delay 0
```

```
!
```

```
interface Serial1/3
```

```
  no shutdown
```

```
  no ip address
```

```
  shutdown
```

```
serial restart-delay 0
!
router ospf 107
  log-adjacency-changes
  network 107.0.0.0 0.0.0.255 area 0
  network 107.0.2.0 0.0.0.255 area 0
  network 107.0.4.1 0.0.0.0 area 0
  network 145.0.0.32 0.0.0.3 area 0
!
ip forward-protocol nd
!
no ip http server
no ip http secure-server
!
control-plane
!
line con 0
  exec-timeout 0 0
  logging synchronous
line aux 0
line vty 0 4
  login
!
exception data-corruption buffer truncate
end
```

- RZ-PE3

version 12.4

service timestamps debug datetime msec

service timestamps log datetime msec

no service password-encryption

!

hostname RZ-PE3

!

boot-start-marker

boot-end-marker

!

no aaa new-model

mmi polling-interval 60

no mmi auto-configure

no mmi pvc

mmi snmp-timeout 180

ip source-route

!

ip cef

no ipv6 traffic interface-statistics

no ipv6 cef

!

multilink bundle-name authenticated

!

redundancy

!

interface Loopback0

```
no shutdown  
ip address 107.0.5.1 255.255.255.0  
!  
interface Multilink8  
no shutdown  
ip address 145.0.0.29 255.255.255.252  
ppp multilink  
ppp multilink group 8  
!  
interface Ethernet0/0  
no shutdown  
no ip address  
shutdown  
!  
interface Ethernet0/1  
no shutdown  
ip address 107.0.1.2 255.255.255.0  
!  
interface Ethernet0/2  
no shutdown  
ip address 107.0.2.2 255.255.255.0  
!  
interface Ethernet0/3  
no shutdown  
no ip address  
shutdown  
!
```

```
interface Serial1/0
```

```
  no shutdown
```

```
  no ip address
```

```
  encapsulation ppp
```

```
  ppp multilink
```

```
  ppp multilink group 8
```

```
  no fair-queue
```

```
  serial restart-delay 0
```

```
!
```

```
interface Serial1/1
```

```
  no shutdown
```

```
  no ip address
```

```
  encapsulation ppp
```

```
  ppp multilink
```

```
  ppp multilink group 8
```

```
  serial restart-delay 0
```

```
!
```

```
interface Serial1/2
```

```
  no shutdown
```

```
  no ip address
```

```
  shutdown
```

```
  serial restart-delay 0
```

```
!
```

```
interface Serial1/3
```

```
  no shutdown
```

```
  no ip address
```

```
  shutdown
```

```
serial restart-delay 0
!
router ospf 107
  log-adjacency-changes
  network 107.0.1.0 0.0.0.255 area 0
  network 107.0.2.0 0.0.0.255 area 0
  network 107.0.5.1 0.0.0.0 area 0
  network 145.0.0.28 0.0.0.3 area 0
!
ip forward-protocol nd
!
no ip http server
no ip http secure-server
!
control-plane
!
line con 0
  exec-timeout 0 0
  logging synchronous
line aux 0
line vty 0 4
  login
!
exception data-corruption buffer truncate
end
```

Chapter-5 Conclusion

5.1 Summary

The project aimed to simulate a secure and resilient network infrastructure to connect three companies, BlueTech, Monsters, Inc, and CyberBooks, via dual Internet Service Providers (ISPs). It utilized advanced networking technologies such as VLANs, redundancy protocols, and VPNs to ensure high availability and secure data exchange across different operational scales.

Key features of the project included:

- Implementation of three-tier and collapsed core network architectures appropriate to the scale of operations at each company.
- Use of redundancy protocols like EtherChannel and HSRP to ensure network reliability and fault tolerance.
- Deployment of Docker-based email servers configured to handle SMTP, IMAP, and POP3 protocols securely.
- The network simulation and testing were conducted using the EVE-NG platform, leveraging Cisco network devices and Linux servers to emulate real-world operations effectively.

5.2 Limitations and Future Work

1. **Scalability Concerns:** As the network grows, the complexity and management overhead associated with maintaining and expanding the network architecture could pose challenges.
2. **Dependence on Simulated Environment:** The project's reliance on EVE-NG for simulation may not fully capture the performance variances encountered in a live, production environment.
3. **Security Risks:** While measures were put in place, the increasing sophistication of cyber threats could necessitate continuous updates and patches to security protocols and hardware.
4. **Technological Dependencies:** The project's success is heavily reliant on specific technologies like Cisco devices and Docker containers, which might limit flexibility in integrating diverse technologies or vendors.

Future Work:

1. **Integration of Cloud Services:** To enhance scalability and reduce operational overhead, future iterations could explore integrating cloud-managed network services.
2. **Advanced Security Features:** Implementing next-generation firewalls, intrusion detection systems, and enhanced endpoint security to bolster the network's defenses against evolving cyber threats.
3. **Automation and Orchestration:** Leveraging network automation tools to streamline configuration, management, and response to network events.
4. **Performance Benchmarking:** Conducting extensive live environment testing to benchmark performance and identify optimization opportunities in real-world scenarios.
5. **Expandability for IoT and Edge Computing:** Adapting the network to support IoT devices and edge computing applications, which are becoming increasingly prevalent in corporate environments.

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