

KING FAHD UNIVERSITY OF PETROLEUM & MINERALS

College of Computing and Mathematics



COMPUTER ENGINEERING DEPARTMENT

GRADUATION PROJECT

Design and Implementation of an Enterprise Campus Network

Prepared by

Name	ID
Waad Alotaibi	202104910
Asma Alwadie	202104890
Rawan Alnemari	202105070
Maryam Almutairi	202105050

Supervised by
<Dr. Tarek Sheltami >
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I. Student Declaration

Student acknowledges that he has read the above policy pertaining to plagiarism and understands that the penalty for such act could result in disciplinary action.

Project Title: **Design and Implementation of an Enterprise Campus Network**

	Student Name	Student ID number	Student signature	Date
1	Waad Alotaibi	202104910		30/8/2022
2	Asma Alwadie	202104890		30/8/2022
3	Rawan Alnemari	202105070		30/8/2022
4	Maryam Almutairi	202105050		30/8/2022

II. Acknowledgements

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III. Abstract

Networking is at the heart of modern businesses, so its design can have a direct impact on business outcomes. To find the right balance between network performance, security, redundancy, and cost, a combination of project management and technical skills are required. The general aim of this project is to design and implement a scalable, secure, and redundant enterprise network. Our design is based on the Enterprise Composite Network Model (ECNM), a more recent Cisco model, is considerably more complicated and makes explicit suggestions for how and where certain network operations should be implemented in order to address the main flaws of the Hierarchical Design Model. The Cisco Architecture for Voice, Video, and Integrated Data (AVVID) is the foundation for ECNM concept. Troubleshooting, building, repairing, and understanding the network all will become easier using this approach.

Three areas are included in the Enterprise Composite Network Model, each of which can be broken down into smaller modules. An Enterprise Campus is the part of the design that resembles the previous hierarchical design. The Access layer enables network access to local and remote workgroups or users. In general, the Distribution layer serves as a connection between the Access layer and the Core layer that enabling the Access layer devices to exchange information among themselves and with the Core layer. When VLANs are used in the Access layer to separate traffic, the Distribution layer has the responsibility to route between the VLANs. For this layer, redundancy is also important, so we can add redundancy for the network by using Cisco HSRP. Adding a little complexity decreases the chances of a network failure bringing it down. To meet the connection and transport demands of the distribution layer devices, the core (or backbone) layer delivers high-speed transport.

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CHAPTER1:

INTRODUCTION

1.1 Introduction

Technology has reached its peak due to its ability to make life easier for people. It has become an integral part of our lives as it allows people to connect with each other. It is used in various fields of life, such as education, health, and the military. The computer network is a component that enables various fields of work to perform their functions more efficiently.

A campus network is typically the portion of an enterprise network that enables end users to connect and communicate over a single geographic location. Some networks have a single campus that acts as the hub or backbone of the network. It can also provide connectivity between other parts of the network.

The campus network is a set of integrated elements that consists of various services that are used by various users and end-station devices. These components include network security, traffic monitoring, wireless and wired packet-transport services and overall system management and provisioning. The need for a secure and reliable enterprise network has become more critical issue. This project aims to design and build a secure, reliable, and scalable enterprise network.

A good design principle can help guide the entire network's structure and operations. Prior to network implementation (Putting the design into practice and deploying and configuring it), network design begins with the identification of business and technical needs. There are several things involved in network design, including IP addressing, hardware selection, network analysis, and planning for the implementation. Most homes and small offices have simple networks, which are relatively straightforward to design. It is common for large enterprise networks to go through a complex network design process, with multiple stakeholders being involved.

Network designers can utilize the Enterprise Composite Network Model as a guide to reduce the complexity of a big internetwork. By analyzing the functional, logical, and physical elements of a network with the Business Composite Network Model, you may make the process of creating an enterprise network more straightforward. And this what we use in our project. Remember that this is a Cisco recommendation rather than an industry standard.

Three main sections of the Enterprise Composite Network Model, each of which may be broken down into smaller modules, are as follows:

- **Enterprise Campus:**

The enterprise campus consists of the elements needed to create a strong campus network that offers scalability, flexibility, and high availability. All the network components necessary for autonomous operation are located in this region of the campus. A company may have many campuses.

The common approach model to design an enterprise campus network is to divide it into three layers as shown in Fig-1: The Access layer, The Distribution layer, and The Core layer. The Access layer serves as the connection between the host computers and the network. The Distribution layer is the point where all the Access layer devices are connected to the network. The Core layer manages all the traffic and processes it efficiently.

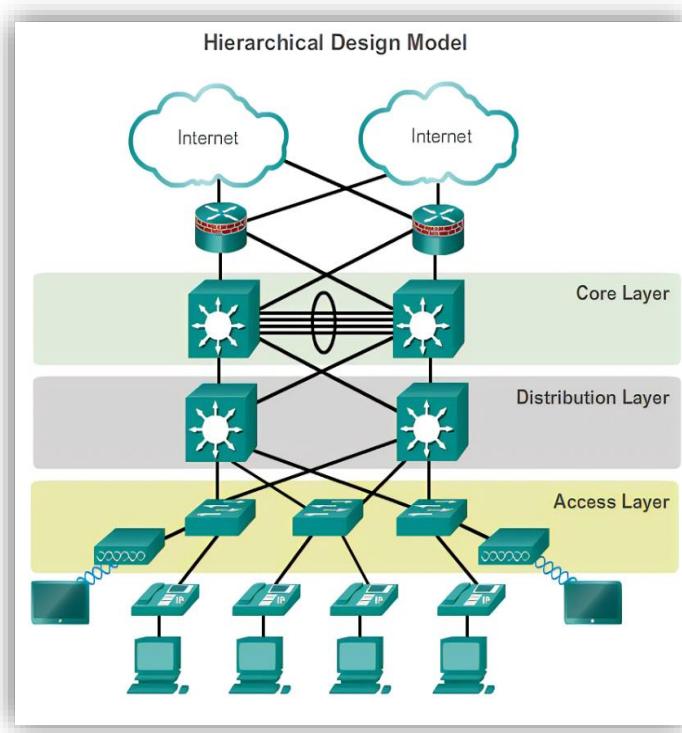


FIGURE 1 HIERARCHICAL DESIGN MODEL

- **Enterprise edge:**
This area is at the edge of an enterprise network that collects connections from multiple components. Traffic coming from the edge modules is filtered by the enterprise edge functional area and sent to the enterprise campus. All the network components necessary for effective and secure communication between the enterprise campus and business partners, off-campus sites, mobile users, and the Internet are present at the enterprise edge.
- **Service Provider Edge:**
To facilitate contact with other networks utilizing various WAN technologies and Internet service providers (ISPs), the service provider edge modules are added. The enterprise does not implement the modules in this functional area.

1.2 Problem Description

Networking is more than configuring routers and switches. Our network needs to have a plan. Therefore, we have to come up with a design that fits to the business requirements. Network design is an integral part of any organization's infrastructure, and it plays a vital role in addressing the various requirements of today's fast-paced businesses. As technology continues to improve, network analysis and redesign is important to ensure the system is operating efficiently.

Before going to implementation, it is important to measure how good our network design is. We can do this by measuring three key factors: resiliency, scalability, and manageability. It is important that any network meet these three requirements at least to some extent. We can create the best design by understanding what these requirements are about.

- **Resilient networks** are able to withstand problems with devices and continue working even if a primary component fails. Secondary devices can facilitate this by taking over the load in the event of a failure
- The ability to handle more traffic and support more users is known as **Network scalability** (bandwidth elasticity). This allows network administrators to easily add more switches and devices without disrupting the operation of the network.
- The ease of **managing a network** is very important when it comes to keeping it running smoothly. You should be able to easily identify and troubleshoot issues.

A bad network is one that has multiple switches that are connected next to each other. This is known as a switch chain. It is the most common deployment that you will find in a bad network. The number of users on the network is not so bad yet. However, as the business grows (the number of users continues to grow), the switch can no longer handle all of them, and the only solution is to add more switches. This type of design comes with various problems. One of these is the Single Point of Failure, which means that switch failure can cause all users (connected to it) to be disconnected from the network, also it cannot be upgraded without causing downtime.

So, to design a network that accommodates growth while being robust, we use what is known as Three-Tier Architecture. Its flexible and simple design makes it the ideal solution for a continuously growing business. Its ability to handle large numbers of devices and provide resilient connectivity makes it the best choice for campuses. The Three-tier model groups devices into three tiers. Each device has its own unique role in the network.

1.3 Motivation

Can we imagine a world now without emails, online newspapers, blogs, chat, and the other services offered by the internet? these days Computer networks help users on the network to share the resources and in communication with one another. Today's computer networks are designed not only for file transfer or printing, but a variety of different traffic types like voice, video, torrents etc.

Over the last decade, our reliance on computer networks has increased rapidly in many areas of life. Whether it's for fun, employment, medical or even education as in our Enterprise Campus Network project, almost everything we do is now dependent on the skills of computer network professionals, this makes the world of computer networking an exciting place to be, as a result, our project will be extremely beneficial to our future careers and our skills.

1.4 Objectives

- Design a reliable network that is always on and resilient.
- Establish a high availability of the network that's has a fast link failover and a redundant link.
- Protect the enterprise campus network by preventing the different types of threats and attacks and minimize unauthorized accessing user to avoid security attacks associated with network
- Provide end users and employees with fast, secure Internet access. Also, they allow them to easily share files and data.
- Implementation of an Enterprise Campus Network that's has a good design can adapting to changing needs and has the capability of a network to scale.

1.5 Outcomes

Our proposed project aims to design and implement a suitable network system for Enterprise Campus that will help us nail our network design skills by giving us more knowledge in configuration and simulation the network using packet tracer, learning how the switches and routers works on the real world, applying a different protocol. At the end of this project, we will acquire the appropriate knowledge and skills needed to design and implement an enterprise network.

1.6 Requirements

1.6.1 Design Requirements

1. The network should be developed by having names for locations, building, floors, rooms, racks, routers, switches, network traffic flow between the different VLANs, and the number of servers with their locations.
2. The network should have several locations that's investigated and each of which should include a switch block.
3. The network layers design must consider the following: security, performance, redundancy, resiliency and scalability.
4. Identifying and explaining the roles and protocols to be used for each layer.
5. The network should avoid switching and routing loops.
6. Assigning IP addresses to users and devices, except servers.
7. The network should be configured with standard protocols and proprietary protocols should be avoided.
8. The VLANs should be created and used at the access layer, where a VLAN can span several access layers switches and a user in one VLAN can connect to the same VLAN and access all services provided in that VLAN even if they relocate to a new location.
9. The VLAN shouldn't propagate to the switch if VLAN isn't needed on that switch.
10. The network should be able to let the users access to the WAN or the Internet via a dedicated block.
11. Analysis of the project's cost.

1.6.2 Implementation Requirements

12. Determining the devices (routers and switches) that will be utilized at each layer and focusing on their capabilities for that layer.
13. Setting up each router and switch with the appropriate security features as well as secure the access to control and monitor the equipment.
14. Ensuring end-to-end connectivity by using both IPv4 and IPv6 addresses.

1.7 Cost

TABLE 1 DEVICES COST ESTIMATEION

DEVICE	SPECIFICATION	PRICE	BUDGET
Cisco 2811 Router	1- HWIC-4A/S: Provide four Serial Async/Sync Ports using Smart Serial Connectors and cabling, low speed, up to 256K bps per port, multiprotocol support, remote management. 2- Two Fast Ethernet.	2,495.00 US\$	x2,495.00 =7,485.00 US\$
Cisco 1841 Router	1- WAN Interface Cards (WIC -2T): WIC-2T provide two Serial Ports using the Smart Serial Connector, Async with maximum speed of 115.2 Kbps per port /Sync with maximum speed of 8 Mbps per port. 2- Two Fast Ethernet. 3 - CONSOLE 4 – AUX 5 - HWIC-4ESW: Four port 10/100 Ethernet switch interface card Cisco Router High-Speed WAN Interface card.	1,395.00 US\$	x1,395.00 =4,185.00 US\$
Cisco 2621XM Router	1 - Tow WAN Interface Cards (WIC -1T): Provide One Port Serial WAN Interface Card, serial connections to remote sites. 2- Two Fast Ethernet. 3 - CONSOLE 4 – AUX 5 - 4A/S: Four Port Async/Sync Network Module.	399.00 US\$	x399.00 = 1,197.00 US\$
Cisco 2621 Router	1 - WAN Interface Cards (WIC -1T): Provide One Port Serial WAN Interface Card, serial connections to remote sites. 2- Two Fast Ethernet. 3 - CONSOLE 4 – AUX	150.00 US\$	x150.00 = 450.00 US\$
Cisco Catalyst 3560 Series Switches	1 - Cisco Catalyst 3560-24TS: 24 Ethernet 10/100 ports and 2 Small Form-Factor Pluggable (SFP)-based Gigabit Ethernet ports; 1 rack unit (RU).	4,900.00 US\$	x4,900.00 = 14,700.00 US\$
Cisco Catalyst 2950 Series Switches	1 - C2950-12 /24 port, 10/100 auto-sensing and auto-negotiating Ethernet ports.	343.00 US\$	x343.00 = 1,029 US\$
Cisco Catalyst 2960 Series Switches	1 - Cisco Catalyst 24 ports of Gigabit Ethernet (GbE) 10/100/1000 desktop connectivity	454.86 US\$	x454.86 =1,364.58 US\$

CHAPTER2:

REVIEW

2.1 Related works

The topic of Enterprise Networks has been the subject of multiple studies. Shiv-Yadav and Ashraf (2016) [1] conducted a study on Enterprise Network Design and Implementation for Airports. They focused on three major areas: quality, security, and safety. The researchers compiled a list of useful network security tools to enhance network security. This included proxy server, domain server, hardware firewalls, Mac address port security, and IP access control lists. A local web server was used to provide high levels of security. Moreover, to ensure the backup operation at the Air Traffic Control Complex could be confirmed outside the local network, two internet service providers were assigned to the Air Traffic Control System.

In a study conducted in (2014) [2], Agbetuyi and his co-researcher designed and simulated a secured enterprise network. The study presented a comprehensive view of the various services that comprise an enterprise network. The researchers then put together various security policies such as port security and web authentication. They conducted their research on Covenant University Senate Building infrastructure, their design involved an authentication server which used for validating the credentials of the client. After that, the client is permitted to connect to the network. With the execution of Multi-Layer Switching (MLS), security services didn't hinder network execution.

According to Johanes and Honnia (2016) [3], their study focused on the use of VLAN for LAN switching to break up broadcast domains into segments. In their study they examined the use of VLAN to improve network performance.

In 2015[4] Garima and his partners examined various aspects of network topologies design, configuration of IP addresses on networks devices, and how packets are sent and received within a single network by using the Cisco packet tracer network simulator.

In 2017[5], a research project was carried out by Nathaniel and his co-researcher to design and simulate a local area network for the College of Engineering at the University of Agriculture, Makurdi, Nigeria using Cisco packet tracer. According to the study, Virtual Local Area Network was used to segment the network for each department in the college of engineering. Furthermore, the study analyzed the network packet flow.

CHAPTER3:

DESIGN

3.1 Network Design Approaches:

There are basically two network designs approaches that's used in network designing Flat network design and Structure network design, choosing one of them it depends on many factors we will first give some description on both first we will start with flat network design.

3.1.1 Flat network design

Instead of having multiple switches and routers, a flat network design allows the devices to connect to a single switch instead of multiple devices. This eliminates the need for costly and time-consuming network administration.

A flat network is typically built with fewer devices and is maintenance-free. It doesn't require the use of separate broadcast areas for different devices. The topology is not separated from the broadcast area by using separate routers and switches. Instead, devices are grouped together into the same broadcast area. So, all devices on the network are part of the same broadcast area.

- **Uses and Advantages**

Flat networks are typically used for low-level networking requirements such as homes and small businesses that don't require extensive security or separation because the network is often used to provide multiple users with Internet access. Because of the smaller size and less complexity of switches and routers the flat networks are easier to maintain, also they don't require the same number of resources to set up and manage.

- **Disadvantages**

Security -flat networks are typically not secure and can be easily exploited by hackers to modify the data on the network. They can also cause hardware failure and prevent the network from working seamlessly.

No redundant connections – since there are usually only a few switches in the network, failure when happen even entire switch will get damaged, network will totally lose the connectivity.

Lack of portability and speed – since devices can connect to the same central switch, the network's portability can be severely affected that will leads to reduce the speed of transmission the date.

Bad scalability -connecting multiple devices to a single switch can increase the likelihood of collisions and slow down the data transmission that's tends to scale badly and causes the network to fail.

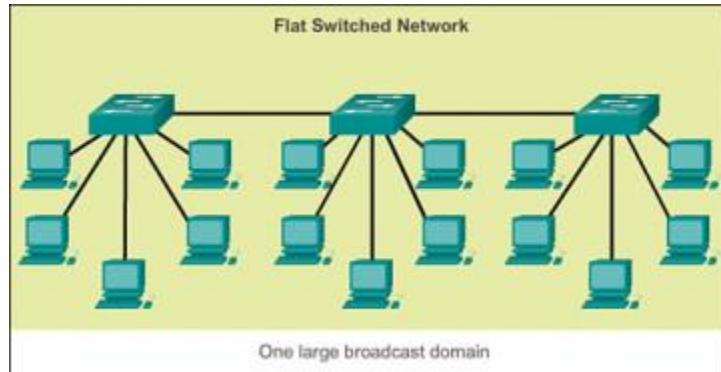


FIGURE 2: FLAT NETWORK DESIGN

3.1.2 Hierarchical Network Design

The network design model breaks down the complex flat network into smaller and more manageable components. A hierarchy of networks simplifies the work of network designers by defining the roles of each layer, the network designers perform specific roles for each layer that's helps them select the right hardware and software for each layer.

In a hierarchical structure, local traffic moves to a higher layer when it moves to another network. The logical layers of a network are typically mapped according to the physical layout. However, they can also differ. A three-layer network design is most used, but not required.

- **Uses and Advantages**

Easy Management and Troubleshooting

This hierarchical design of the network makes the network structure clear and can be implemented at various levels of management also will make it possible to implement different network management techniques at different levels. Hierarchical network design can help network managers easily identify the various network failures. It can also break down the network into easy-to-understand sub-networks.

Reduce Cost

The cost of networking equipment is typically an expensive necessity, but a hierarchical network design can help organizations reduce their costs. This can be done through the logical structure of the organization, which can then limit the number of devices needed.

Increased Scalability and Better Redundancy

A hierarchical network is more flexible than its counterpart. It can easily add and replace segments and elements without disrupting the existing network. Its modular design allows network administrators to easily implement network expansions without experiencing downtime. The Three-Layer network model provides better network redundancy by providing multiple links it allows for better network connectivity. If one switch is down, another path can be established to reach the destination.

Enhanced Performance

A network design that is hierarchically manages data flows, which means that they are routed through aggregated links at close to wire rate. The distribution and core layers of a network are composed of high-performing switches, which can provide better network performance and lower network bandwidth issues.

Improved Reliability

The ability to implement network redundancies makes it easier to maintain availability. For instance, if one of the two switches in the access layer fails, the other one comes in play. The concept of a hierarchical network enables networks to be more resilient, as they can easily isolate and route around failing or degraded segments.

Better Security

A hierarchical network allows for a more level of control. It allows administrators to create policies that are specific to the needs of the organization. Having these policies can help prevent unauthorized access and improve network performance. Also, having these policies can help minimize the risk of accidental network issues.

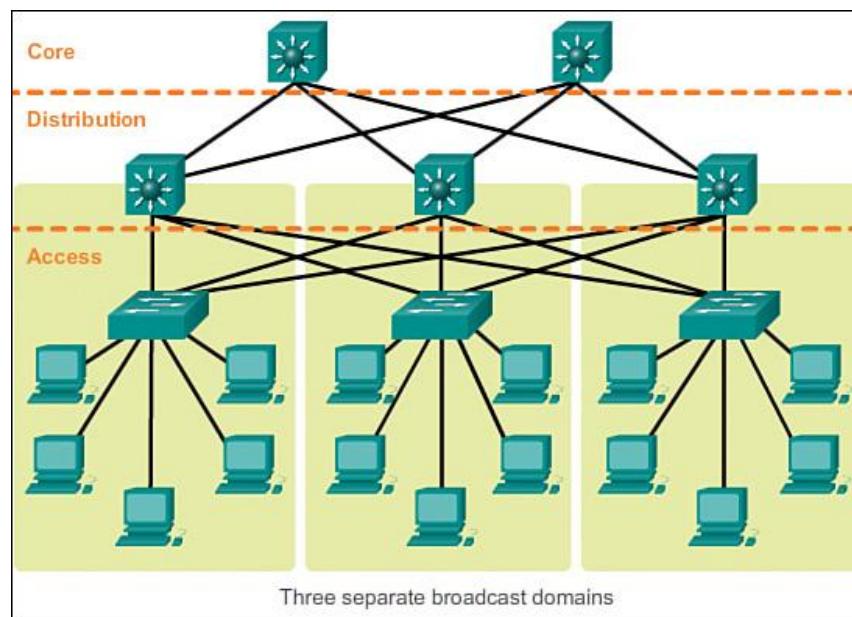


FIGURE 3: HIERARCHICAL NETWORK DESIGN

The Approach that we chose

A network can be categorized depending on the number of devices it provides. For instance,

A small network can serve up to 200 devices.

A medium-sized network can support up to 1,000 devices.

A Large network: Provides services for more than 1,000 devices.

The network design for a given project will also vary depending on the size and complexity of the organization. For instance, a small organization might require less complex network infrastructure compared to a large one. Regardless of the size or complexity of the network, implementing good design principles is a critical component of any network design.

For our network design which is a portion of an enterprise network that provides access to various network communication services and devices that are typically spread across a single geographic location.

The design of an enterprise network should meet the needs of its customers for performance, availability, and scalability. It should also feature small bandwidth domains, redundant servers, and multiple ways for a workstation to connect to a router. It should be built using a modular approach so that it can be easily upgraded and maintained.

Usually, we should consider that the campus network is a part of an optimized network architecture that runs on high-speed physical infrastructure. We also should consider the number of users and the business goals when we are designing the network.

Comparing the two approaches we can see that the flat design prevents network administrators from expanding their network in one direction, which made it hard to control and remove non-important traffic. As a network grew, response times would eventually decline.

A network should also be flexible enough to accommodate new technologies while still being able to meet the requirements of an existing organization. As the hierarchical network have advantages over flat network design as we mentioned and can fit the requirements of our needs in designing our network. Specifically, we use in our project the Enterprise Composite Network Model (ECNM) which builds on the conventional hierarchical concepts of the 3-Tier architecture (core, distribution, and access layers).

The implementation of a hierarchical network design model will allow the network to be more adaptable and scalable. This design method will allow the network to meet the varying business needs of our project. It can be managed in a way that allows for continuous upgrades and changes.

3.2.1 Enterprise Composite Network Model (ECNM)

An Enterprise Composite Network Model (ECNM) describes in detail the network design of an enterprise campus and the infrastructure necessary to access IT resources in multiple locations across an organization. The ideas outlined in Cisco's definition of converged networks serve as the foundation for this architecture, which builds on the conventional hierarchical concepts of the 3-Tier architecture (core, distribution, and access layers). The Enterprise Campus, Enterprise Edge, and Service Provider Edge are the three functional modules of the enterprise network. In this section we will talk about each of these functional areas and their submodules in detail.

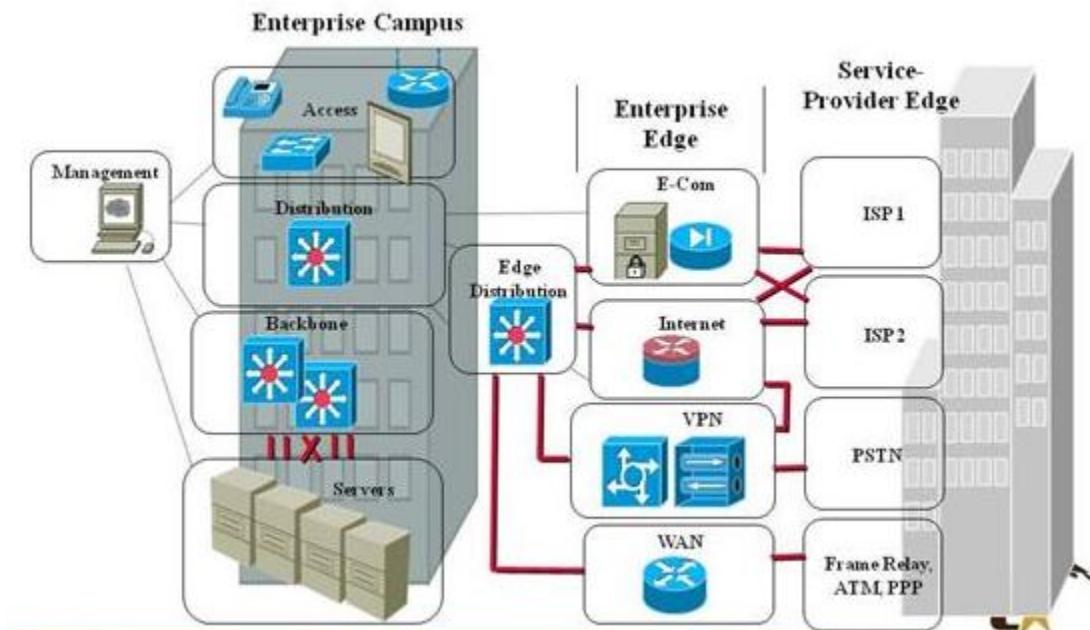


FIGURE 4: Enterprise Composite Network Model (ECNM)

Enterprise Campus Module:

The Enterprise Campus functional area is introduced in this section, along with a description of each module's role. Additionally, connections with other modules are covered. An enterprise campus site is a sizable location that frequently houses significant offices or the business headquarters. The Campus Infrastructure module and, often, Server Farm module, and Edge Distribution are parts of the Enterprise Campus functional area.

1. Campus Infrastructure submodule:

Several buildings are connected across a campus core to form a Campus Infrastructure. Devices on a campus are connected to the Server Farm and Enterprise Edge modules through the Campus Infrastructure module. Building Access and Building Distribution layers are present in a single building in a campus infrastructure architecture. There is a backbone or Campus Core layer between buildings when new buildings are added to the campus infrastructure. Three layers make up the Campus Infrastructure module.

The Three Layers are:

- Core Layer: The distribution layer devices connectivity
- Distribution Layer: The smaller local networks connectivity
- Access Layer: The network hosts and end devices connectivity.

• Building Access Layer

Within a campus building, the access layer devices gather end users from various workgroups and connect them to the distribution layer devices through uplinks. End users can be workstations, network printers and Cisco IP phone. VLANs (Virtual Local Area Networks) and STP (Spanning Tree Protocol) could also be supported at this layer. Important services including protocol filtering, IP multicast, broadcast suppression, network access, and QoS are offered by the building access layer. A dual attachment between the access and distribution switches is used to maintain high availability.

Access Layer Functions:

- Provide network access to the user and connecting the end devices to LANs.
- Implementing various security policies by preventing the unauthorized access.
- High availability and Broadcast control
- Routing and Quality of service.

• Building Distribution Layer

Building wiring closets are collected at the Building Distribution layer, which also connects to the Campus Core layer. It also creates a fault boundary to prevent the loss of network traffic if it gets disconnected from the access layer. Routing, access control, and Quality of Service are handled by the Building Distribution layer. Redundancy and load balancing are recommended in the connectivity of the Building Distribution Layer with the Building Access Layer and Campus Core Layer. This ensures that the network can maintain high availability even in the event of a failed link or node. It can also provide routing between VLANs and uses a special switch that works on layer 2 and layer 3 called (Multilayer switch) or (Core switch).

Distribution Layer Functions:

- Providing the access control to core devices and redundancy to access devices.
- Grouping LAN links and routing between the Virtual LANs (VLANs).
- Routing protocols boundaries and Route summarization.
- Route filtering and Static routing.
- Controlling Broadcast domain and Separate multicast.
- Policy-based connectivity and security that assure the quality of services.
- Provide Media translations for boundaries and Load balancing.

- **Campus Core Layer**

Several buildings and areas of the Enterprise Campus are connected by a high-performance, switched backbone called Campus Core layer. This layer specifically connects the Enterprise Edge and Server Farm modules to the Building Distribution layer. The core should also be redundant and highly available. It should be capable of handling the flow of traffic from the distribution layer and Enterprise Edge module. For high-throughput operations, this module often includes multilayer switches with routing, QoS, and security capabilities. The design of the core should also be designed to provide the necessary level of resilience to prevent network failures. This part contains servers, routers, call manager and firewall devices etc.

Core Layer Functions:

- Low latency and Fault tolerance.
- Load balancing and Redundancy.
- Providing fast transport (high-speed switching) and large amount of data.
- Ability to scale the size of the campus network Facilitating the network growth.
- Good manageability by providing High reliability and availability.
- Assuring the quality of service (QoS) classification as a quality of packet (no filter, packet handling or other overhead) and maximize throughput.

2. Edge Distribution submodule:

Connectivity between the Campus Core layer and the Enterprise Edge is achieved through the Edge Distribution submodule.

Enterprise Edge:

The Enterprise Edge module collects connections from different network edge components, such as firewalls or routers with an external interface. Network traffic filtered by the Enterprise Edge and routed to the Enterprise Campus functional area. Connections to the public network are provided by this layer. To achieve better performance and management, you need to integrate proper security and traffic engineering, as well as load balancing techniques, at this crucial layer. You need a sound strategy and a high availability architecture at the Enterprise Edge. The following submodules make up the Enterprise Edge:

- Enterprise WAN
- Demilitarized zone (DMZ) and Internet connectivity.
- VPN and remote access
- E-commerce networks.

Server Provider Edge:

Service Provider Edge provide the Enterprise Campus with network services such as internet access. The company's network can be routed by ISPs to their network, as well as to upstream and peer Internet service providers. DSL access is a service that some ISPs can offer.

The elements of service provider Edge are as follows:

- WAN services.
- PSTN services.
- Internet services.

As an enterprise network designer, you are not required to design this module, but you still need to have some familiarity with it in order to be able to choose the right service provider or providers for your customer network design.

CHAPTER4:

METHODOLOGY

4.1 (PPDIOO) Methodology

The Cisco Lifecycle Services framework consists of six stages: plan, prepare, design, implement, operate, and optimize. This method is used by most carriers and ISPs to manage their networks. Cisco's lifecycle services approach helps organizations successfully deploy and operate their network technologies. This framework describes six phases that help them achieve their goals.



FIGURE 5: PPDIOO NETWORK LIFECYCLE INFULENCE DESIGN

4.2 PPDIOO Phases

- **Prepare:** The Prepare phase involves developing a network strategy and identifying technologies that can support it. The financial justification for the proposed architecture is then established.
- **Plan:** This network requirements phase involves identifying the goals and requirements for the network, as well as the various network services that will be required. The Plan phase involves assessing the existing networks and their capabilities.
- **Design:** The initial requirements that are determined during the planning phase are the main factors that drive the work of the network design specialists, then design networks according to these requirements and gather additional data during the analysis and planning phases.

The network design specification serves as the basis for the various activities related to the design of networks. It features specifications that support various technical and business requirements.

- **Implement:** After the design has been approved, the implementation and verification process begin. The goal is to minimize the impact of the network on the existing infrastructure. The network and its components are designed according to the specifications of the design, so they can be integrated seamlessly into the existing infrastructure. Each step in the implementation should include a detailed description, step-by-step instructions, and any additional details that are necessary to implement the changes.
- **Operate:** The operation phase is the last test of design's validation. It involves carrying out day-to-day operations that are designed to maintain the network's availability and it can help identify issues and improve the network's performance.
- **Optimize:** The goal of the Optimize phase is to identify and resolve issues as they arise before they become problematic. This process involves identifying and addressing potential issues before they become critical.

In the design phase we have two network design approaches:

❖ **The Top-Down Approach**

A network designer's top-down approach focuses on the general applications that are required for a project. This approach doesn't necessarily mean that a web server or Internet Explorer is needed, but rather that the goals of the network are related to the applications or services that are required.

An organization might want to upgrade its network to support new applications, such as VoIP. Likewise, it might want to connect its network to a partner's platform to enable e-commerce.

The top-down approach doesn't start with talking about any technical elements. Instead, it focuses on the specific goals of the organization and the various technologies that will be needed to achieve those goals.

❖ **The Bottom-Up Approach**

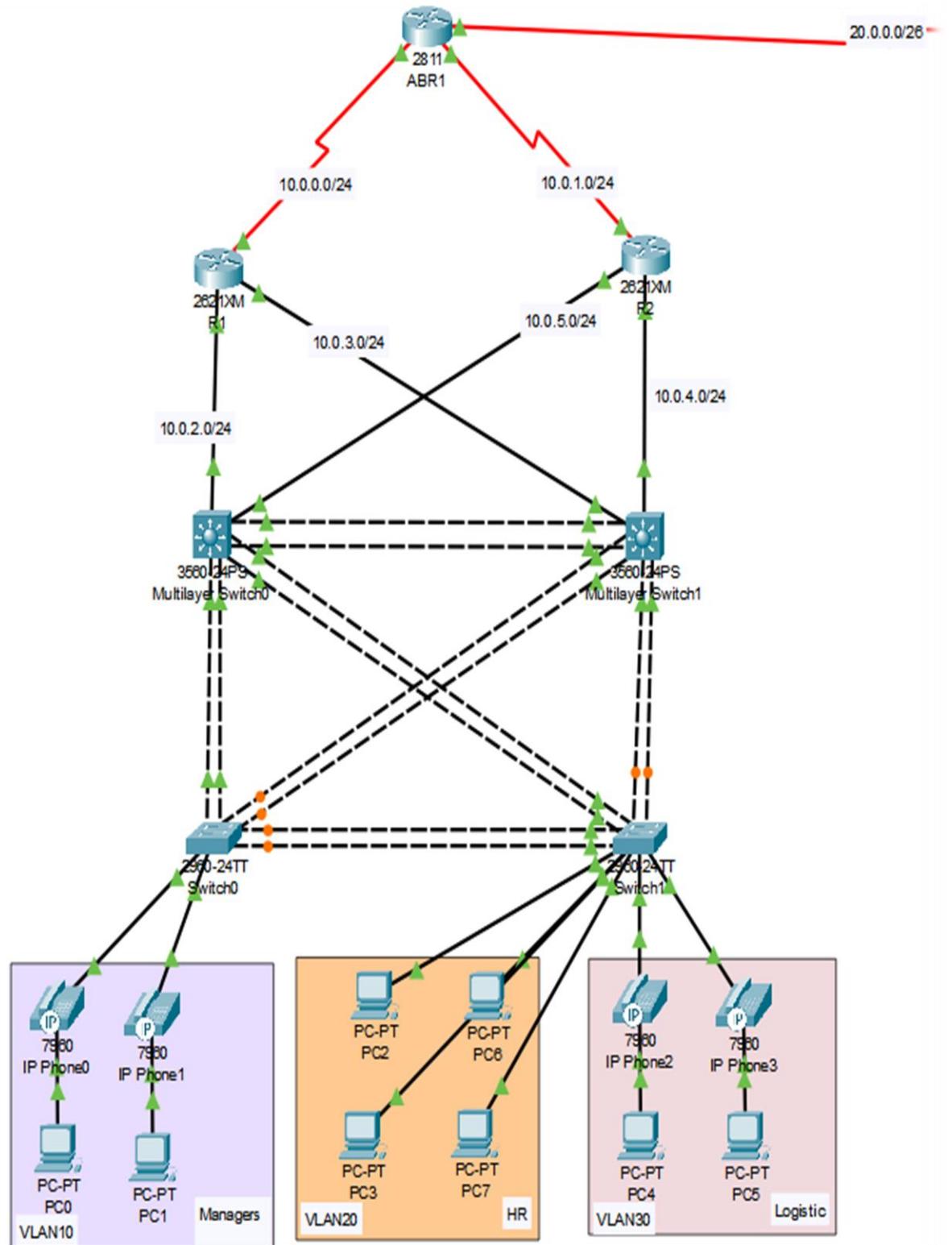
The bottom-up approach is often used, but it is not optimal. This approach tends to focus on the applications that need to be redesigned, rather than the various issues that need to be resolved to make a new network work.

This is the area that most networking professionals are familiar with. They tend to start this process at the beginning, leaving services and applications as an afterthought. The bottom-up approach is typically not successful, as it tends to involve a lot of fixes that are not immediately necessary.

CHAPTER5:

SIMULATION

Block1



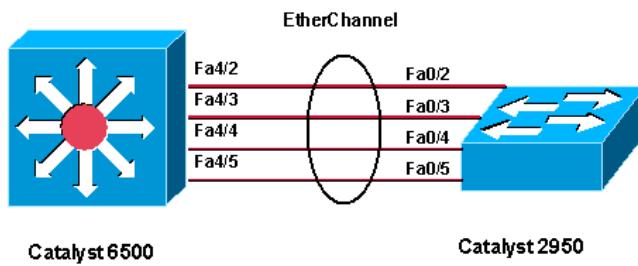
5.1 Block 1 Configuration:

❖ Access and Distribution layers Configuration

Step 1: EtherChannel:

EtherChannel is a port link aggregation technology that groups multiple physical port links into a single logical link. Used to provide fast connectivity and redundancy (fault-tolerance). You can combine up to eight links into one logical link.

FIGURE 6: ETHERCHANNEL PORTS



Note: to form an EtherChannel, all ports should have:

- Same duplex.
- Same speed.
- Same VLAN configuration.
- Same switch port modes (access or trunk).

There are two protocols that can be used to form an EtherChannel, Link Aggregation Control Protocol (LACP) and Port Aggregation Protocol (PAgP), the preceding one is Cisco proprietary protocol, whereas LACP is part of IEEE specification 802.3ad, we chose LACP because it provides a standard (help in compatibility and interoperability).

With LACP you can configure the interface to be on one of the four modes:

- ON: In this mode, the interface will be a part of EtherChannel, but no negotiation takes place
- Active: In this mode, the interface will continuously attempt to convert the other side interface into an EtherChannel.
- Passive: In this mode, the interface will become a part of EtherChannel if and only if it is requested by the opposite interface.
- Off: No EtherChannel configured on the interface.

Note: before configuring the physical ports to be grouped as port-channel it is recommended to shut them down. You can enable them after EtherChannel is configured.

We started with the multi-layer switch, and we named it MS1.

```
Switch>en
Switch>conf t
Enter configuration commands, one per line. End with CNTL/Z.
Switch(config)#host MS1
MS1(config)#int range Fa0/1-6
MS1(config-if-range)#sv trunk encapsulation dot1q
MS1(config-if-range)#sv mode trunk

MS1(config-if-range)#
*LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to down
*LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to up
*LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/2, changed state to down
*LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/2, changed state to up
*LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/3, changed state to down
*LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/3, changed state to up
*LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/4, changed state to down
*LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/4, changed state to up
*LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/5, changed state to down
*LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/5, changed state to up
```

```
Switch(config-if-range)#exit
Switch(config)#int range Fa0/1-2
Switch(config-if-range)#shut

Switch(config-if-range)#
*LINK-5-CHANGED: Interface FastEthernet0/1, changed state to administratively down
*LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to down
*LINK-5-CHANGED: Interface FastEthernet0/2, changed state to administratively down
*LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/2, changed state to down
Switch(config-if-range)#channel-group 1 mode active
Switch(config-if-range)#
Creating a port-channel interface Port-channel 1

Switch(config-if-range)#no shut

Switch(config-if-range)#
*LINK-5-CHANGED: Interface FastEthernet0/1, changed state to up
*LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to up
*LINK-5-CHANGED: Interface FastEthernet0/2, changed state to up
*LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/2, changed state to up
Switch(config-if-range)#exit
Switch(config)#int port-channel 1
Switch(config-if)#sv trunk encapsulation dot1q
Switch(config-if)#sv mode trunk
```

```
Switch(config-if-range)#
*LINK-5-CHANGED: Interface FastEthernet0/3, changed state to administratively down
*LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/3, changed state to down
*LINK-5-CHANGED: Interface FastEthernet0/4, changed state to administratively down
*LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/4, changed state to down
Switch(config-if-range)#channel-group 2 mode active
Switch(config-if-range)#
Creating a port-channel interface Port-channel 2

Switch(config-if-range)#no shut

Switch(config-if-range)#
*LINK-5-CHANGED: Interface FastEthernet0/3, changed state to up
*LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/3, changed state to up
*LINK-5-CHANGED: Interface FastEthernet0/4, changed state to up
*LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/4, changed state to up
```


- After that, we configured the next switch, which is the layer 2 switch, we gave it a name S1.

```
Switch>
Switch#en
Switch#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Switch(config)#host S1
S1(config)#int range Fa0/1-6
S1(config-if-range)#sw mode trunk
```

```
#(config-if-range)#
#(config-if-range-5-UPDOWN): Line protocol on Interface FastEthernet0/1, changed state to down
#(LINEPROTO-5-UPDOWN): Line protocol on Interface FastEthernet0/1, changed state to up
#(LINEPROTO-5-UPDOWN): Line protocol on Interface FastEthernet0/2, changed state to down
#(LINEPROTO-5-UPDOWN): Line protocol on Interface FastEthernet0/2, changed state to up
#(LINEPROTO-5-UPDOWN): Line protocol on Interface FastEthernet0/5, changed state to down
#(LINEPROTO-5-UPDOWN): Line protocol on Interface FastEthernet0/5, changed state to up
#(LINEPROTO-5-UPDOWN): Line protocol on Interface FastEthernet0/6, changed state to down
#(LINEPROTO-5-UPDOWN): Line protocol on Interface FastEthernet0/6, changed state to up

#(config-if-range)#exit
#(config)#int range Fa0/1-2
#(config-if-range)#shut
```

```
%!config-if-range#
LINK-5-CHANGED: Interface FastEthernet0/1, changed state to administratively down
LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to down

LINK-5-CHANGED: Interface FastEthernet0/2, changed state to administratively down
LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/2, changed state to down
```

```
!<config-if-range>
:LINK-5-CHANGED: Interface FastEthernet0/1, changed state to up

:LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to up

:LINK-5-CHANGED: Interface FastEthernet0/2, changed state to up

:LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/2, changed state to up

:LINK-5-CHANGED: Interface Port-channel1, changed state to up

:LINEPROTO-5-UPDOWN: Line protocol on Interface Port-channel1, changed state to up

!<config-if-range>#exit
!<config-if>#int port-channel 1
!<config-if>#sw mode trunk
!<config-if>#exit
```

```
>#(config-if-range) #shut
```

```
!<config-if-range>
!LINK-5-CHANGED: Interface FastEthernet0/3, changed state to administratively down
!LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/3, changed state to down
!LINK-5-CHANGED: Interface FastEthernet0/4, changed state to administratively down
!LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/4, changed state to down

!<config-if-range>#channel-group 2 mode active
!<config-if-range>
!Creating a port-channel interface Port-channel 2

!<config-if-range>no shut

!<config-if-range>
!LINK-5-CHANGED: Interface FastEthernet0/3, changed state to up
!LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/3, changed state to up
!LINK-5-CHANGED: Interface FastEthernet0/4, changed state to up
!LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/4, changed state to up
!LINK-5-CHANGED: Interface Port-channel2, changed state to up
!LINEPROTO-5-UPDOWN: Line protocol on Interface Port-channel2, changed state to up
```

```
#:config#>int port-channel  
#:config-if#>sw mode trunk  
#:config-if#>exit  
#:config#>int range Fa0/5-6  
#:config-if-range#>shut
```

```
!!(config-if-range)#
!!LINK-5-CHANGED: Interface FastEthernet0/5, changed state to administratively down
!!LINEPROTO-5-UPDOWNN: Line protocol on Interface FastEthernet0/5, changed state to down
!!LINK-5-CHANGED: Interface FastEthernet0/6, changed state to administratively down
!!LINEPROTO-5-UPDOWNN: Line protocol on Interface FastEthernet0/6, changed state to down

!!(config-if-range)#
!!Creating a port-channel interface Port-channel 3
!!(config-if-range)no shut

!!(config-if-range)#
!!LINK-5-CHANGED: Interface FastEthernet0/5, changed state to up
!!LINEPROTO-5-UPDOWNN: Line protocol on Interface FastEthernet0/5, changed state to up
!!LINK-5-CHANGED: Interface FastEthernet0/6, changed state to up
!!LINEPROTO-5-UPDOWNN: Line protocol on Interface FastEthernet0/6, changed state to up

!!(config-if-range)exit
!!(config)#int port-channel 3
```

- The configuration of the second layer 2 switches in this block (S2).

```

Switch>
Switch>en
Switch>conf t
Enter configuration commands, one per line. End with CNTL/Z.
Switch(config)#host S2
S2(config)#int range Fa0/1-6
S2(config-if-range)#sw mode trunk

```

```

S2(config-if-range)#exit
S2(config)#int range Fa0/1-2
S2(config-if-range)#shut

S2(config-if-range)#channel-group 1 mode active
S2(config-if-range)#no shut

```

```

S2(config-if-range)#exit
S2(config)#int port-channel 1
S2(config-if)#sw mode trunk
S2(config-if)#exit
S2(config)#int range Fa0/3-4
S2(config-if-range)#shut

```

```

S2(config-if-range)#channel-group 2 mode active
S2(config-if-range)#no shut

```

```

S2(config-if-range)#exit
S2(config)#int port-channel 2
S2(config-if)#sw mode trunk

```

```

I2(config-if-range)#exit
I2(config)#int port-channel 2
I2(config-if)#sw mode trunk
I2(config-if)#exit
I2(config)#int range Fa0/5-6
I2(config-if-range)#shut

```

```

I2(config-if-range)#channel-group 3 mode active
I2(config-if-range)#no shut

```

```

I2(config-if-range)#exit
I2(config)#int port-channel 3
I2(config-if)#sw mode trunk
I2(config-if)#exit

```

changed state to down

:LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to up

:LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/2, changed state to down

:LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/2, changed state to up

:LINK-5-CHANGED: Interface FastEthernet0/1, changed state to administratively down

:LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to down

:LINK-5-CHANGED: Interface FastEthernet0/2, changed state to administratively down

:LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/2, changed state to down

:Creating a port-channel interface Port-channel 1

- We used “show ether summary” command in each switch to check the configuration.

```

:LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/4, changed state to up
:LINK-5-CHANGED: Interface Port-channel2, changed state to up
:LINEPROTO-5-UPDOWN: Line protocol on Interface Port-channel2, changed state to up

```

```

Switch>
Switch>en
Switch>show ether summary

```

```

* Invalid input detected at `*' marker.

Switch#show ether summary
Flags: D - down P - in port-channel
      I - stand-alone S - suspended
      H - Hot-standby (LACP only)
      R - Layer3   S - Layer2
      U - in use   f - failed to allocate aggregator
      u - unsuitable for bundling
      w - waiting to be aggregated
      d - default port

```

```

Number of channel-groups in use: 3
Number of aggregators: 3

```

Group	Port-channel	Protocol	Ports
1	Po1(SU)	LACP	Fa0/1(P) Fa0/2(P)
2	Po2(SU)	LACP	Fa0/3(P) Fa0/4(P)
3	Po3(SU)	LACP	Fa0/5(P) Fa0/6(P)

```

:LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to up
:LINK-5-CHANGED: Interface FastEthernet0/2, changed state to up
:LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/2, changed state to up
:LINK-5-CHANGED: Interface Port-channell, changed state to up
:LINEPROTO-5-UPDOWN: Line protocol on Interface Port-channell, changed state to up

```

```

GS>
GS2>
GS2>show ether summary
Flags: D - down P - in port-channel
      I - stand-alone S - suspended
      H - Hot-standby (LACP only)
      R - Layer3   S - Layer2
      U - in use   f - failed to allocate aggregator
      u - unsuitable for bundling
      w - waiting to be aggregated
      d - default port

```

```

Number of channel-groups in use: 3
Number of aggregators: 3

```

Group	Port-channel	Protocol	Ports
1	Po1(SU)	LACP	Fa0/1(P) Fa0/2(P)
2	Po2(SU)	LACP	Fa0/3(P) Fa0/4(P)
3	Po3(SU)	LACP	Fa0/5(P) Fa0/6(P)

```

S1>
S1#en
S1#show ether summary
Flags: D - down P - in port-channel
I - stand-alone S - suspended
H - Hot-standby (LACP only)
R - Layer3 S - Layer2
U - in use f - failed to allocate aggregator
u - unsuitable for bundling
v - waiting to be aggregated
d - default port

Number of channel-groups in use: 3
Number of aggregators: 3

Group Port-channel Protocol Ports
-----+-----+-----+-----+
1 Po1(SU) LACP Fa0/1(P) Fa0/2(P)
1 Po2(SU) LACP Fa0/3(P) Fa0/4(P)
3 Po3(SU) LACP Fa0/5(P) Fa0/6(P)
...

```

```

LINK-5-CHANGED: Interface Port-channel1, changed state to up
LINEPROTO-5-UPDOWN: Line protocol on Interface Port-channel1, changed state to up
LINK-5-CHANGED: Interface Port-channel3, changed state to up
LINEPROTO-5-UPDOWN: Line protocol on Interface Port-channel3, changed state to up
LINK-5-CHANGED: Interface Port-channel2, changed state to up
LINEPROTO-5-UPDOWN: Line protocol on Interface Port-channel2, changed state to up

S2(config)#do show ether summary
Flags: D - down P - in port-channel
I - stand-alone S - suspended
H - Hot-standby (LACP only)
R - Layer3 S - Layer2
U - in use f - failed to allocate aggregator
u - unsuitable for bundling
v - waiting to be aggregated
d - default port

Number of channel-groups in use: 3
Number of aggregators: 3

Group Port-channel Protocol Ports
-----+-----+-----+-----+
1 Po1(SU) LACP Fa0/1(P) Fa0/2(P)
1 Po2(SU) LACP Fa0/3(P) Fa0/4(P)
3 Po3(SU) LACP Fa0/5(P) Fa0/6(P)
S2(config)#

```

Step 2: VTP Configuration:

VLAN Trunking Protocol (VTP) is a Cisco-specific protocol used by Cisco switches to exchange VLAN information. VTP allows switches belonging to the same VTP domain to synchronize their VLAN information (such as VLAN ID and VLAN name).

VTP domain is a group of interconnected trunked switches with the same VTP setting (VTP version, domain name, and password).

VTP modes:

- *Server mode:*
Switches, by default, are set to the server mode. Any changes (create, delete, add, rename VLANs) that are made by a switch in server mode will be propagated to all other switches that belong to the same domain as that switch.
- *Client mode:*
With the client mode, switches can receive and forward VLANs information from and to other switches that are sharing the same VTP domain with it.
Switches in client mode are not allowed to create VLAN.
- *Transparent mode:*
Switches in transparent mode only forward the VTP advertisements to the connected switches in the same VTP domain. Transparent mode allows switches to make their own local database.
The main purpose of this mode is to forward the VTP advertisements (switches in this mode will not take part in VLAN assignments).

Configurations:

- We configured MS1 and MS2 in the server mode. For VTP setting for this block (VTP domain: ent, VTP password 2022).

```

Switch>
Switch>en
Switch>conf t
Enter configuration commands, one per line. End with CNTL/Z.
Switch(config)#vtp domain ent
Changing VTP domain name from NULL to ent
Switch(config)#vtp password 2022
Setting device VLAN database password to 2022
Switch(config)#do show vtp status
VTP Version capable : 1 to 2
VTP version running : 1
VTP Domain Name : ent
VTP Pruning Mode : Disabled
VTP Traps Generation : Disabled
Device ID : 0001.4270.76D0
Configuration last modified by 0.0.0.0 at 0-0-00 00:00:00
Local update ID is 0.0.0.0 (no valid interface found)

Feature VLAN :

VTP Operating Mode : Server
Maximum VLANs supported locally : 1005
Number of existing VLANs : 5
Configuration Revision : 0
MD5 digest : 0xF7 0x8E 0x30 0xD7 0xB9 0x54 0x43 0xDA
             0x54 0xBE 0x2F 0x68 0x7F 0x1B 0xE2 0x29

```

```

GS2>
GS2>en
GS2>conf t
Enter configuration commands, one per line. End with CNTL/Z.
GS2(config)#vtp domain ent
Domain name already set to ent.
GS2(config)#vtp password 2022
Setting device VLAN database password to 2022
GS2(config)#do show vtp status
VTP Version capable : 1 to 2
VTP version running : 1
VTP Domain Name : ent
VTP Pruning Mode : Disabled
VTP Traps Generation : Disabled
Device ID : 0001.4270.76D0
Configuration last modified by 0.0.0.0 at 0-0-00 00:00:00
Local update ID is 0.0.0.0 (no valid interface found)

Feature VLAN :

VTP Operating Mode : Server
Maximum VLANs supported locally : 1005
Number of existing VLANs : 5
Configuration Revision : 0
MD5 digest : 0xF7 0x8E 0x30 0xD7 0xB9 0x54 0x43 0xDA
             0x54 0xBE 0x2F 0x68 0x7F 0x1B 0xE2 0x29

```

```

S1>
S1>en
S1>conf t
Enter configuration commands, one per line. End with CNTL/Z.
S1(config)#vtp mode client
Setting device to VTP CLIENT mode.
S1(config)#vtp domain ent
Domain name already set to ent.
S1(config)#vtp password 2022
Setting device VLAN database password to 2022
S1(config)#do show vtp status
VTP Version capable : 1 to 2
VTP version running : 1
VTP Domain Name : ent
VTP Pruning Mode : Disabled
VTP Traps Generation : Disabled
Device ID : 0002.1661.E8E0
Configuration last modified by 0.0.0.0 at 0-0-00 00:00:00

Feature VLAN :

VTP Operating Mode : Client
Maximum VLANs supported locally : 255
Number of existing VLANs : 5
Configuration Revision : 0
MD5 digest : 0xF7 0x8E 0x30 0xD7 0xB9 0x54 0x43 0xDA
             0x54 0xBE 0x2F 0x68 0x7F 0x1B 0xE2 0x29

```

```

S2>
S2>en
S2>conf t
Enter configuration commands, one per line. End with CNTL/Z.
S2(config)#vtp mode client
Setting device to VTP CLIENT mode.
S2(config)#vtp domain ent
Domain name already set to ent.
S2(config)#vtp password 2022
Setting device VLAN database password to 2022
S2(config)#do show vtp status
VTP Version capable : 1 to 2
VTP version running : 1
VTP Domain Name : ent
VTP Pruning Mode : Disabled
VTP Traps Generation : Disabled
Device ID : 0006.2A9A.E020
Configuration last modified by 0.0.0.0 at 0-0-00 00:00:00

Feature VLAN :

VTP Operating Mode : Client
Maximum VLANs supported locally : 255
Number of existing VLANs : 5
Configuration Revision : 0
MD5 digest : 0xF7 0x8E 0x30 0xD7 0xB9 0x54 0x43 0xDA
             0x54 0xBE 0x2F 0x68 0x7F 0x1B 0xE2 0x29

```

- After that we added and named the VLANs of this block just once on the MS1 and VLANs information propagated to all other switches, we used “show vtp status” command to check. Note that the **Number of existing VLANs** and the **Configuration Revision** number are increased.

```

MD5 digest : 0xF7 0x8E 0x30 0xD7 0xB9 0x54 0x43 0xDA
Switch(config)#vlan 10
Switch(config-vlan)#name Managers
Switch(config-vlan)#vlan 20
Switch(config-vlan)#name Logistic
Switch(config-vlan)#vlan 30
Switch(config-vlan)#name HR
Switch(config-vlan)#vlan 15
Switch(config-vlan)#name IP-Tele
Switch(config-vlan)#do show vlan

VLAN Name          Status Ports
----- -----
1    default        active Fa0/7, Fa0/8, Fa0/9, Fa0/10
                           Fa0/11, Fa0/12, Fa0/13, Fa0/14
                           Fa0/15, Fa0/16, Fa0/17, Fa0/18
                           Fa0/19, Fa0/20, Fa0/21, Fa0/22
                           Fa0/23, Fa0/24, Gi0/0/1, Gi0/0/2

10   Managers       active
15   IP-Tele        active
20   Logistic       active
30   HR             active
1002 fddi-default  active
1003 token-ring-default  active
1004 fddinet-default  active
1005 trnet-default  active

VLAN Type SAID      MTU Parent RingNo BridgeNo Stp  BrdgMode Transl Trans2
----- -----
1    enet 100001     1500 -      -      -      -      0      0
10   enet 100010     1500 -      -      -      -      0      0
15   enet 100015     1500 -      -      -      -      0      0
--More--

```

```

VTP Domain Name : ent
VTP Pruning Mode : Disabled
VTP Traps Generation : Disabled
Device ID : 0001.4270.76D0
Configuration last modified by 0.0.0.0 at 0-0-00 00:00:00
Local updaer ID is 0.0.0.0 (no valid interface found)

Feature VLAN :

VTP Operating Mode : Server
maximum VLANs supported locally : 1005
Number of existing VLANs : 5
Configuration Revision : 0
MD5 digest : 0xF7 0x8E 0x30 0xD7 0xB9 0x54 0x43 0xDA
0x54 0x8E 0x2F 0x68 0x7F 0x1B 0xE2 0x2

S2(config)#do show vtp status
VTP Version capable : 1 to 2
VTP version running : 1
VTP Domain Name : ent
VTP Pruning Mode : Disabled
VTP Traps Generation : Disabled
Device ID : 0001.4270.76D0
Configuration last modified by 0.0.0.0 at 3-1-93 01:02:24
Local updaer ID is 0.0.0.0 (no valid interface found)

Feature VLAN :

VTP Operating Mode : Server
maximum VLANs supported locally : 1005
Number of existing VLANs : 9
Configuration Revision : 8
MD5 digest : 0xB4 0xEE 0x73 0xD5 0xCC 0x9D 0x43 0x6A
0x1C 0xE1 0x16 0xD2 0x42 0xCD 0xD3 0xBF

S2(config)#

```

```

S2(config)#show vtp status
VTP Version capable : 1 to 2
VTP version running : 1
VTP Domain Name : ent
VTP Pruning Mode : Disabled
VTP Traps Generation : Disabled
Device ID : 0002.1661.E8E0
Configuration last modified by 0.0.0.0 at 0-0-00 00:00:00

Feature VLAN :

VTP Operating Mode : Client
maximum VLANs supported locally : 255
Number of existing VLANs : 5
Configuration Revision : 0
MD5 digest : 0xF7 0x8E 0x30 0xD7 0xB9 0x54 0x43 0xDA
0x54 0x8E 0x2F 0x68 0x7F 0x1B 0xE2 0x2

S1(config)#do show vtp status
VTP Version capable : 1 to 2
VTP version running : 1
VTP Domain Name : ent
VTP Pruning Mode : Disabled
VTP Traps Generation : Disabled
Device ID : 0002.1661.E8E0
configuration last modified by 0.0.0.0 at 3-1-93 01:02:24

Feature VLAN :

VTP Operating Mode : Client
maximum VLANs supported locally : 255
Number of existing VLANs : 9
Configuration Revision : 8
MD5 digest : 0xB4 0xEE 0x73 0xD5 0xCC 0x9D 0x43 0x6A
0x1C 0xE1 0x16 0xD2 0x42 0xCD 0xD3 0xBF

S1(config)#

```

```

S2(config)#
VTP Version capable : 1 to 2
VTP version running : 1
VTP Domain Name : ent
VTP Pruning Mode : Disabled
VTP Traps Generation : Disabled
Device ID : 0006.2A9A.E020
Configuration last modified by 0.0.0.0 at 0-0-00 00:00:00

Feature VLAN :

VTP Operating Mode : Client
maximum VLANs supported locally : 255
Number of existing VLANs : 5
Configuration Revision : 0
MD5 digest : 0xF7 0x8E 0x30 0xD7 0xB9 0x54 0x43 0xDA
0x54 0x8E 0x2F 0x68 0x7F 0x1B 0xE2 0x2

S2(config)#do show vtp status
VTP Version capable : 1 to 2
VTP version running : 1
VTP Domain Name : ent
VTP Pruning Mode : Disabled
VTP Traps Generation : Disabled
Device ID : 0006.2A9A.E020
Configuration last modified by 0.0.0.0 at 3-1-93 01:02:24

Feature VLAN :

VTP Operating Mode : Client
maximum VLANs supported locally : 255
Number of existing VLANs : 9
Configuration Revision : 8
MD5 digest : 0xB4 0xEE 0x73 0xD5 0xCC 0x9D 0x43 0x6A
0x1C 0xE1 0x16 0xD2 0x42 0xCD 0xD3 0xBF

S2(config)#

```

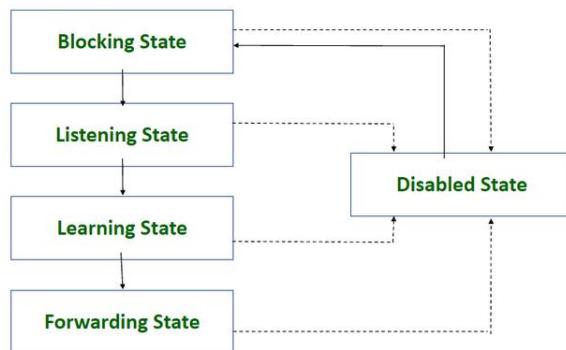
Step 3: Spanning Tree Protocol (STP):

Networks often consist of redundant paths when connecting network segments. Redundancy helps protect against service loss, but it can also lead to bridges or switch loops. Loops occur when data travels a redundant path from source to destination, the data begins to circulate along the same path, amplifying the data and leading to a broadcast storm.

Spanning Tree Protocol (STP) is a Layer 2 network protocol used to prevent loops in a network topology. STP was developed to avoid problems when computers exchange data over a local area network (LAN) that includes redundant paths. Without careful monitoring and control of traffic flow, data can be trapped in loops that circle a network segment, resulting in poor performance and near-stop traffic.

STP monitors all network connections, identifies redundant connections, and disables ports that can cause loops. So, it eliminates frame loops on the LAN by putting switch ports in different states based on criteria such as root bridge selection.

Ports states in Spanning Tree Protocol:



Blocking State:

- The switch port is locked during the Root Bridge selection process when the switch receives a BPDU on a port that indicates a better path to the Root Bridge, or when the port is not the Root Port.
 - Port in this state can receive and transmit BPDUs to switch module for processing.
 - The switch port remains blocked for 20 seconds and then goes into listening.

Listening State:

- In this state, STP determines whether the port will participate in frame forwarding or not.
 - Port in this state receive and transmit BPDUs to switch module for processing and process the BPDUs that come from the switch module system.
 - The port remains in the listening state for 15 seconds and then goes into the learning state.

Learning State:

- Port in this state receive and transmit BPDU to switch module for processing and process the BPDU that come from the switch module system.
- The port integrates the location information of the LAN host into its MAC address database.
- The switch port stays in the learning state for 15 seconds and then goes into the forwarding state.

Forwarding State:

- The switch port goes into the forwarding state after going through all the previous states.
- Port in this state receive and transmit BPDU to switch module for processing and process the BPDU that come from the switch module system.
- The port integrates the location information of the LAN host into its MAC address database.
- A switch port stays in forwarding mode until a change is detected in the network.

Disable State:

- The switch port is disabled as a result of the management command that disables the port. In this state, the port is considered non-operational and thus does not participate in STP operations.

Configurations:

- We configured Per VLAN Spanning Tree (PVST), we chose MS1 as the primary Root Bridge for all the four VLANs and MS2 as the secondary Root Bridge for the four VLANs.

Command we used:

- In MS1: spanning-tree vlan 10,15,20,30 root primary.
- In MS1: spanning-tree vlan 10,15,20,30 root secondary.

```

VLAN0010
Spanning tree enabled protocol ieee
Root ID Priority 24586
Address 000A.4179.60C2
This bridge is the root
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec

Bridge ID Priority 24586 (priority 24576 sys-id-ext 10)
Address 000A.4179.60C2
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
Aging Time 20

Interface Role Sts Cost Prio.Nbr Type
----- -----
Fa0/1 Desg FWD 19 128.1 P2p
Fa0/3 Desg FWD 19 128.3 P2p
Fa0/4 Desg FWD 19 128.4 P2p
Fa0/5 Desg FWD 19 128.5 P2p
Fa0/2 Desg FWD 19 128.2 P2p
Po2 Desg FWD 9 128.28 Shr
Po1 Desg FWD 9 128.27 Shr
Fa0/6 Desg FWD 19 128.6 P2p
Po3 Desg FWD 9 128.29 Shr

VLAN0015
Spanning tree enabled protocol ieee
Root ID Priority 24591
Address 000A.4179.60C2
This bridge is the root
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec

Bridge ID Priority 24591 (priority 24576 sys-id-ext 10)
Address 000A.4179.60C2
...

```

```

Spanning tree enabled protocol ieee
Root ID Priority 24586
Address 000A.4179.60C2
This bridge is the root
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec

Bridge ID Priority 24586 (priority 24576 sys-id-ext 10)
Address 000A.4179.60C2
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
Aging Time 20

Interface Role Sts Cost Prio.Nbr Type
----- -----
'Fa0/1 Desg FWD 19 128.1 P2p
'Fa0/3 Desg FWD 19 128.3 P2p
'Fa0/4 Desg FWD 19 128.4 P2p
'Fa0/5 Desg FWD 19 128.5 P2p
'Fa0/2 Desg FWD 19 128.2 P2p
'Po2 Desg FWD 9 128.28 Shr
'Po1 Desg FWD 9 128.27 Shr
'Fa0/6 Desg FWD 19 128.6 P2p
'Po3 Desg FWD 9 128.29 Shr

VLAN0030
Spanning tree enabled protocol ieee
Root ID Priority 24606
Address 000A.4179.60C2
This bridge is the root
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec

Bridge ID Priority 24606 (priority 24576 sys-id-ext 30)
Address 000A.4179.60C2
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec

```

```

VLAN0010
Spanning tree enabled protocol ieee
Root ID Priority 24586
Address 000A.4179.60C2
Cost 9
Port 29(Port-channel3)
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec

Bridge ID Priority 28682 (priority 28672 sys-id-ext 10)
Address 000D.BD8D.39E8
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
Aging Time 20

Interface Role Sts Cost Prio.Nbr Type
----- -----
'a0/1 Desg FWD 19 128.1 P2p
'a0/4 Desg FWD 19 128.4 P2p
'a0/2 Desg FWD 19 128.2 P2p
'a0/6 Desg FWD 19 128.6 P2p
'a0/3 Desg FWD 19 128.3 P2p
'a0/5 Desg FWD 19 128.5 P2p
'Po1 Desg FWD 9 128.27 Shr
'Po2 Desg FWD 9 128.28 Shr
'Po3 Root FWD 9 128.29 Shr

VLAN0015
Spanning tree enabled protocol ieee
Root ID Priority 24591
Address 000A.4179.60C2
Cost 9
Port 29(Port-channel3)
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec

```

```

Po2 Desg FWD 9 128.28 Shr
Po3 Root FWD 9 128.29 Shr

VLAN0020
Spanning tree enabled protocol ieee
Root ID Priority 24586
Address 000A.4179.60C2
Cost 9
Port 29(Port-channel3)
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec

Bridge ID Priority 28692 (priority 28672 sys-id-ext 20)
Address 000D.BD8D.39E8
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
Aging Time 20

Interface Role Sts Cost Prio.Nbr Type
----- -----
'Fa0/1 Desg FWD 19 128.1 P2p
'Fa0/4 Desg FWD 19 128.4 P2p
'Fa0/2 Desg FWD 19 128.2 P2p
'Fa0/6 Desg FWD 19 128.6 P2p
'Fa0/3 Desg FWD 19 128.3 P2p
'Fa0/5 Desg FWD 19 128.5 P2p
'Po1 Desg FWD 9 128.27 Shr
'Po2 Desg FWD 9 128.28 Shr
'Po3 Root FWD 9 128.29 Shr

VLAN0030
Spanning tree enabled protocol ieee
Root ID Priority 24606
Address 000A.4179.60C2
Cost 9
Port 29(Port-channel3)

```

- Then we configured the ports of the access layer switches, each port with the appropriate VLAN access, and for those ports (which are not participate on SPT operations) we enabled the BPDU guard.

Command we used:

- int range <range of interfaces>
- switchport access vlan <VLAN ID>
- switchport voice vlan <VLAN ID>
- spanning-tree bpduguard enable

```
!LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/7, changed state to down
!LINK-5-CHANGED: Interface FastEthernet0/7, changed state to up
!LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/7, changed state to up
!LINK-5-CHANGED: Interface FastEthernet0/8, changed state to up
!LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/8, changed state to up

!ipen
!#conf t
!Enter configuration commands, one per line. End with CNTL/Z.
!#(config)#int range Fa0/7-8
!#(config-if-range)#sw access vlan 10
!#(config-if-range)#sw voice vlan 15
!#(config-if-range)#span bpduguard enable
!#(config-if-range)#span portfast

Warning: portfast should only be enabled on ports connected to a single
host. Connecting hubs, concentrators, switches, bridges, etc... to this
interface when portfast is enabled, can cause temporary bridging loops.
See with CAUTION

!Portfast has been configured on FastEthernet0/7 but will only
have effect when the interface is in a non-trunking mode.
!Warning: portfast should only be enabled on ports connected to a single
host. Connecting hubs, concentrators, switches, bridges, etc... to this
interface when portfast is enabled, can cause temporary bridging loops.
See with CAUTION

!Portfast has been configured on FastEthernet0/8 but will only
have effect when the interface is in a non-trunking mode.
!!
```

Press RETURN to get started.

```
!2>
!2>en
!2#conf t
!Enter configuration commands, one per line. End with CNTL/Z.
!2#(config)#int range Fa0/7-10
!2#(config-if-range)#sw access vlan 20
!2#(config-if-range)#
!2#(config-if-range)#exit
!2#(config)#int range Fa0/11-12
!2#(config-if-range)#sw access vlan 30
!2#(config-if-range)#sw voice vlan 15
!2#(config-if-range)#exit
!2#(config)#int range Fa0/7-12
!2#(config-if-range)#span bpduguard enable
```

Step 4: Hot Standby Router Protocol (HSRP):

Hot Standby Routing Protocol (HSRP) is a redundancy routing protocol defined by Cisco, the protocol defines the default fault tolerance and framework for failover of the underlying network gateway. HSRP is designed for multi-access or broadcast local area networks (LAN) and supports inaccessibility of IP traffic. Each host on a local area network (LAN) has a default gateway address that acts as the primary gateway for outside traffic. HSRP allows you to group multiple routers and only one of them as an active router and two or more of routers as standby routers. In single HSRP group all routers has the same Virtual IP address and MAC address. If the Active router (primary) fails to forward the traffic, the Standby router (secondary) takes over the duties. The two routers will have the same physical IP address but will also have a virtual (HSRP) address. Regardless of IP addresses of the primary and the secondary routers, the VIP will be the same.

Terms related to HSRP:

- *Virtual IP (VIP):*
All hosts on a local subnet are assigned an IP address from the local subnet as their default gateway, this assigned IP address is the VIP.
- *Virtual MAC Address:*
The MAC address is automatically generated by HSRP. The first 24 bits are the standard CISCO address (that is, 0000.0c). The next 16 bits are HSRPID (that is, 07.ac). The next 8 bits are hexadecimal group numbers.
- *Hello message:*
A periodic message exchanged between the active router and the standby router. These messages are exchanged every 3 seconds to indicate the status of the router.
- *Hold down time:*
The default value of the Hold down timer is 10 sec, which is almost 3 times the Hello message retransmit time. The timer tells the standby router how much time it has to wait for the delayed Hello message.
- *Priority:*
The priority number is used to determine which router will be the active one and which will be the standby, the one with the higher priority will be the active. The default priority is 100 on all Cisco's routers and Layer 3 switches.
- *Preempt:*
It allows the active router to take over the standby one as soon as it comes back after failure.

Configuration:

- First, we enabled routing functionality on the Layer 3 switch using “ip routing” command inside the configuration mode of the MS.
- We created an interface for each VLAN and assigned to it IP address from the local subnet of the VLAN.
- Under the VLAN interface configuration we implemented the HSRP configuration
For the MS1 we gave it higher priority 150 and we left the MS2 with the default priority.

```

switch>config#*
Switch(config)#
Switch(config)#
Switch(config)#ip routing
Switch(config)#int vlan 10
Switch(config)#
LINK-5-CHANGED: Interface Vlan10, changed state to up

*LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan10, changed state to up

Switch(config-if)#ip add 192.168.10.2 255.255.255.0
Switch(config-if)#standby 10 ip 192.168.10.1
Switch(config-if)#standby 10 priority 150
Switch(config-if)#standby 10 preempt
Switch(config-if)#
HSRP-6-STATECHANGE: Vlan10 Grp 10 state Speak -> Standby

HSRP-6-STATECHANGE: Vlan10 Grp 10 state Standby -> Active

Switch(config-if)#exit
Switch(config)#int vlan 15
Switch(config)#
LINK-5-CHANGED: Interface Vlan15, changed state to up

*LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan15, changed state to up

Switch(config-if)#ip add 192.168.15.2 255.255.255.0
Switch(config-if)#standby 15 ip 192.168.15.1
Switch(config-if)#standby 15 priority 150
Switch(config-if)#standby 15 preempt
Switch(config-if)#
HSRP-6-STATECHANGE: Vlan15 Grp 15 state Speak -> Standby

HSRP-6-STATECHANGE: Vlan15 Grp 15 state Standby -> Active

```

```

Switch(config-if)#exit
Switch(config)#
Switch(config)#
Switch(config)#int vlan 20
Switch(config)#
LINK-5-CHANGED: Interface Vlan20, changed state to up

*LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan20, changed state to up

Switch(config-if)#ip add 192.168.20.2 255.255.255.0
Switch(config-if)#standby 20 ip 192.168.20.1
Switch(config-if)#standby 20 priority 150
Switch(config-if)#standby 20 preempt
Switch(config-if)#
HSRP-6-STATECHANGE: Vlan20 Grp 20 state Speak -> Standby

HSRP-6-STATECHANGE: Vlan20 Grp 20 state Standby -> Active

Switch(config-if)#
Switch(config)#
Switch(config)#
Switch(config)#int vlan 30
Switch(config)#
LINK-5-CHANGED: Interface Vlan30, changed state to up

*LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan30, changed state to up

Switch(config-if)#ip add 192.168.30.2 255.255.255.0
Switch(config-if)#standby 30 ip 192.168.30.1
Switch(config-if)#standby 30 priority 150
Switch(config-if)#standby 30 preempt
Switch(config-if)#
Switch(config)#
HSRP-6-STATECHANGE: Vlan30 Grp 30 state Speak -> Standby

HSRP-6-STATECHANGE: Vlan30 Grp 30 state Standby -> Active

```

```

HS2>
HS2>en
HS2#conf t
Enter configuration commands, one per line. End with CNTL/Z.
HS2(config)#ip routing
HS2(config)#int vlan 10
HS2(config)#
LINK-5-CHANGED: Interface Vlan10, changed state to up

*LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan10, changed state to up

HS2(config-if)#ip add 192.168.10.3 255.255.255.0
HS2(config-if)#standby 10 ip 192.168.10.1
HS2(config-if)#
HS2(config)#
HSRP-6-STATECHANGE: Vlan10 Grp 10 state Speak -> Standby

HS2(config)#int vlan 15
HS2(config)#
LINK-5-CHANGED: Interface Vlan15, changed state to up

*LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan15, changed state to up

HS2(config-if)#ip add 192.168.15.3 255.255.255.0
HS2(config-if)#standby 15 ip 192.168.15.1
HS2(config-if)#
HS2(config)#
HSRP-6-STATECHANGE: Vlan15 Grp 15 state Speak -> Standby

HS2(config)#int vlan 20
HS2(config)#
LINK-5-CHANGED: Interface Vlan20, changed state to up

*LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan20, changed state to up

```

```

LINK-5-CHANGED: Interface Vlan15, changed state to up

*LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan15, changed state to up

HS2(config-if)#ip add 192.168.15.3 255.255.255.0
HS2(config-if)#standby 15 ip 192.168.15.1
HS2(config-if)#
HS2(config)#
HSRP-6-STATECHANGE: Vlan15 Grp 15 state Speak -> Standby

HS2(config)#int vlan 20
HS2(config)#
LINK-5-CHANGED: Interface Vlan20, changed state to up

*LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan20, changed state to up

HS2(config-if)#ip add 192.168.20.3 255.255.255.0
HS2(config-if)#standby 20 ip 192.168.20.1
HS2(config-if)#
HS2(config)#
HSRP-6-STATECHANGE: Vlan20 Grp 20 state Speak -> Standby

HS2(config)#int vlan 30
HS2(config)#
LINK-5-CHANGED: Interface Vlan30, changed state to up

*LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan30, changed state to up

HS2(config-if)#ip add 192.168.30.3 255.255.255.0
HS2(config-if)#standby 30 ip 192.168.30.1
HS2(config-if)#
HS2(config)#
HSRP-6-STATECHANGE: Vlan30 Grp 30 state Speak -> Standby

```

- To check the configuration, we used “show stand bri” command.

```

Switch(config)#int vlan 30
Switch(config-if)#
LINK-5-CHANGED: Interface Vlan30, changed state to up
LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan30, changed state to up

Switch(config-if)#ip add 192.168.30.2 255.255.255.0
Switch(config-if)#standby 30 ip 192.168.30.1
Switch(config-if)#standby 30 priority 150
Switch(config-if)#standby 30 preempt
Switch(config-if)#exit
Switch(config)#
MSRP-6-STATECHANGE: Vlan30 Grp 30 state Speak -> Standby
MSRP-6-STATECHANGE: Vlan30 Grp 30 state Standby -> Active

Switch(config)#
Switch(config)#
Switch# Config from console by console

Switch#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Switch(config)#host MS1
MS1(config)#
MS1(config)#do show stand bri
    P indicates configured to preempt.

Interface  Grp  Pri  P State   Active      Standby      Virtual IP
V110       10   150  P Active   local        192.168.10.3   192.168.10.1
V115       15   150  P Active   local        192.168.15.3   192.168.15.1
V120       20   150  P Active   local        192.168.20.3   192.168.20.1
V130       30   150  P Active   local        192.168.30.3   192.168.30.1
MS1#conf t

```

```

MS2(config)#int vlan 20
MS2(config-if)#
LINK-5-CHANGED: Interface Vlan20, changed state to up
LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan20, changed state to up

MS2(config-if)#ip add 192.168.20.3 255.255.255.0
MS2(config-if)#standby 20 ip 192.168.20.1
MS2(config-if)#exit
MS2(config)#
MSRP-6-STATECHANGE: Vlan20 Grp 20 state Speak -> Standby
MS2(config)#int vlan 30
MS2(config-if)#
LINK-5-CHANGED: Interface Vlan30, changed state to up
LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan30, changed state to up

MS2(config-if)#ip add 192.168.30.3 255.255.255.0
MS2(config-if)#standby 30 ip 192.168.30.1
MS2(config-if)#exit
MS2(config)#
MSRP-6-STATECHANGE: Vlan30 Grp 30 state Speak -> Standby

MS2(config)#
MS2(config)#do show stand bri
    P indicates configured to preempt.

Interface  Grp  Pri  P State   Active      Standby      Virtual IP
V110       10   100  P Standby  192.168.10.2   local        192.168.10.1
V115       15   100  P Standby  192.168.15.2   local        192.168.15.1
V120       20   100  P Standby  192.168.20.2   local        192.168.20.1
V130       30   100  P Standby  192.168.30.2   local        192.168.30.1
MS2#conf t

```

Step 5: Dynamic Host Configuration Protocol (DHCP):

- In the MS1 we created and DHCP pool for each VLAN.

Note: use the appropriate VIP for the default-router in each pool

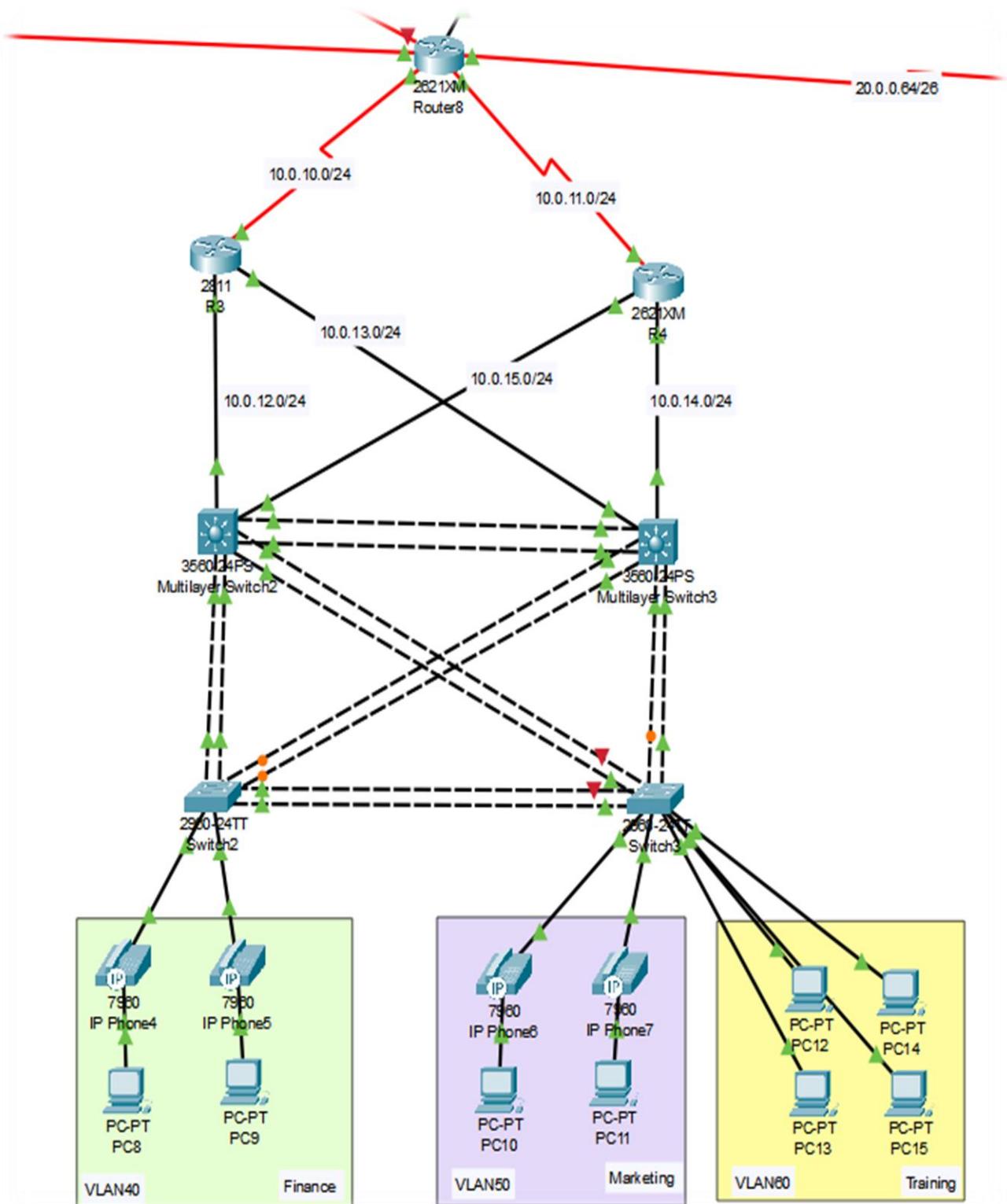
```

MS1>
MS1>en
MS1#conf t
Enter configuration commands, one per line. End with CNTL/Z.
MS1(config)#ip dhcp pool VLAN10
MS1(dhcp-config)#network 192.168.10.0 255.255.255.0
MS1(dhcp-config)#default-router 192.168.10.1
% Invalid input detected at '^' marker.

MS1(dhcp-config)#default-router 192.168.10.1
MS1(dhcp-config)#dns-server 172.16.0.10
MS1(dhcp-config)#exit
MS1(config)#ip dhcp pool VLAN15
MS1(dhcp-config)#network 192.168.15.0 255.255.255.0
MS1(dhcp-config)#default-router 192.168.15.1
MS1(dhcp-config)#o*DHCPPD-4-PING_CONFLICT: DHCP address conflict: server pinged
192.168.15.1.
% DHCPPD-4-PING_CONFLICT: DHCP address conflict: server pinged 192.168.15.2.
p*DHCPPD-4-PING_CONFLICT: DHCP address conflict: server pinged 192.168.15.3.
% Incomplete command.
MS1(dhcp-config)#
MS1(dhcp-config)#exit
MS1(config)#ip dhcp pool VLAN20
MS1(dhcp-config)#network 192.168.20.0 255.255.255.0
MS1(dhcp-config)#default-router 192.168.20.1
MS1(dhcp-config)#dns-server 172.16.0.10
MS1(dhcp-config)#exit
MS1#conf t

```

Block2



5.2 Block 2 Configuration:

Step 1: EtherChannel:

- We started with the Layer 3 switches we named them MS3 and MS4.

```
Switch>conf t
Enter configuration commands, one per line. End with CNTL/Z.
Switch(config)#host MS3
MS3(config)#
MS3(config)#int range Fa0/1-6
MS3(config-if-range)#sv trunk encapsulation dot1q
MS3(config-if-range)#sv mode trunk
```

```
MS3(config-if-range)#exit
MS3(config)#int range Fa0/1-2
MS3(config-if-range)#shut

MS3(config-if-range)#channel-group 1 mode active
MS3(config-if-range)#no shut
```

```
MS3(config-if-range)#exit
MS3(config)#int port-channel 1
MS3(config-if)#sv trunk encapsulation dot1q
MS3(config-if)#sv mode trunk
MS3(config-if-range)#exit
MS3(config)#int range Fa0/3-4
MS3(config-if-range)#shut

MS3(config-if-range)#channel-group 2 mode active
MS3(config-if-range)#no shut
```

```
Switch>en
Switch>conf t
Enter configuration commands, one per line. End with CNTL/Z.
Switch(config)#host MS4
MS4(config)#
MS4(config)#int range Fa0/1-6
MS4(config-if-range)#sv trunk encapsulation dot1q
MS4(config-if-range)#sv mode trunk
```

```
MS4(config-if-range)#exit
MS4(config)#int range Fa0/1-2
MS4(config-if-range)#shut

MS4(config-if-range)#channel-group 1 mode active
MS4(config-if-range)#no shut
```

```
MS4(config-if-range)#exit
MS4(config)#int port-channel 1
MS4(config-if)#sv trunk encapsulation dot1q
MS4(config-if)#sv mode trunk
MS4(config-if-range)#exit
MS4(config)#int range Fa0/3-4
MS4(config-if-range)#shut

MS4(config-if-range)#channel-group 2 mode active
MS4(config-if-range)#no shut
```

```
MS4(config-if-range)#exit
MS4(config)#int port-channel 2
MS4(config-if)#sv trunk encapsulation dot1q
MS4(config-if)#sv mode trunk
MS4(config-if)#exit
MS4(config)#int range Fa0/5-6
MS4(config-if-range)#shut

MS4(config-if-range)#channel-group 3 mode active
MS4(config-if-range)#no shut

MS4(config-if-range)#exit
MS4(config)#int port-channel 3
MS4(config-if)#sv trunk encapsulation dot1q
MS4(config-if)#sv mode trunk
MS4(config-if)#exit
$LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to down
$LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to up
$LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/2, changed state to down
$LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/2, changed state to up
$LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/3, changed state to down
$LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/3, changed state to up
$LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/4, changed state to down
$LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/4, changed state to up
```

```
Switch>
Switch>en
Switch>conf t
Enter configuration commands, one per line. End with CNTL/Z.
Switch(config)#host S3
S3(config)#
S3(config)#int range Fa0/1-6
S3(config-if-range)#sv mode trunk
```

```
S3(config-if-range)#exit
S3(config)#int range Fa0/1-2
S3(config-if-range)#shut

S3(config-if-range)#channel-group 1 mode active
S3(config-if-range)#no shut
```

```
S3(config-if-range)#exit
S3(config)#int port-channel 1
S3(config-if)#sv mode trunk
S3(config-if)#exit
S3(config)#int range Fa0/3-4
S3(config-if-range)#shut

S3(config-if-range)#channel-group 2 mode active
S3(config-if-range)#no shut
```

```
S3(config-if-range)#exit
S3(config)#int port-channel 2
S3(config-if)#sv mode trunk
S3(config-if)#exit
```

```
S3(config-if-range)#exit  
S3(config)#int port-channel 2  
S3(config-if)#sv mode trunk  
S3(config-if)#exit  
S3(config)#int range Fa0/5-6
```

```
S3(config-if-range)#channel-group 3 mode active  
S3(config-if-range)#no shut
```

```
S3(config-if-range)#exit  
S3(config)#int port-channel 3
```

```
%LINK-5-UPDOWN: Line protocol on Interface FastEthernet0/5, changed state to down  
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/5, changed state to up  
%LINK-5-UPDOWN: Line protocol on Interface FastEthernet0/6, changed state to down  
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/6, changed state to up  
%LINK-5-CHANGED: Interface FastEthernet0/1, changed state to administratively down  
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to down  
%LINK-5-CHANGED: Interface FastEthernet0/2, changed state to administratively down  
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/2, changed state to down
```

```
Creating a port-channel interface Port-channel 1
```

```
Switch>  
Switch>en  
Switch>conf t  
Enter configuration commands, one per line. End with CNTL/Z.  
Switch(config)#host S4  
S4(config)#int range Fa0/1-6  
S4(config-if-range)#sv mode trunk  
S4(config-if-range)#exit  
S4(config)#int range Fa0/1-2  
S4(config-if-range)#shut
```

```
S4(config-if-range)#channel-group 1 mode active  
S4(config-if-range)#no shut
```

```
S4(config-if-range)#exit  
S4(config)#int port-channel 1  
S4(config-if)#sv mode trunk  
S4(config)#int range Fa0/3-4
```

```
S4(config-if-range)#channel-group 2 mode active  
S4(config-if-range)#no shut
```

```
S4(config-if-range)#exit  
S4(config)#int port-channel 2  
S4(config-if)#sv mode trunk  
S4(config-if)#exit  
S4(config)#int range Fa0/5-6
```

```
o:UNILAB-ALL-Range>#show  
S4(config-if-range)#channel-group 2 mode active  
S4(config-if-range)#no shut
```

```
S4(config-if-range)#exit  
S4(config)#int port-channel 2  
S4(config-if)#sv mode trunk  
S4(config-if)#exit  
S4(config)#int range Fa0/5-6
```

```
S4(config-if-range)#channel-group 3 mode active  
S4(config-if-range)#no shut
```

```
S4(config-if-range)#exit  
S4(config)#int port-channel 3  
S4(config-if)#sv mode trunk
```

```
%LINK-5-CHANGED: Interface FastEthernet0/1, changed state to administratively down  
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to down  
%LINK-5-CHANGED: Interface FastEthernet0/2, changed state to administratively down  
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/2, changed state to down
```

```
Creating a port-channel interface Port-channel 1
```

```
%LINK-5-CHANGED: Interface FastEthernet0/1, changed state to up
```

- To check the configuration, we used “show ether summary” command.

```

!LINK-5-CHANGED: Interface FastEthernet0/3, changed state to up
!LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/3, changed state to up
!LINK-5-CHANGED: Interface FastEthernet0/4, changed state to up
!LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/4, changed state to up
!LINK-5-CHANGED: Interface Port-channel2, changed state to up
!LINEPROTO-5-UPDOWN: Line protocol on Interface Port-channel2, changed state to up

G3(config)#
G3(config)#do show ether summary
Flags: D - down P - in port-channel
I - stand-alone S - suspended
H - Hot-standby (LACP only)
R - Layer3 S - Layer2
U - in use f - failed to allocate aggregator
u - unsuitable for bundling
w - waiting to be aggregated
d - default port

Number of channel-groups in use: 3
Number of aggregators: 3

Group Port-channel Protocol Ports
-----+-----+-----+-----+
1 Po1(SU) LACP Fa0/1(P) Fa0/2(P)
2 Po2(SU) LACP Fa0/3(P) Fa0/4(P)
3 Po3(SU) LACP Fa0/5(P) Fa0/6(P)
G3(config)#

```

```

!LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to up
!LINK-5-CHANGED: Interface FastEthernet0/2, changed state to up
!LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/2, changed state to up
!LINK-5-CHANGED: Interface Port-channel1, changed state to up
!LINEPROTO-5-UPDOWN: Line protocol on Interface Port-channel1, changed state to up

G4(config)#
G4(config)#en
! Ambiguous command: "en"
G4(config)#do show ether summary
Flags: D - down P - in port-channel
I - stand-alone S - suspended
H - Hot-standby (LACP only)
R - Layer3 S - Layer2
U - in use f - failed to allocate aggregator
u - unsuitable for bundling
w - waiting to be aggregated
d - default port

Number of channel-groups in use: 3
Number of aggregators: 3

Group Port-channel Protocol Ports
-----+-----+-----+-----+
1 Po1(SU) LACP Fa0/1(P) Fa0/2(P)
2 Po2(SU) LACP Fa0/3(P) Fa0/4(P)
3 Po3(SU) LACP Fa0/5(P) Fa0/6(P)
G4(config)#

```

```

!LINK-5-CHANGED: Interface FastEthernet0/5, changed state to up
!LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/5, changed state to up
!LINK-5-CHANGED: Interface FastEthernet0/6, changed state to up
!LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/6, changed state to up
!LINK-5-CHANGED: Interface Port-channel3, changed state to up
!LINEPROTO-5-UPDOWN: Line protocol on Interface Port-channel3, changed state to up

S3(config)#
S3(config)#do show ether summary
Flags: D - down P - in port-channel
I - stand-alone S - suspended
H - Hot-standby (LACP only)
R - Layer3 S - Layer2
U - in use f - failed to allocate aggregator
u - unsuitable for bundling
w - waiting to be aggregated
d - default port

Number of channel-groups in use: 3
Number of aggregators: 3

Group Port-channel Protocol Ports
-----+-----+-----+-----+
1 Po1(SU) LACP Fa0/1(P) Fa0/2(P)
2 Po2(SU) LACP Fa0/3(P) Fa0/4(P)
3 Po3(SU) LACP Fa0/5(P) Fa0/6(P)
S3(config)#

```

```

!LINK-5-CHANGED: Interface Port-channel1, changed state to up
!LINEPROTO-5-UPDOWN: Line protocol on Interface Port-channel1, changed state to up
!LINK-5-CHANGED: Interface Port-channel2, changed state to up
!LINEPROTO-5-UPDOWN: Line protocol on Interface Port-channel2, changed state to up
!LINK-5-CHANGED: Interface Port-channel3, changed state to up
!LINEPROTO-5-UPDOWN: Line protocol on Interface Port-channel3, changed state to up

I4(config)#
I4(config)#do show ether summary
Flags: D - down P - in port-channel
I - stand-alone S - suspended
H - Hot-standby (LACP only)
R - Layer3 S - Layer2
U - in use f - failed to allocate aggregator
u - unsuitable for bundling
w - waiting to be aggregated
d - default port

Number of channel-groups in use: 3
Number of aggregators: 3

Group Port-channel Protocol Ports
-----+-----+-----+-----+
1 Po1(SU) LACP Fa0/1(P) Fa0/2(P)
2 Po2(SU) LACP Fa0/3(P) Fa0/4(P)
3 Po3(SU) LACP Fa0/5(P) Fa0/6(P)
I4(config)#

```

Step 2: VTP Configuration:

- We configured MS3 and MS4 in the server mode. For VTP setting for this block (VTP domain: entb2, VTP password 2022).

```
MS3>en
MS3#conf t
Enter configuration commands, one per line. End with CNTL/Z.
MS3(config)#vtp domain entb2
Changing VTP domain name from NULL to entb2
MS3(config)#vtp password 2022
Setting device VLAN database password to 2022
MS3(config)#do show vtp status
VTP Version capable : 1 to 2
VTP version running : 1
VTP Domain Name : entb2
VTP Pruning Mode : Disabled
VTP Traps Generation : Disabled
Device ID : 0005.5EED.2600
Configuration last modified by 0.0.0.0 at 0-0-00 00:00:00
Local update ID is 0.0.0.0 (no valid interface found)

Feature VLAN :
-----
VTP Operating Mode : Server
maximum VLANs supported locally : 1005
Number of existing VLANs : 5
Configuration Revision : 0
MD5 digest : 0xA9 0x4E 0x2B 0x4A 0xE1 0xDB 0x6B 0xBB
              0xDF 0x8F 0x2C 0x69 0x1F 0x87 0x45 0x06
MS3#-----!
```

```
MS4>en
MS4#conf t
Enter configuration commands, one per line. End with CNTL/Z.
MS4(config)#vtp domain entb2
Domain name already set to entb2.
MS4(config)#vtp password 2022
Setting device VLAN database password to 2022
MS4(config)#do show vtp status
VTP Version capable : 1 to 2
VTP version running : 1
VTP Domain Name : entb2
VTP Pruning Mode : Disabled
VTP Traps Generation : Disabled
Device ID : 0001.4394.5BB0
Configuration last modified by 0.0.0.0 at 0-0-00 00:00:00
Local update ID is 0.0.0.0 (no valid interface found)

Feature VLAN :
-----
VTP Operating Mode : Server
maximum VLANs supported locally : 1005
Number of existing VLANs : 5
Configuration Revision : 0
MD5 digest : 0xA9 0x4E 0x2B 0x4A 0xE1 0xDB 0x6B 0xBB
              0xDF 0x8F 0x2C 0x69 0x1F 0x87 0x45 0x06
MS4#-----!
```

```
S3>
S3>en
Translating "esn"...domain server (255.255.255.255)
Unknown command or computer name, or unable to find computer address

S3#conf t
Enter configuration commands, one per line. End with CNTL/Z.
S3(config)#vtp mode client
Setting device to VTP CLIENT mode.
S3(config)#vtp domain entb2
Domain name already set to entb2.
S3(config)#vtp password 2022
Setting device VLAN database password to 2022
S3(config)#do show vtp status
VTP Version capable : 1 to 2
VTP version running : 1
VTP Domain Name : entb2
VTP Pruning Mode : Disabled
VTP Traps Generation : Disabled
Device ID : 0010.1163.01B0
Configuration last modified by 0.0.0.0 at 0-0-00 00:00:00

Feature VLAN :
-----
VTP Operating Mode : Client
Maximum VLANs supported locally : 255
Number of existing VLANs : 5
Configuration Revision : 0
MD5 digest : 0xA9 0x4E 0x2B 0x4A 0xE1 0xDB 0x6B 0xBB
              0xDF 0x8F 0x2C 0x69 0x1F 0x87 0x45 0x06
S3#-----!
```

```
LINK-5-CHANGED: Line protocol on interface FastEthernet0/8, changed state to up
LINK-5-CHANGED: Interface FastEthernet0/8, changed state to up
LINK-PROT-5-UPDOWN: Line protocol on Interface FastEthernet0/8, changed state to up

S4>
S4#conf t
Enter configuration commands, one per line. End with CNTL/Z.
S4(config)#vtp mode client
Setting device to VTP CLIENT mode.
S4(config)#vtp domain entb2
Domain name already set to entb2.
S4(config)#vtp password 2022
Setting device VLAN database password to 2022
S4(config)#do show vtp status
VTP Version capable : 1 to 2
VTP version running : 1
VTP Domain Name : entb2
VTP Pruning Mode : Disabled
VTP Traps Generation : Disabled
Device ID : 0060.47C6.2C30
Configuration last modified by 0.0.0.0 at 0-0-00 00:00:00

Feature VLAN :
-----
VTP Operating Mode : Client
Maximum VLANs supported locally : 255
Number of existing VLANs : 5
Configuration Revision : 0
MD5 digest : 0xA9 0x4E 0x2B 0x4A 0xE1 0xDB 0x6B 0xBB
              0xDF 0x8F 0x2C 0x69 0x1F 0x87 0x45 0x06
S4#-----!
```

- After that we added and named the VLANs of this block just once on the MS3 and VLANs information propagated to all other switches, we used “show vtp status” command to check. Note that the **Number of existing VLANs** and the **Configuration Revision** number are increased.

```

GS3(config)#vlan 40
GS3(config-vlan)#name Finance
GS3(config-vlan)#vlan 45
GS3(config-vlan)#name IP-Tele
GS3(config-vlan)#vlan 50
GS3(config-vlan)#name Marketing
GS3(config-vlan)#vlan 60
GS3(config-vlan)#name Training

* Invalid input detected at `~` marker.

GS3(config-vlan)#name Training
GS3(config-vlan)#do show vlan

VLAN Name          Status    Ports
-----  -----
1  default         active    Fa0/7, Fa0/8, Fa0/9, Fa0/10
                           Fa0/11, Fa0/12, Fa0/13, Fa0/14
                           Fa0/15, Fa0/16, Fa0/17, Fa0/18
                           Fa0/19, Fa0/20, Fa0/21, Fa0/22
                           Fa0/23, Fa0/24, Fa0/25, Fa0/26
10  Finance        active
15  IP-Tele        active
50  Marketing       active
60  Training        active
1002 fddi-default  active
1003 token-ring-default  active
1004 fddinet-default  active
1005 xernet-default  active

VLAN Type   SAID      MTU    Parent RingNo BridgeNo Stp  BrdgMode Transl Trans2
-----  -----  -----
1  static  100001  1500      -     -     -     -     0     0


```

```

HS4(config)#show vtp status
VTP Version capable : 1 to 2
VTP version running : 1
VTP Domain Name : entb2
VTP Pruning Mode : Disabled
VTP Trap Generation : Disabled
Device ID : 0001.4394.5BB0
Configuration last modified by 0.0.0.0 at 3-1-93 01:16:06
Local update ID is 0.0.0.0 (no valid interface found)

Feature VLAN :
-----
VTP Operating Mode : Server
Maximum VLANs supported locally : 1005
Number of existing VLANs : 9
Configuration Revision : 8
MD5 digest : 0x92 0x93 0xD3 0xB8 0xF5 0x69 0x92 0xA6
              0xEB 0x8A 0x2D 0x21 0x46 0x1E 0xBB 0x3A

HS4(config)#do show vlan

VLAN Name          Status    Ports
-----  -----
1  default         active    Fa0/7, Fa0/8, Fa0/9, Fa0/10
                           Fa0/11, Fa0/12, Fa0/13, Fa0/14
                           Fa0/15, Fa0/16, Fa0/17, Fa0/18
                           Fa0/19, Fa0/20, Fa0/21, Fa0/22
                           Fa0/23, Fa0/24, Gi0/0, Gi0/1
40  Finance        active
45  IP-Tele        active
50  Marketing       active
60  Training        active
1002 fddi-default  active
1003 token-ring-default  active
1004 fddinet-default  active
1005 xernet-default  active


```

```

S3(config)#do show vtp status
VTP Version capable : 1 to 2
VTP version running : 1
VTP Domain Name : entb2
VTP Pruning Mode : Disabled
VTP Trap Generation : Disabled
Device ID : 0010.1163.01B0
Configuration last modified by 0.0.0.0 at 3-1-93 01:16:06

Feature VLAN :
-----
VTP Operating Mode : Client
Maximum VLANs supported locally : 255
Number of existing VLANs : 9
Configuration Revision : 8
MD5 digest : 0x92 0x93 0xD3 0xB8 0xF5 0x69 0x92 0xA6
              0xEB 0x8A 0x2D 0x21 0x46 0x1E 0xBB 0x3A

S3(config)#do show vlan

VLAN Name          Status    Ports
-----  -----
1  default         active    Fa0/7, Fa0/8, Fa0/9, Fa0/10
                           Fa0/11, Fa0/12, Fa0/13, Fa0/14
                           Fa0/15, Fa0/16, Fa0/17, Fa0/18
                           Fa0/19, Fa0/20, Fa0/21, Fa0/22
                           Fa0/23, Fa0/24, Gi0/0, Gi0/1
40  Finance        active
45  IP-Tele        active
50  Marketing       active
60  Training        active
1002 fddi-default  active
1003 token-ring-default  active
1004 fddinet-default  active


```

```

S4(config)#do show vtp status
VTP Version capable : 1 to 2
VTP version running : 1
VTP Domain Name : entb2
VTP Pruning Mode : Disabled
VTP Trap Generation : Disabled
Device ID : 0040.47C6.2C30
Configuration last modified by 0.0.0.0 at 3-1-93 01:16:06

Feature VLAN :
-----
VTP Operating Mode : Client
Maximum VLANs supported locally : 255
Number of existing VLANs : 9
Configuration Revision : 8
MD5 digest : 0x92 0x93 0xD3 0xB8 0xF5 0x69 0x92 0xA6
              0xEB 0x8A 0x2D 0x21 0x46 0x1E 0xBB 0x3A

S4(config)#do show vlan

VLAN Name          Status    Ports
-----  -----
1  default         active    Fa0/7, Fa0/8, Fa0/9, Fa0/10
                           Fa0/11, Fa0/12, Fa0/13, Fa0/14
                           Fa0/15, Fa0/16, Fa0/17, Fa0/18
                           Fa0/19, Fa0/20, Fa0/21, Fa0/22
                           Fa0/23, Fa0/24, Gi0/0, Gi0/1
40  Finance        active
45  IP-Tele        active
50  Marketing       active
60  Training        active
1002 fddi-default  active
1003 token-ring-default  active
1004 fddinet-default  active


```

Step 3: Spanning Tree Protocol (STP):

- We configured Per VLAN Spanning Tree (PVST), we chose MS3 as the primary Root Bridge for all the four VLANs and MS4 as the secondary Root Bridge for the four VLANs.

Command we used:

- In MS3: spanning-tree vlan 40,45,50,60 root primary.
- In MS4: spanning-tree vlan 40,45,50,60 root secondary.

```
MS3(config)#span vlan 40,45,50,60 root primary
MS3(config)#do show snmp
/VLAN0001
Spanning tree enabled protocol ieee
Root ID Priority 32769
Address 000B.BEDE.4782
Cost 9
Port 28(Port-channel12)
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec

Bridge ID Priority 32769 (priority 32768 sys-id-ext 1)
Address 0060.7047.3A20
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
Aging Time 20

Interface Role Sts Cost Prio.Nbr Type
-----  

Po2 Root FWD 9 128.28 Shr
Po1 Desg FWD 9 128.27 Shr
Po3 Altn BLK 9 128.29 Shr

/VLAN0040
Spanning tree enabled protocol ieee
Root ID Priority 24616
Address 0060.7047.3A20
This bridge is the root
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec

Bridge ID Priority 24616 (priority 24576 sys-id-ext 40)
Address 0060.7047.3A20
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
Aging Time 20
```

```
/VLAN0045
Spanning tree enabled protocol ieee
Root ID Priority 24621
Address 0060.7047.3A20
This bridge is the root
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec

Bridge ID Priority 24621 (priority 24576 sys-id-ext 45)
Address 0060.7047.3A20
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
Aging Time 20

Interface Role Sts Cost Prio.Nbr Type
-----  

Fa0/3 Desg FWD 19 128.3 P2p
Fa0/2 Desg FWD 19 128.2 P2p
Fa0/1 Desg FWD 19 128.1 P2p
Fa0/4 Desg FWD 19 128.4 P2p
Fa0/6 Desg FWD 19 128.6 P2p
Fa0/5 Desg FWD 19 128.5 P2p
Po2 Desg FWD 9 128.28 Shr
Po1 Desg FWD 9 128.27 Shr
Po3 Desg LSN 9 128.29 Shr

/VLAN0050
Spanning tree enabled protocol ieee
Root ID Priority 24626
Address 0060.7047.3A20
This bridge is the root
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec

Bridge ID Priority 24626 (priority 24576 sys-id-ext 50)
Address 0060.7047.3A20
```

```
/VLAN0050
Spanning tree enabled protocol ieee
Root ID Priority 24626
Address 0060.7047.3A20
This bridge is the root
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec

Bridge ID Priority 24626 (priority 24576 sys-id-ext 50)
Address 0060.7047.3A20
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
Aging Time 20

Interface Role Sts Cost Prio.Nbr Type
-----  

Fa0/3 Desg FWD 19 128.3 P2p
Fa0/2 Desg FWD 19 128.2 P2p
Fa0/1 Desg FWD 19 128.1 P2p
Fa0/4 Desg FWD 19 128.4 P2p
Fa0/6 Desg FWD 19 128.6 P2p
Fa0/5 Desg FWD 19 128.5 P2p
Po2 Desg FWD 9 128.28 Shr
Po1 Desg FWD 9 128.27 Shr
Po3 Desg LSN 9 128.29 Shr

/VLAN0060
Spanning tree enabled protocol ieee
Root ID Priority 24636
Address 0060.7047.3A20
This bridge is the root
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec

Bridge ID Priority 24636 (priority 24576 sys-id-ext 60)
Address 0060.7047.3A20
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
```

```
MS4(config)#span vlan 40,45,50,60 root secondary
MS4(config)#do show snmp
/VLAN0001
Spanning tree enabled protocol ieee
Root ID Priority 32769
Address 000B.BEDE.4782
Cost 9
Port 27(Port-channel1)
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec

Bridge ID Priority 32769 (priority 32768 sys-id-ext 1)
Address 0060.4738.0E43
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
Aging Time 20

Interface Role Sts Cost Prio.Nbr Type
-----  

Po2 Desg FWD 9 128.28 Shr
Po3 Desg FWD 9 128.29 Shr
Po1 Root FWD 9 128.27 Shr

/VLAN0040
Spanning tree enabled protocol ieee
Root ID Priority 24616
Address 0060.7047.3A20
Cost 9
Port 29(Port-channel3)
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec

Bridge ID Priority 28712 (priority 28672 sys-id-ext 40)
Address 0060.7047.3A20
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
Aging Time 20
```

```

/PLAN0045
  Spanning tree enabled protocol ieee
    Root ID Priority 24621
      Address 0060.7047.3A20
      Cost 9
      Port 29(Port-channel3)
    Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec

Bridge ID Priority 28717 (priority 28672 sys-id-ext 45)
  Address 0060.4738.0E43
  Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
  Aging Time 20

Interface Role Sts Cost Prio.Nbr Type
-----+-----+-----+-----+-----+-----+
Po2 Desg FMD 9 128.28 Shz
Po3 Root FMD 9 128.29 Shz
Fa0/1 Desg FMD 19 128.1 p2p
Fa0/2 Desg FMD 19 128.2 p2p
Fa0/6 Desg FMD 19 128.6 p2p
Fa0/4 Desg FMD 19 128.4 p2p
Fa0/5 Desg FMD 19 128.5 p2p
Fa0/3 Desg FMD 19 128.3 p2p
Po1 Desg FMD 9 128.27 Shz

/PLAN0050
  Spanning tree enabled protocol ieee
    Root ID Priority 24626
      Address 0060.7047.3A20
      Cost 9
      Port 29(Port-channel3)
    Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec

```

```
VLAN0050
  Spanning tree enabled protocol ieee
  Root ID    Priority  24636
              Address   0060.7047.3A20
              Cost      9
              Port      29(Port-channel13)
  Hello Time 2 sec  Max Age 20 sec  Forward Delay 15 sec

Bridge ID Priority 28722 (priority 28672 sys-id-ext 50)
Address 0060.4738.0E43
Hello Time 2 sec  Max Age 20 sec  Forward Delay 15 sec
Aging Time 20

Interface Role Sts Cost    Prio.Nbr Type
-----+-----+-----+-----+-----+-----+
Po2     Desg FND 9        128.28 Shr
Po3     Root FWD 9        128.29 Shr
Fa0/1   Desg FND 19       128.1   P2p
Fa0/2   Desg FND 19       128.2   P2p
Fa0/6   Desg FND 19       128.6   P2p
Fa0/4   Desg FND 19       128.4   P2p
Fa0/5   Desg FND 19       128.5   P2p
Fa0/3   Desg FND 19       128.3   P2p
Po1     Desg FND 9        128.27 Shr

VLAN0060
  Spanning tree enabled protocol ieee
  Root ID    Priority  24636
              Address   0060.7047.3A20
              Cost      9
              Port      29(Port-channel13)
  Hello Time 2 sec  Max Age 20 sec  Forward Delay 15 sec
```

- Then we configured the ports of the access layer switches, each port with the appropriate VLAN access, and for those ports (which are not participate on SPT operations) we enabled the BPDU guard.

Command we used:

- int range <range of interfaces>
 - switchport access vlan <VLAN ID>
 - switchport voice vlan <VLAN ID>
 - spanning-tree bpduguard enable

```

1005 trnet-default          active

VLAN Type   SAID      MTU  Parent RingNo BridgeNo Stp  BrdgMode Trans1 Trans2
----+-----+-----+-----+-----+-----+-----+-----+-----+
 1  enet    100001  1500   -     -     -     -     -     0     0
 40 enet    100040  1500   -     -     -     -     -     0     0
 45 enet    100045  1500   -     -     -     -     -     0     0
 50 enet    100050  1500   -     -     -     -     -     0     0
 60 enet    100060  1500   -     -     -     -     -     0     0
1002 fddi   101002  1500   -     -     -     -     -     0     0
1003 tr     101003  1500   -     -     -     -     ieee  0     0
1004 fdnet  101004  1500   -     -     -     -     ieee  0     0
1005 trnet  101005  1500   -     -     -     -     ibm  0     0

VLAN Type   SAID      MTU  Parent RingNo BridgeNo Stp  BrdgMode Trans1 Trans2
----+-----+-----+-----+-----+-----+-----+-----+-----+

```

Remote SPAN VLANs

Primary	Secondary	Type	Ports
S3(config) #			
S3(config) # int range Fa0/7-8			
S3(config-if-range) # sw access vlan 40			
S3(config-if-range) # sw voice vlan 45			
S3(config-if-range) # exit			
S3(config) # int range Fa0/7-8			
S3(config-if-range) # span bpduguard enable			
S3(config-if-range) #			

```
#(config)#int range Fa0/7-8
#(config-if-range)#sw access vlan 50
#(config-if-range)#sw voice vlan 45
#(config-if-range)#exit
#(config)#int range Fa0/7-8
#(config-if-range)#span bpduguard enable
#(config-if-range)#exit
#(config)#
*LINK-3-UPDOWN: Interface FastEthernet0/12, changed state to down

*LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/13, changed state to down

*LINK-3-UPDOWN: Interface FastEthernet0/14, changed state to down

*LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/14, changed state to down

*LINK-3-UPDOWN: Interface FastEthernet0/11, changed state to down

*LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/11, changed state to down

*LINK-3-UPDOWN: Interface FastEthernet0/12, changed state to down

*LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/12, changed state to down

*LINK-5-CHANGED: Interface FastEthernet0/9, changed state to up

*LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/9, changed state to up

*LINK-5-CHANGED: Interface FastEthernet0/10, changed state to up

*LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/10, changed state to up

*LINK-5-CHANGED: Interface FastEthernet0/11, changed state to up
```

```

*LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/14, changed state to down
*LINK-3-UPDOWN: Interface FastEthernet0/11, changed state to down
*LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/11, changed state to down
*LINK-3-UPDOWN: Interface FastEthernet0/12, changed state to down
*LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/12, changed state to down
*LINK-5-CHANGED: Interface FastEthernet0/8, changed state to up
*LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/9, changed state to up
*LINK-5-CHANGED: Interface FastEthernet0/10, changed state to up
*LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/10, changed state to up
*LINK-5-CHANGED: Interface FastEthernet0/11, changed state to up
*LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/11, changed state to up
*LINK-5-CHANGED: Interface FastEthernet0/12, changed state to up
*LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/12, changed state to up

#(config)#
#(config)#n
# Ambiguous command: "en"
#(config)int range Fa0/9-12
#(config-if-range)#sv access vlan 60
#(config-if-range)#span bpduguard enable
#(config-if-range)#

```

Step 4: Hot Standby Router Protocol (HSRP):

- First, we enabled routing functionality on the Layer 3 switch using “ip routing” command inside the configuration mode of the MS.
- We created an interface for each VLAN and assigned to it IP address from the local subnet of the VLAN.
- Under the VLAN interface configuration we implemented the HSRP configuration
For the MS3 we gave it higher priority 150 and we left the MS4 with the default priority.

```

MS3(config)#ip routing
MS3(config)#int vlan 40
MS3(config-if)#
*LINK-5-CHANGED: Interface Vlan40, changed state to up
*LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan40, changed state to up

MS3(config-if)#ip add 192.168.40.2 255.255.255.0
MS3(config-if)#standby 40 ip 192.168.40.1
MS3(config-if)#standby 40 priority 150
MS3(config-if)#standby 40 preempt
MS3(config-if)#
*HSRP-6-STATECHANGE: Vlan40 Grp 40 state Speak -> Standby
*HSRP-6-STATECHANGE: Vlan40 Grp 40 state Standby -> Active

MS3(config-if)#exit
MS3(config)#int vlan 45
MS3(config-if)#
*LINK-5-CHANGED: Interface Vlan45, changed state to up
*LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan45, changed state to up

MS3(config-if)#ip add 192.168.45.2 255.255.255.0
MS3(config-if)#standby 45 ip 192.168.45.1
MS3(config-if)#standby 45 priority 150
MS3(config-if)#standby 45 preempt
MS3(config-if)#
*HSRP-6-STATECHANGE: Vlan45 Grp 45 state Speak -> Standby
*HSRP-6-STATECHANGE: Vlan45 Grp 45 state Standby -> Active
MS3(config)#
MS3(config)int vlan 50

```

```

*HSRP-6-STATECHANGE: Vlan45 Grp 45 state Standby -> Active
MS3(config)#
MS3(config)int vlan 50
MS3(config-if)#
*LINK-5-CHANGED: Interface Vlan50, changed state to up
*LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan50, changed state to up

MS3(config-if)#ip add 192.168.50.2 255.255.255.0
MS3(config-if)#standby 50 ip 192.168.50.1
MS3(config-if)#standby 50 priority 150
MS3(config-if)#standby 50 preempt
MS3(config-if)#
*HSRP-6-STATECHANGE: Vlan50 Grp 50 state Speak -> Standby
*HSRP-6-STATECHANGE: Vlan50 Grp 50 state Standby -> Active

MS3(config)#
MS3(config)int vlan 60
MS3(config-if)#
*LINK-5-CHANGED: Interface Vlan60, changed state to up
*LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan60, changed state to up

MS3(config-if)#ip add 192.168.60.2 255.255.255.0
MS3(config-if)#standby 60 ip 192.168.60.1
MS3(config-if)#standby 60 priority 150
MS3(config-if)#standby 60 preempt
MS3(config-if)#
*HSRP-6-STATECHANGE: Vlan60 Grp 60 state Speak -> Standby
*HSRP-6-STATECHANGE: Vlan60 Grp 60 state Standby -> Active

```

```

GS4>
GS4#en
GS4#conf t
Enter configuration commands, one per line. End with CNTL/Z.
GS4(config)#ip routing
GS4(config)#int vlan 40
GS4(config-if)#
LINK-5-CHANGED: Interface Vlan40, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan40, changed state to up

GS4(config-if)#ip add 192.168.40.3 255.255.255.0
GS4(config-if)#standby 40 ip 192.168.40.1
GS4(config-if)#exit
GS4(config)#
HSRP-6-STATECHANGE: Vlan40 Grp 40 state Speak -> Standby

GS4(config)#int vlan 45
GS4(config-if)#
LINK-5-CHANGED: Interface Vlan45, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan45, changed state to up

GS4(config-if)#ip add 192.168.45.3 255.255.255.0
GS4(config-if)#standby 45 ip 192.168.45.1
GS4(config-if)#exit
GS4(config)#
HSRP-6-STATECHANGE: Vlan45 Grp 40 state Speak -> Standby

GS4(config)#int vlan 50
GS4(config-if)#
LINK-5-CHANGED: Interface Vlan50, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan50, changed state to up

GS4(config-if)#ip add 192.168.50.3 255.255.255.0
GS4(config-if)#standby 50 ip 192.168.50.1
GS4(config-if)#exit
GS4(config)#
HSRP-6-STATECHANGE: Vlan50 Grp 50 state Speak -> Standby

GS4(config)#int vlan 60
GS4(config-if)#
LINK-5-CHANGED: Interface Vlan60, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan60, changed state to up

GS4(config-if)#ip add 192.168.60.3 255.255.255.0
GS4(config-if)#standby 60 ip 192.168.60.1
GS4(config-if)#exit
GS4(config)#
HSRP-6-STATECHANGE: Vlan60 Grp 60 state Speak -> Standby

%LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan60, changed state to up

```

```

%LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan45, changed state to up

GS4(config-if)#ip add 192.168.45.3 255.255.255.0
GS4(config-if)#standby 45 ip 192.168.45.1
GS4(config-if)#exit
GS4(config)#
HSRP-6-STATECHANGE: Vlan45 Grp 45 state Speak -> Standby

GS4(config)#int vlan 50
GS4(config-if)#
LINK-5-CHANGED: Interface Vlan50, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan50, changed state to up

GS4(config-if)#ip add 192.168.50.3 255.255.255.0
GS4(config-if)#standby 50 ip 192.168.50.1
GS4(config-if)#exit
GS4(config)#
HSRP-6-STATECHANGE: Vlan50 Grp 50 state Speak -> Standby

GS4(config)#int vlan 60
GS4(config-if)#
LINK-5-CHANGED: Interface Vlan60, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan60, changed state to up

GS4(config-if)#ip add 192.168.60.3 255.255.255.0
GS4(config-if)#standby 60 ip 192.168.60.1
GS4(config-if)#exit
GS4(config)#
HSRP-6-STATECHANGE: Vlan60 Grp 60 state Speak -> Standby

GS4(config)#

```

- To check the configuration, we used “show stand bri” command.

```

%HSRP-6-STATECHANGE: Vlan50 Grp 50 state Standby -> Active

MS3(config-if)#exit
MS3(config)#int vlan 60
MS3(config-if)#
LINK-5-CHANGED: Interface Vlan60, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan60, changed state to up

MS3(config-if)#ip add 192.168.60.2 255.255.255.0
MS3(config-if)#standby 60 ip 192.168.60.1
MS3(config-if)#standby 60 priority 150
MS3(config-if)#standby 60 preempt
MS3(config-if)#exit
MS3(config)#
HSRP-6-STATECHANGE: Vlan60 Grp 60 state Speak -> Standby

HSRP-6-STATECHANGE: Vlan60 Grp 60 state Standby -> Active

MS3(config)#do show stand bri
  -
% Invalid input detected at `-->` marker.

MS3(config)#do show stand bri
  P indicates configured to preempt.
  -
Interface  Grp  Pri  P State   Active      Standby      Virtual IP
V140       40    150  P Active   local       192.168.40.3  192.168.40.1
V145       45    150  P Active   local       192.168.45.3  192.168.45.1
V150       50    150  P Active   local       192.168.50.3  192.168.50.1
V160       60    150  P Active   local       192.168.60.3  192.168.60.1
MS3(config)#

```

```

%HSRP-6-STATECHANGE: Vlan50 Grp 50 state Speak -> Standby

MS4(config)#int vlan 50
MS4(config-if)#
LINK-5-CHANGED: Interface Vlan50, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan50, changed state to up

MS4(config-if)#ip add 192.168.50.3 255.255.255.0
MS4(config-if)#standby 50 ip 192.168.50.1
MS4(config-if)#exit
MS4(config)#
HSRP-6-STATECHANGE: Vlan50 Grp 50 state Speak -> Standby

MS4(config)#int vlan 60
MS4(config-if)#
LINK-5-CHANGED: Interface Vlan60, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan60, changed state to up

MS4(config-if)#ip add 192.168.60.3 255.255.255.0
MS4(config-if)#standby 60 ip 192.168.60.1
MS4(config-if)#exit
MS4(config)#
HSRP-6-STATECHANGE: Vlan60 Grp 60 state Speak -> Standby

MS4(config)#

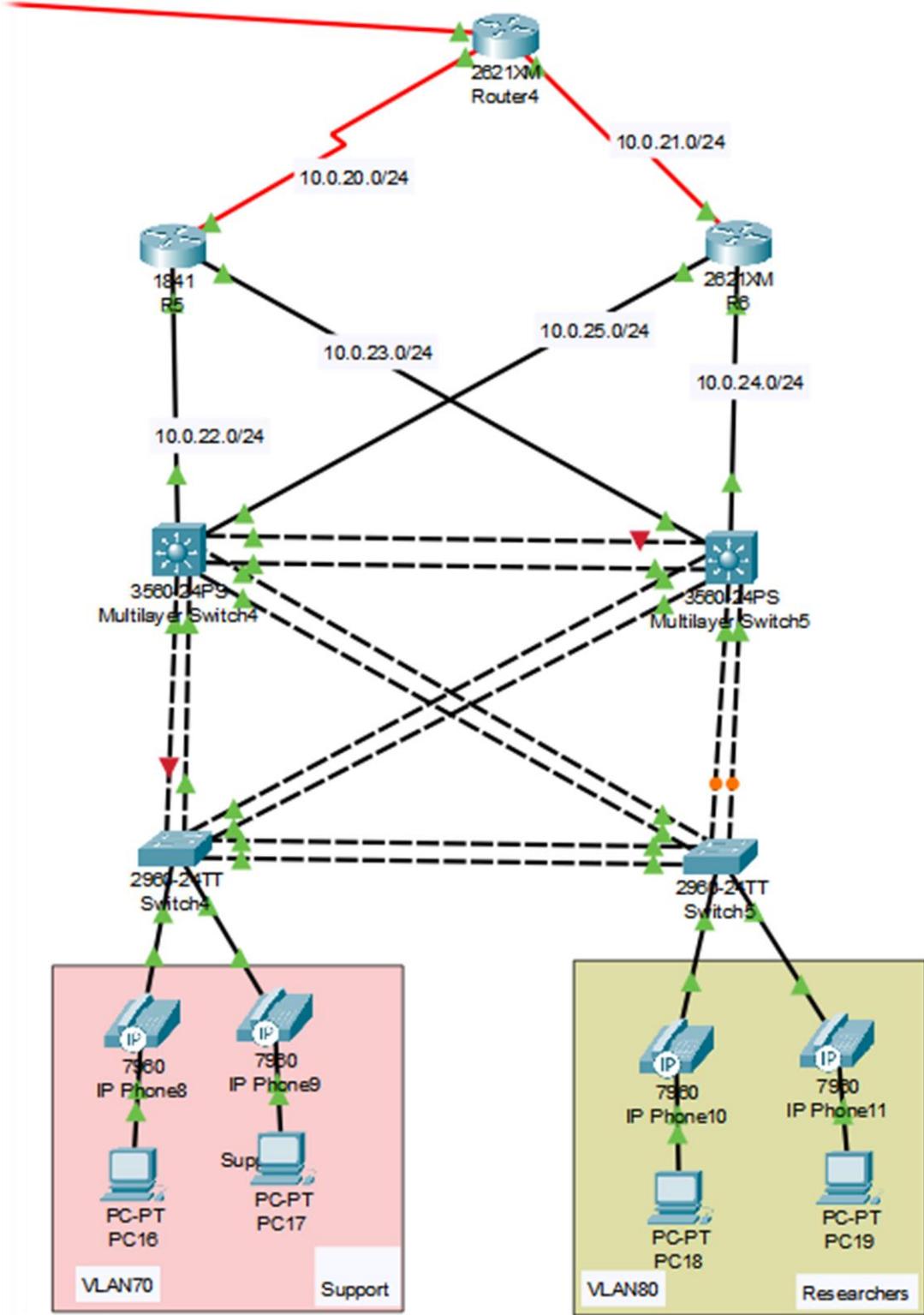
```

Step 5: Dynamic Host Configuration Protocol (DHCP):

- In the MS3 we created and DHCP pool for each VLAN.

Note: use the appropriate VIP for the default-router in each pool

Block3



5.3 Block 3 Configuration:

Step 1: EtherChannel:

- We started with the Layer 3 switches we named them MS5 and MS6.

```
Switch>en
Switch#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Switch(config)#host MS5
MS5(config)#int range Fa0/1-6
MS5(config-if-range)#sv trunk encapsulation dot1q
MS5(config-if-range)#sv mode trunk
```

```
MS5(config-if-range)#exit
MS5(config)#int range Fa0/1-2
MS5(config-if-range)#shut
```

```
MS5(config-if-range)#channel-group 1 mode active
MS5(config-if-range)#no shut
```

```
MS5(config-if-range)#exit
MS5(config)#int port-channel 1
MS5(config-if)#sv trunk encapsulation dot1q
MS5(config-if)#sv mode trunk
MS5(config-if)#exit
MS5(config)#int range Fa0/3-4
MS5(config-if-range)#shut
```

```
MS5(config-if-range)#channel-group 2 mode active
MS5(config-if-range)#no shut
```

```
MS5(config-if-range)#exit
MS5(config)#int port-channel 2
MS5(config-if)#sv trunk encapsulation dot1q
MS5(config-if)#sv mode trunk
MS5(config-if)#exit
MS5(config)#int range Fa0/5-6
MS5(config-if-range)#shut
```

```
MS5(config-if-range)#channel-group 3 mode active
MS5(config-if-range)#no shut
```

```
MS5(config-if-range)#exit
MS5(config)#int port-channel 3
MS5(config-if)#sv trunk encapsulation dot1q
MS5(config-if)#sv mode trunk
MS5(config-if)#exit
```

```
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to down
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/2, changed state to down
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/2, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/3, changed state to down
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/3, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/4, changed state to down
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/4, changed state to up
```

```
Switch>en
Switch#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Switch(config)#host MS6
MS6(config)#int range Fa0/1-6
MS6(config-if-range)#sv trunk encapsulation dot1q
MS6(config-if-range)#sv mode trunk
```

```
MS6(config-if-range)#exit
MS6(config)#int range Fa0/1-2
MS6(config-if-range)#shut
```

```
MS6(config-if-range)#channel-group 1 mode active
MS6(config-if-range)#no shut
```

```
MS6(config-if-range)#exit
MS6(config)#int port-channel 1
MS6(config-if)#sv trunk encapsulation dot1q
MS6(config-if)#sv mode trunk
MS6(config-if)#exit
MS6(config)#int range Fa0/3-4
MS6(config-if-range)#shut
```

```
MS6(config-if-range)#channel-group 2 mode active
MS6(config-if-range)#no shut
```

```
MS6(config-if-range)#exit
```

```
MS6(config-if-range)#exit
MS6(config)#int port-channel 2
MS6(config-if)#sv trunk encapsulation dot1q
MS6(config-if)#sv mode trunk
MS6(config-if)#exit
MS6(config)#int range Fa0/5-6
MS6(config-if-range)#shut
```

```
MS6(config-if-range)#channel-group 3 mode active
MS6(config-if-range)#no shut
```

```
MS6(config-if-range)#exit
MS6(config)#int port-channel 3
MS6(config-if)#sv trunk encapsulation dot1q
MS6(config-if)#sv mode trunk
```

```
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to down
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/2, changed state to down
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/2, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/3, changed state to down
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/3, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/4, changed state to down
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/4, changed state to up
%LINKPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/4, changed state to un
```

```

Switch>
Switch>en
Switch>conf t
Enter configuration commands, one per line. End with CNTL/Z.
Switch(config)#host S6
S6(config)int range Fa0/1-6
S6(config-if-range)#sw mode trunk

S6(config-if-range)#exit
S6(config)int range Fa0/1-2
S6(config-if-range)#shut

S6(config-if-range)#channel-group 1 mode active
S6(config-if-range)no shut

S6(config-if-range)#exit
S6(config)int port-channel 1
S6(config-if)#sw mode trunk
S6(config-if)#exit
S6(config)int range Fa0/3-4
S6(config-if-range)#shut

S6(config-if-range)#channel-group 2 mode active
S6(config-if-range)no shut

S6(config-if-range)#exit
S6(config)int port-channel 2
S6(config-if)#sw mode trunk
S6(config-if)#exit

```

```

S6(config-if-range)#exit
S6(config)int port-channel 2
S6(config-if)#sw mode trunk
S6(config-if)#exit
S6(config)int range Fa0/5-6
S6(config-if-range)#shut

S6(config-if-range)#channel-group 3 mode active
S6(config-if-range)no shut

S6(config-if-range)#exit
S6(config)int port-channel 3
S6(config-if)#sw mode trunk
S6(config-if)#exit
S6(config)#
$LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/5, changed state to down
$LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/5, changed state to up
$LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/6, changed state to down
$LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/6, changed state to up
$LINK-5-CHANGED: Interface FastEthernet0/1, changed state to administratively down
$LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to down
$LINK-5-CHANGED: Interface FastEthernet0/2, changed state to administratively down
$LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/2, changed state to down
Creating a port-channel interface Port-channel 1

```

```

Switch>
Switch>en
Switch>conf t
Enter configuration commands, one per line. End with CNTL/Z.
Switch(config)#host S6
% Incomplete command.
Switch(config)#host S6
S6(config)int range Fa0/1-6
S6(config-if-range)#sw mode trunk
S6(config-if-range)#exit
S6(config)int range Fa0/1-2
S6(config-if-range)#shut

S6(config-if-range)#channel-group 1 mode active
S6(config-if-range)no shut

S6(config-if-range)#exit
S6(config)int port-channel 1
S6(config-if)#sw mode trunk
S6(config-if)#exit
S6(config)int range Fa0/3-4
S6(config-if-range)no shut

S6(config-if-range)#channel-group 2 mode active
S6(config-if-range)no shut

S6(config-if-range)#exit
S6(config)int port-channel 2
S6(config-if)#sw mode trunk

```

```

S6(config-if-range)#exit
S6(config)int port-channel 2
S6(config-if)#sw mode trunk
S6(config-if)#exit
S6(config)int range Fa0/5-6
S6(config-if-range)#shut

S6(config-if-range)#channel-group 3 mode active
S6(config-if-range)no shut

S6(config-if-range)#exit
S6(config)int port-channel 3
S6(config-if)#sw mode trunk
S6(config-if)#exit
$LINK-5-CHANGED: Interface FastEthernet0/1, changed state to administratively down
$LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to down
$LINK-5-CHANGED: Interface FastEthernet0/2, changed state to administratively down
$LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/2, changed state to down
Creating a port-channel interface Port-channel 1
$LINK-5-CHANGED: Interface FastEthernet0/1, changed state to up
$LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to up
$LINK-5-CHANGED: Interface FastEthernet0/2, changed state to up
$LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/2, changed state to up

```

- To check the configuration, we used “show ether summary” command.

```

!LINK-5-CHANGED: Interface FastEthernet0/3, changed state to up
!LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/3, changed state to up
!LINK-5-CHANGED: Interface FastEthernet0/4, changed state to up
!LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/4, changed state to up
!LINK-5-CHANGED: Interface Port-channel2, changed state to up
!LINEPROTO-5-UPDOWN: Line protocol on Interface Port-channel2, changed state to up

MS5(config)#do show ether summary
Flags: D - down P - in port-channel
I - stand-alone s - suspended
H - Hot-standby (LACP only)
R - Layer3 S - Layer2
U - in use f - failed to allocate aggregator
u - unsuitable for bundling
w - waiting to be aggregated
d - default port

Number of channel-groups in use: 3
Number of aggregators: 3

Group Port-channel Protocol Ports
-----+-----+-----+-----+
1 Po1(SU) LACP Fa0/1(P) Fa0/2(P)
2 Po2(SU) LACP Fa0/3(P) Fa0/4(P)
3 Po3(SU) LACP Fa0/5(P) Fa0/6(P)
MS5(config)#

```

```

!LINK-5-CHANGED: Interface FastEthernet0/1, changed state to up
!LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to up
!LINK-5-CHANGED: Interface FastEthernet0/2, changed state to up
!LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/2, changed state to up
!LINK-5-CHANGED: Interface Port-channel1, changed state to up
!LINEPROTO-5-UPDOWN: Line protocol on Interface Port-channel1, changed state to up

MS6(config)#do show ether summary
Flags: D - down P - in port-channel
I - stand-alone s - suspended
H - Hot-standby (LACP only)
R - Layer3 S - Layer2
U - in use f - failed to allocate aggregator
u - unsuitable for bundling
w - waiting to be aggregated
d - default port

Number of channel-groups in use: 3
Number of aggregators: 3

Group Port-channel Protocol Ports
-----+-----+-----+-----+
1 Po1(SU) LACP Fa0/1(P) Fa0/2(P)
2 Po2(SU) LACP Fa0/3(P) Fa0/4(P)
3 Po3(SU) LACP Fa0/5(P) Fa0/6(P)
MS6(config)#

```

```

!LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/6, changed state to up
!LINK-5-CHANGED: Interface FastEthernet0/6, changed state to up
!LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/6, changed state to up
!LINK-5-CHANGED: Interface Port-channel3, changed state to up
!LINEPROTO-5-UPDOWN: Line protocol on Interface Port-channel3, changed state to up

MS(config)#
MS(config)#en
* Ambiguous command: "en"
MS(config)#
MS(config)#do show ether summary
Flags: D - down P - in port-channel
I - stand-alone s - suspended
H - Hot-standby (LACP only)
R - Layer3 S - Layer2
U - in use f - failed to allocate aggregator
u - unsuitable for bundling
w - waiting to be aggregated
d - default port

Number of channel-groups in use: 3
Number of aggregators: 3

Group Port-channel Protocol Ports
-----+-----+-----+-----+
1 Po1(SU) LACP Fa0/1(P) Fa0/2(P)
2 Po2(SU) LACP Fa0/3(P) Fa0/4(P)
3 Po3(SU) LACP Fa0/5(P) Fa0/6(P)
MS(config)#

```

```

!LINK-5-CHANGED: Interface Port-channel1, changed state to up
!LINEPROTO-5-UPDOWN: Line protocol on Interface Port-channel1, changed state to up
!LINK-5-CHANGED: Interface Port-channel3, changed state to up
!LINEPROTO-5-UPDOWN: Line protocol on Interface Port-channel3, changed state to up
!LINK-5-CHANGED: Interface Port-channel2, changed state to up
!LINEPROTO-5-UPDOWN: Line protocol on Interface Port-channel2, changed state to up

MS(config)#do show ether summary
Flags: D - down P - in port-channel
I - stand-alone s - suspended
H - Hot-standby (LACP only)
R - Layer3 S - Layer2
U - in use f - failed to allocate aggregator
u - unsuitable for bundling
w - waiting to be aggregated
d - default port

Number of channel-groups in use: 3
Number of aggregators: 3

Group Port-channel Protocol Ports
-----+-----+-----+-----+
1 Po1(SU) LACP Fa0/1(P) Fa0/2(P)
2 Po2(SU) LACP Fa0/3(P) Fa0/4(P)
3 Po3(SU) LACP Fa0/5(P) Fa0/6(P)
MS(config)#

```

Step 2: VTP Configuration:

- We configured MS3 and MS4 in the server mode. For VTP setting for this block (VTP domain: entb3, VTP password 2022).

```

MS>
MS#en
MS#conf t
Enter configuration commands, one per line. End with CNTL/Z
MS(config)#vtp domain entb3
Changing VTP domain name from NULL to entb3
MS(config)vtp password 2022
Setting device VLAN database password to 2022
MS(config)#do show vtp status
VTP Version capable : 1 to 2
VTP version running : 1
VTP Domain Name : entb3
VTP Pruning Mode : Disabled
VTP Traps Generation : Disabled
Device ID : 0001.649C.8880
Configuration last modified by 0.0.0.0 at 0-0-00 00:00:00
Local update ID is 0.0.0.0 (no valid interface found)

Feature VLAN :

VTP Operating Mode : Server
Maximum VLANs supported locally : 1005
Number of existing VLANs : 5
Configuration Revision : 0
MD5 digest : 0xAB 0x38 0xDC 0xDA 0x52 0x17 0x60 0x5B
              0x48 0x5E 0xB0 0xD7 0x9C 0xE3 0x92 0xA

```

```

*LINEPROTO-5-UPDOWN: Line protocol on Interface Port-channel3, changed state to up

MS>en
MS#conf t
      ^
      ! Invalid input detected at `'' marker.

MS#conf t
Enter configuration commands, one per line. End with CNTL/Z
MS(config)#vtp domain entb3
Domain name already set to entb3.
MS(config)vtp password 2022
Setting device VLAN database password to 2022
MS(config)#do show vtp status
VTP Version capable : 1 to 2
VTP version running : 1
VTP Domain Name : entb3
VTP Pruning Mode : Disabled
VTP Traps Generation : Disabled
Device ID : 0003.E49.BD90
Configuration last modified by 0.0.0.0 at 0-0-00 00:00:00
Local update ID is 0.0.0.0 (no valid interface found)

Feature VLAN :

VTP Operating Mode : Server
Maximum VLANs supported locally : 1005
Number of existing VLANs : 5
Configuration Revision : 0
MD5 digest : 0xAB 0x38 0xDC 0xDA 0x52 0x17 0x60 0x5B
              0x48 0x5E 0xB0 0xD7 0x9C 0xE3 0x92 0xA

```

```

*LINK-5-CHANGED: Interface FastEthernet0/8, changed state to up
*LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/8, changed state to up

MS>
MS#en
MS#conf t
Enter configuration commands, one per line. End with CNTL/Z.
MS(config)#vtp mode client
Setting device to VTP CLIENT mode.
MS(config)#vtp domain entb3
Domain name already set to entb3.
MS(config)vtp password 2022
Setting device VLAN database password to 2022
MS(config)#do show vtp status
VTP Version capable : 1 to 2
VTP version running : 1
VTP Domain Name : entb3
VTP Pruning Mode : Disabled
VTP Traps Generation : Disabled
Device ID : 0000.0C8A.2540
Configuration last modified by 0.0.0.0 at 0-0-00 00:00:00

Feature VLAN :

VTP Operating Mode : Client
Maximum VLANs supported locally : 255
Number of existing VLANs : 5
Configuration Revision : 0
MD5 digest : 0xAB 0x38 0xDC 0xDA 0x52 0x17 0x60 0x5B
              0x48 0x5E 0xB0 0xD7 0x9C 0xE3 0x92 0xA

```

```

*LINK-5-CHANGED: Interface FastEthernet0/8, changed state to up
*LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/8, changed state to up

MS>
MS#en
MS#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Setting device to VTP CLIENT mode.
MS(config)#vtp domain entb3
Domain name already set to entb3.
MS(config)vtp password 2022
Setting device VLAN database password to 2022
MS(config)#do show vtp status
VTP Version capable : 1 to 2
VTP version running : 1
VTP Domain Name : entb3
VTP Pruning Mode : Disabled
VTP Traps Generation : Disabled
Device ID : 0000.0C78.27E0
Configuration last modified by 0.0.0.0 at 0-0-00 00:00:00

Feature VLAN :

VTP Operating Mode : Client
Maximum VLANs supported locally : 255
Number of existing VLANs : 5
Configuration Revision : 0
MD5 digest : 0xAB 0x38 0xDC 0xDA 0x52 0x17 0x60 0x5B
              0x48 0x5E 0xB0 0xD7 0x9C 0xE3 0x92 0xA

```

- After that we added and named the VLANs of this block just once on the MS5 and VLANs information propagated to all other switches, we used “show vtp status” command to check. Note that the **Number of existing VLANs** and the **Configuration Revision** number are increased.

```

MS# show vtp status
MS digest : 0xAB 0x38 0xDC 0xDA 0x52 0x17 0x60 0x5B
          : 0x48 0x5E 0xB0 0xD7 0x9C 0xE3 0x92 0x8A
MS(config)#
MS(config)#
MS(config)#vlan 70
MS(config-vlan)#name Support
MS(config-vlan)#vlan 75
MS(config-vlan)#name IP-Tele
MS(config-vlan)#vlan 80
MS(config-vlan)#name Researchers
MS(config-vlan)#do show vlan
VLAN Name      Status    Ports
-----+-----+-----+
1   default      active   Fa0/7, Fa0/8, Fa0/9, Fa0/10
                  Fa0/11, Fa0/12, Fa0/13, Fa0/14
                  Fa0/15, Fa0/16, Fa0/17, Fa0/18
                  Fa0/19, Fa0/20, Fa0/21, Fa0/22
                  Fa0/23, Fa0/24, Gig0/1, Gig0/2
70  Support       active
75  IP-Tele      active
80  Researchers   active
1002 fddi-default active
1003 token-ring-default active
1004 fddinet-default active
1005 trnet-default active
VLAN Type SAID   MTU Parent RingNo BridgeNo Stp  BrdgMode Transl Trans2
-----+-----+-----+-----+-----+-----+-----+-----+
1   enet 100001 1500 -   -   -   -   0   0
70  enet 100070 1500 -   -   -   -   0   0
75  enet 100075 1500 -   -   -   -   0   0
--  ---  ---  ---  ---  ---  ---  ---  ---  ---

```

```

MS# do show vtp status
MS Version capable : 1 to 2
MS Version running  : 1
MS Domain Name     : entb3
MS Pruning Mode    : Disabled
MS Traps Generation: Disabled
Device ID          : 0003.E429.BD90
Configuration last modified by 0.0.0.0 at 3-1-93 01:46:11
Local updater ID is 0.0.0.0 (no valid interface found)

Feature VLAN :
-----+-----+-----+
VTP Operating Mode : Server
Maximum VLANs supported locally : 1005
Number of existing VLANs : 8
Configuration Revision : 6
MS digest : 0x35 0x64 0xBF 0xC9 0x47 0x74 0xA8 0x4D
          : 0x98 0xBF 0x49 0x3F 0xC7 0xCC 0x9E 0x9B
VLAN Name      Status    Ports
-----+-----+-----+
1   default      active   Fa0/7, Fa0/8, Fa0/9, Fa0/10
                  Fa0/11, Fa0/12, Fa0/13, Fa0/14
                  Fa0/15, Fa0/16, Fa0/17, Fa0/18
                  Fa0/19, Fa0/20, Fa0/21, Fa0/22
                  Fa0/23, Fa0/24, Gig0/1, Gig0/2
70  Support       active
75  IP-Tele      active
80  Researchers   active
1002 fddi-default active
1003 token-ring-default active
1004 fddinet-default active
1005 trnet-default active

```

```

MS# do show vtp status
MS Version capable : 1 to 2
MS Version running  : 1
MS Domain Name     : entb3
MS Pruning Mode    : Disabled
MS Traps Generation: Disabled
Device ID          : 0000.CCEA.2540
Configuration last modified by 0.0.0.0 at 3-1-93 01:46:11

Feature VLAN :
-----+-----+-----+
VTP Operating Mode : Client
Maximum VLANs supported locally : 255
Number of existing VLANs : 8
Configuration Revision : 6
MS digest : 0x35 0x64 0xBF 0xC9 0x47 0x74 0xA8 0x4D
          : 0x98 0xBF 0x49 0x3F 0xC7 0xCC 0x9E 0x9B
MS# do show vlan
VLAN Name      Status    Ports
-----+-----+-----+
1   default      active   Fa0/7, Fa0/8, Fa0/9, Fa0/10
                  Fa0/11, Fa0/12, Fa0/13, Fa0/14
                  Fa0/15, Fa0/16, Fa0/17, Fa0/18
                  Fa0/19, Fa0/20, Fa0/21, Fa0/22
                  Fa0/23, Fa0/24, Gig0/1, Gig0/2
70  Support       active
75  IP-Tele      active
80  Researchers   active
1002 fddi-default active
1003 token-ring-default active
1004 fddinet-default active
1005 trnet-default active

```

```

MS# do show vtp status
MS Version capable : 1 to 2
MS Version running  : 1
MS Domain Name     : entb3
MS Pruning Mode    : Disabled
MS Traps Generation: Disabled
Device ID          : 0000.CC78.27E0
Configuration last modified by 0.0.0.0 at 3-1-93 01:46:11

Feature VLAN :
-----+-----+-----+
VTP Operating Mode : Client
Maximum VLANs supported locally : 255
Number of existing VLANs : 8
Configuration Revision : 6
MS digest : 0x35 0x64 0xBF 0xC9 0x47 0x74 0xA8 0x4D
          : 0x98 0xBF 0x49 0x3F 0xC7 0xCC 0x9E 0x9B
MS# do show vlan
VLAN Name      Status    Ports
-----+-----+-----+
1   default      active   Fa0/7, Fa0/8, Fa0/9, Fa0/10
                  Fa0/11, Fa0/12, Fa0/13, Fa0/14
                  Fa0/15, Fa0/16, Fa0/17, Fa0/18
                  Fa0/19, Fa0/20, Fa0/21, Fa0/22
                  Fa0/23, Fa0/24, Gig0/1, Gig0/2
70  Support       active
75  IP-Tele      active
80  Researchers   active
1002 fddi-default active
1003 token-ring-default active
1004 fddinet-default active
1005 trnet-default active

```

Step 3: Spanning Tree Protocol (STP):

- We configured Per VLAN Spanning Tree (PVST), we chose MS5 as the primary Root Bridge for all the four VLANs and MS6 as the secondary Root Bridge for the four VLANs.

Command we used:

- In MS5: spanning-tree vlan 70,75,80 root primary.
- In MS6: spanning-tree vlan 70,75,80 root secondary.

```
MS5(config)#span vlan 70,75,80 root primary
VLAN0001
Spanning tree enabled protocol ieee
Root ID Priority 32769
Address 00E0.F777.A591
Cost 9
Port 27(Port-channel)
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec

Bridge ID Priority 32769 (priority 32769 sys-id-ext 1)
Address 00E0.F777.A591
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
Aging Time 20

Interface Role Sts Cost Prio.Nbr Type
-----+
Po1 Root FWD 9 128.27 Shr
Po2 Altn BLK 9 128.28 Shr
Po3 Altn BLK 9 128.29 Shr

VLAN0070
Spanning tree enabled protocol ieee
Root ID Priority 24646
Address 00E0.F777.A591
This bridge is the root
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec

Bridge ID Priority 24646 (priority 24576 sys-id-ext 70)
Address 00E0.F777.A591

MS5(config)#

```

* Invalid input detected at '^' marker.

```
VLAN0075
Spanning tree enabled protocol ieee
Root ID Priority 24651
Address 00E0.F777.A591
Cost 9
Port 29(Port-channel3)
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec

Bridge ID Priority 24651 (priority 24576 sys-id-ext 75)
Address 00E0.F777.A591
This bridge is the root
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec

Bridge ID Priority 24651 (priority 24576 sys-id-ext 75)
Address 00E0.F777.A591
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec

Interface Role Sts Cost Prio.Nbr Type
-----+
'01 Desg FWD 9 128.27 Shr
'02 Desg FWD 9 128.28 Shr
'0/2 Desg FWD 19 128.2 P2p
'0/1 Desg FWD 19 128.1 P2p
'0/6 Desg FWD 19 128.6 P2p
'0/3 Desg FWD 19 128.3 P2p
'0/4 Desg FWD 19 128.4 P2p
'0/5 Desg FWD 19 128.5 P2p
'03 Desg FWD 9 128.29 Shr

VLAN0080
Spanning tree enabled protocol ieee
Root ID Priority 24656
Address 00E0.F777.A591
This bridge is the root
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec

Bridge ID Priority 24656 (priority 24576 sys-id-ext 80)
Address 00E0.F777.A591
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec

Bridge ID Priority 24656 (priority 24576 sys-id-ext 80)
Address 00E0.F777.A591
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
```

```
VLAN0070
Spanning tree enabled protocol ieee
Root ID Priority 24646
Address 00E0.F777.A591
Cost 9
Port 29(Port-channel3)
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec

Bridge ID Priority 28742 (priority 28672 sys-id-ext 70)
Address 00E0.5C78.54CE
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
Aging Time 20

Interface Role Sts Cost Prio.Nbr Type
-----+
Fa0/2 Desg FWD 19 128.2 P2p
Fa0/1 Desg FWD 19 128.1 P2p
Fa0/3 Desg FWD 19 128.3 P2p
Po3 Root FWD 9 128.29 Shr
Po1 Desg FWD 9 128.27 Shr
Po2 Desg LSN 9 128.28 Shr
Fa0/5 Desg FWD 19 128.5 P2p
Fa0/6 Desg FWD 19 128.6 P2p
Fa0/4 Desg FWD 19 128.4 P2p

VLAN0075
Spanning tree enabled protocol ieee
Root ID Priority 24651
Address 00E0.F777.A591
Cost 9
Port 29(Port-channel3)
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
```

```
Spanning tree enabled protocol ieee
Root ID Priority 24651
Address 00E0.F777.A591
Cost 9
Port 29(Port-channel3)
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec

Bridge ID Priority 28747 (priority 28672 sys-id-ext 75)
Address 00E0.5C78.54CE
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
Aging Time 20

Interface Role Sts Cost Prio.Nbr Type
-----+
Fa0/2 Desg FWD 19 128.2 P2p
Fa0/1 Desg FWD 19 128.1 P2p
Fa0/3 Desg FWD 19 128.3 P2p
Po3 Root FWD 9 128.29 Shr
Po1 Desg FWD 9 128.27 Shr
Po2 Desg LSN 9 128.28 Shr
Fa0/5 Desg FWD 19 128.5 P2p
Fa0/6 Desg FWD 19 128.6 P2p
Fa0/4 Desg FWD 19 128.4 P2p

VLAN0080
Spanning tree enabled protocol ieee
Root ID Priority 24656
Address 00E0.F777.A591
Cost 9
Port 29(Port-channel3)
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec

Bridge ID Priority 28752 (priority 28672 sys-id-ext 80)
Address 00E0.F777.A591
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
--More-- |
```

- Then we configured the ports of the access layer switches, each port with the appropriate VLAN access, and for those ports (which are not participate on SPT operations) we enabled the BPDU guard.

Command we used:

- int range <range of interfaces>
 - switchport access vlan <VLAN ID>
 - switchport voice vlan <VLAN ID>
 - spanning-tree bpduguard enable

Step 4: Hot Standby Router Protocol (HSRP):

- First, we enabled routing functionality on the Layer 3 switch using “ip routing” command inside the configuration mode of the MS.
 - We created an interface for each VLAN and assigned to it IP address from the local subnet of the VLAN.
 - Under the VLAN interface configuration we implemented the HSRP configuration
For the MS5 we gave it higher priority 150 and we left the MS6 with the default priority.

```

HS5(config)#int vlan 70
HS5(config-if)#
!LINK-5-CHANGED: Interface Vlan70, changed state to up

!LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan70, changed state to up

HS5(config-if)#ip add 192.168.70.2 255.255.255.0
HS5(config-if)#standby 70 ip 192.168.70.1
HS5(config-if)#
! Incomplete command.
HS5(config-if)#standby 70 priority 150
HS5(config-if)#standby 70 preempt
HS5(config-if)#exit
HS5(config)#
!HSRP-6-STATECHANGE: Vlan70 Grp 70 state Speak -> Standby

!HSRP-6-STATECHANGE: Vlan70 Grp 70 state Standby -> Active

HS5(config)#int vlan 75
HS5(config-if)#
!LINK-5-CHANGED: Interface Vlan75, changed state to up

!LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan75, changed state to up

HS5(config-if)#ip add 192.168.75.2 255.255.255.0
HS5(config-if)#standby 75 ip 192.168.75.1
HS5(config-if)#
! Incomplete command.
HS5(config-if)#standby 75 priority 150
HS5(config-if)#standby 75 preempt
HS5(config-if)#exit
HS5(config)#
!HSRP-6-STATECHANGE: Vlan75 Grp 75 state Speak -> Standby

!HSRP-6-STATECHANGE: Vlan75 Grp 75 state Standby -> Active

HS5(config)#

```

```

HS6(config)#int vlan 75
HS6(config-if)#
!LINK-5-CHANGED: Interface Vlan75, changed state to up

!LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan75, changed state to up

HS6(config-if)#ip add 192.168.75.2 255.255.255.0
HS6(config-if)#standby 75 ip 192.168.75.1
HS6(config-if)#
! Incomplete command.
HS6(config-if)#standby 75 priority 150
HS6(config-if)#standby 75 preempt
HS6(config-if)#exit
HS6(config)#
!HSRP-6-STATECHANGE: Vlan75 Grp 75 state Speak -> Standby

!HSRP-6-STATECHANGE: Vlan75 Grp 75 state Standby -> Active

HS6(config)#int vlan 80
HS6(config-if)#
!LINK-5-CHANGED: Interface Vlan80, changed state to up

!LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan80, changed state to up

HS6(config-if)#ip add 192.168.80.2 255.255.255.0
HS6(config-if)#standby 80 ip 192.168.80.1
HS6(config-if)#
! Incomplete command.
HS6(config-if)#standby 80 priority 150
HS6(config-if)#standby 80 preempt
HS6(config-if)#exit
HS6(config)#
!HSRP-6-STATECHANGE: Vlan80 Grp 80 state Speak -> Standby

!HSRP-6-STATECHANGE: Vlan80 Grp 80 state Standby -> Active

HS6(config)#

```

- To check the configuration, we used “show stand bri” command.

```

HS6(config-if)#ip add 192.168.75.2 255.255.255.0
HS6(config-if)#standby 75 ip 192.168.75.1
HS6(config-if)#
! Incomplete command.
HS6(config-if)#
!HSRP-6-STATECHANGE: Vlan75 Grp 75 state Speak -> Standby
!HSRP-6-STATECHANGE: Vlan75 Grp 75 state Standby -> Active

HS6(config)#int vlan 80
HS6(config-if)#
!LINK-5-CHANGED: Interface Vlan80, changed state to up

!LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan80, changed state to up

HS6(config-if)#ip add 192.168.80.2 255.255.255.0
HS6(config-if)#standby 80 ip 192.168.80.1
HS6(config-if)#
! Incomplete command.
HS6(config-if)#standby 80 priority 150
HS6(config-if)#standby 80 preempt
HS6(config-if)#exit
HS6(config)#
!HSRP-6-STATECHANGE: Vlan80 Grp 80 state Speak -> Standby
!HSRP-6-STATECHANGE: Vlan80 Grp 80 state Standby -> Active

HS6(config)#
!do show stand bri
    P indicates configured to preempt.
    !
Interface  Grp  Pri  P State      Active      Standby      Virtual IP
V170       70   150  P Active    local        192.168.70.3  192.168.70.1
V175       75   150  P Active    local        192.168.75.3  192.168.75.1
V180       80   150  P Active    local        192.168.80.3  192.168.80.1

```

```

HS6(config)#int vlan 75
HS6(config-if)#
!LINK-5-CHANGED: Interface Vlan75, changed state to up

!LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan75, changed state to up

HS6(config-if)#ip add 192.168.75.3 255.255.255.0
HS6(config-if)#standby 75 ip 192.168.75.1
HS6(config-if)#
! Incomplete command.
HS6(config-if)#
!HSRP-6-STATECHANGE: Vlan75 Grp 75 state Speak -> Standby

HS6(config)#int vlan 80
HS6(config-if)#
!LINK-5-CHANGED: Interface Vlan80, changed state to up

!LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan80, changed state to up

HS6(config-if)#ip add 192.168.80.3 255.255.255.0
HS6(config-if)#standby 80 ip 192.168.80.1
HS6(config-if)#
! Incomplete command.
HS6(config-if)#
!HSRP-6-STATECHANGE: Vlan80 Grp 80 state Speak -> Standby

HS6(config)#
HS6(config)#do show stand bri
    P indicates configured to preempt.
    !
Interface  Grp  Pri  P State      Active      Standby      Virtual IP
V170       70   100  Standby    192.168.70.2  local        192.168.70.1
V175       75   100  Standby    192.168.75.2  local        192.168.75.1
V180       80   100  Standby    192.168.80.2  local        192.168.80.1

```

Step 5: Dynamic Host Configuration Protocol (DHCP):

- In the MS5 we created a DHCP pool for each VLAN.

Note: use the appropriate VIP for the default-router in each pool

```
V150      50  150 P Active   local      192.168.50.3  192.168.50.1
V160      60  150 P Active   local      192.168.60.3  192.168.60.1

M53(config)*
M53(config)*
M53(config)*
M53(config)*
M53(config)*

M53(config)#ip dhcp pool VLAN40
M53(dhcp-config)#network 192.168.40.0 255.255.255.0
M53(dhcp-config)#default-router 192.168.40.1
M53(dhcp-config)#dns-server 172.16.0.10
M53(dhcp-config)#exit

M53(config)#ip dhcp pool VLAN45
M53(dhcp-config)#network 192.168.45.0 255.255.255.0
M53(dhcp-config)#default-router 192.168.45.1
M53(dhcp-config)#option 150 ip +DHCPD-4-PING_CONFLICT: DHCP address conflict: server pinged 192.168.45.1.
%DHCPD-4-PING_CONFLICT: DHCP address conflict: server pinged 192.168.45.2.
%DHCPD-4-PING_CONFLICT: DHCP address conflict: server pinged 192.168.45.3.

# Incomplete command.
M53(dhcp-config)#option 150 ip 192.168.45.1
M53(dhcp-config)#exit

M53(config)#ip dhcp pool VLAN50
M53(dhcp-config)#network 192.168.50.0 255.255.255.0
M53(dhcp-config)#default-router 192.168.50.1
M53(dhcp-config)#dns-server 172.16.0.10
M53(dhcp-config)#exit

M53(config)#ip dhcp pool VLAN60
M53(dhcp-config)#network 192.168.60.0 255.255.255.0
M53(dhcp-config)#default-router 192.168.60.1
M53(dhcp-config)#dns-server 172.16.0.10
M53(dhcp-config)#exit
M53(config)*
```

Step 6: Open Shortest Path Protocol (OSPF):

❖ Core Layer and Edge Distribution Configuration

The OSPF (*Open Shortest Path First*) is one of IP route protocols that are used to distribute information about the Internet's IP routing to an Autonomous System. OSPF is a link-state routing protocol that allows the routers to exchange information about their network's topology with their nearest neighbors. This information is then used to determine the end-to-end paths through the system.

The OSPF protocol has a distinctive feature, the routing areas, which is the division of routers within an independent OSPF system into regions so that each region consists of a group of interconnected routers. Zones are intended to facilitate management and to optimize the use of resources available in the network. Rationalizing network resources is very important in large networks, which contain many subnets and links.

Exchange of link state database (LSDB) in large networks may fill the network with packets and consequently reduce its performance, thus resorting to the creation of zones. Routers belonging to the same region share the value of the region identifier.

The first region created in the network bears the number 0 and is called the backbone area. All network areas must be connected to the backbone area by routers called ABRs (Area Boarder Routers) and connected to an external internetwork by ASBR (autonomous system border router). Data that travels from one area to another inevitably passes through the backbone.

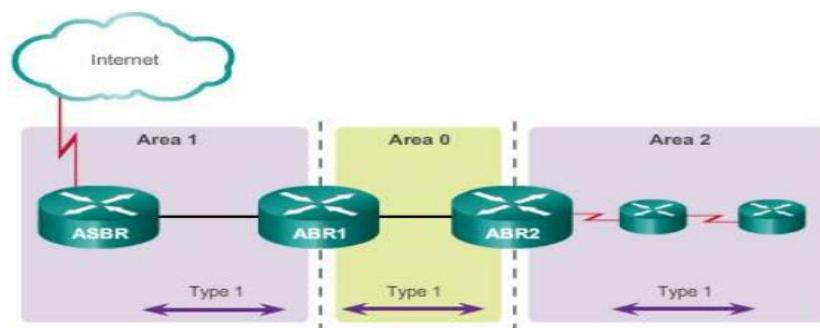


FIGURE 7: Open Shortest Path Protocol (OSPF) Areas.

Configuration:

- We connected the routers of the three blocks using the OSPF protocol, our network is divided into three area, area 0 (block 2), area 1 (block 1) and area 3 (block 3).

Block 1 (area 1)

- First, we configured the interfaces of the routers. Then we did the OSPF configuration.

```
%DHCPPD-4-PING_CONFLICT: DHCP address conflict: server pinged 192.168.15.8.
%DHCPPD-4-PING_CONFLICT: DHCP address conflict: server pinged 192.168.15.6.
%DHCPPD-4-PING_CONFLICT: DHCP address conflict: server pinged 192.168.15.3.
%DHCPPD-4-PING_CONFLICT: DHCP address conflict: server pinged 192.168.15.9.
%DHCPPD-4-PING_CONFLICT: DHCP address conflict: server pinged 192.168.15.6.
%DHCPPD-4-PING_CONFLICT: DHCP address conflict: server pinged 192.168.15.4.

MS1>
MS1>
MS1>%DHCPPD-4-PING_CONFLICT: DHCP address conflict: server pinged 192.168.15.6.
%DHCPPD-4-PING_CONFLICT: DHCP address conflict: server pinged 192.168.15.6.
MS1>en
MS1>conf t
Enter configuration commands, one per line. End with CNTL/Z.
MS1(config)*#DHCPPD-4-PING CONFLICT: DHCP address conflict: server pinged 192.168.15.3.
%DHCPPD-4-PING_CONFLICT: DHCP address conflict: server pinged 192.168.15.3.
%DHCPPD-4-PING_CONFLICT: DHCP address conflict: server pinged 192.168.15.4.
%DHCPPD-4-PING_CONFLICT: DHCP address conflict: server pinged 192.168.15.8.

MS1(config)*#%DHCPPD-4-PING_CONFLICT: DHCP address conflict: server pinged 192.168.15.6.

MS1(config)#no ip dhcp pool VLAN15
MS1(config)#int Fa0/7
MS1(config-if)#no sv
MS1(config-if)#no shut
MS1(config-if)#ip add 10.0.2.1 255.255.255.0
MS1(config-if)#exit
MS1(config)#int Fa0/8
MS1(config-if)#no sv
MS1(config-if)#no shut
MS1(config-if)#ip add 10.0.5.1 255.255.255.0
MS1(config-if)#exit
MS1(config)*#
```

```
Router>en
Router>conf t
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)*#host R1
R1(config)*#int Fa0/0
R1(config-if)#no shut

R1(config-if)*#
%LINK-5-CHANGED: Interface FastEthernet0/0, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
R1(config-if)#ip add 10.0.2.2 255.255.255.0
R1(config-if)#exit
R1(config)*#exit
R1(config)#int Fa0/1
R1(config-if)#no shut

R1(config-if)*#
%LINK-5-CHANGED: Interface FastEthernet0/1, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to up
R1(config-if)#ip add 10.0.3.2 255.255.255.0
R1(config-if)#exit
R1(config)*#exit
R1(config)#int Se0/0
R1(config-if)#no shu
                                         ^
                                         *
% Invalid input detected at '^' marker.

R1(config-if)#no shu

%LINK-5-CHANGED: Interface Serial0/0, changed state to down
R1(config-if)#ip add 10.0.0.2 255.255.255.0
R1(config-if)#exit
R1(config)*#
```

```
%HSRP-6-STATECHANGE: Vlan30 Grp 30 state Standby -> Active
%HSRP-6-STATECHANGE: Vlan30 Grp 30 state Speak -> Standby
%HSRP-6-STATECHANGE: Vlan10 Grp 10 state Speak -> Standby
%HSRP-6-STATECHANGE: Vlan20 Grp 20 state Speak -> Standby
%HSRP-6-STATECHANGE: Vlan15 Grp 15 state Speak -> Standby
%LINK-5-CHANGED: Interface FastEthernet0/7, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/7, changed state to up

MS2>en
MS2>conf t
Enter configuration commands, one per line. End with CNTL/Z.
MS2(config)*#int Fa0/7
MS2(config-if)#no sv
MS2(config-if)*#
%LINK-5-CHANGED: Interface FastEthernet0/7, changed state to down
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/7, changed state to up

MS2(config-if)#no shut
MS2(config-if)#ip add 10.0.3.1 255.255.255.0
MS2(config-if)*#exit
MS2(config-if)#no sv
MS2(config-if)#no shut
MS2(config-if)#ip add 10.0.4.1 255.255.255.0
MS2(config-if)*#exit
MS2(config)*#
```

```
Router>conf t
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)*#host R2
R2(config)*#int Fa0/0
R2(config-if)#no shut

R2(config-if)*#
%LINK-5-CHANGED: Interface FastEthernet0/0, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
R2(config-if)#ip add 10.0.4.2 255.255.255.0
R2(config-if)#exit
R2(config)*#exit
R2(config)#int Fa0/1
R2(config-if)#no shut

R2(config-if)*#
%LINK-5-CHANGED: Interface FastEthernet0/1, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to up
R2(config-if)#ip add 10.0.5.2 255.255.255.0
R2(config-if)#exit
R2(config)*#exit
R2(config)#int Se0/0
R2(config-if)#no shu
                                         ^
                                         *
% Invalid input detected at '^' marker.

R2(config-if)#no shu

%LINK-5-CHANGED: Interface Serial0/0, changed state to down
R2(config-if)#ip add 10.0.1.2 255.255.255.0
R2(config-if)*#exit
R2(config)*#
```

```
louter#en
louterconf t
Enter configuration commands, one per line. End with CNTL/Z.
louter(config)#host AR1
louter(config)#int serial0/0/0
louter(config-if)#no shutdown
louter(config-if)#no shut

lBR1(config-if)#
!LINK-5-CHANGED: Interface Serial0/0/0, changed state to up

!LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/0/0, changed state to up

lBR1(config-if)#ip add 10.0.0.1 255.255.255.0
lBR1(config-if)exit
lBR1(config)#int Se0/0/1
lBR1(config-if)#no shut

lBR1(config-if)#
!LINK-5-CHANGED: Interface Serial0/0/1, changed state to up

!LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/0/1, changed state to up

lBR1(config-if)#ip add 10.0.1.1 255.255.255.0
lBR1(config-if)exit
lBR1(config)#int Se0/1/0
lBR1(config-if)#no shuy
      ^
      ! Invalid input detected at `*' marker.

lBR1(config-if)#no shut

!LINK-5-CHANGED: Interface Serial0/1/0, changed state to down
lBR1(config-if)#ip add 10.0.0.2 255.255.255.192
lBR1(config-if)exit
```

```
R1>
R1#en
R1#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R1(config)#show ip rro
R1(config)#router ospf 1
R1(config-router)#do show ip route con
C 10.0.0.0/24 is directly connected, Serial0/0
C 10.0.2.0/24 is directly connected, FastEthernet0/0
C 10.0.3.0/24 is directly connected, FastEthernet0/1

R1(config-router)#network 10.0.2.0 0.0.0.255 area 1
R1(config-router)#network 10.0.3.0 0.0.0.255 area 1
R1(config-router)#network 10.0.0.0 0.0.0.255 area 1
R1(config-router)#exit
R1(config)#
01:23:28: 40SPF=5-ADJCHG: Process 1, Nbr 20.0.0.2 on Serial0/0 from LOADING to FULL
Loading Done
```

```
LINK-3-UPDOWN: Interface Serial0/0, changed state to down
LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/0, changed state to down
LINK-5-CHANGED: Interface Serial0/0, changed state to up
LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/0, changed state to up

12>
12<en
12<conf t
Enter configuration commands, one per line. End with CNTL/Z.

12(config-router)#router ospf 1
12(config-router)#do show ip route co
C 10.0.1.0/24 is directly connected, Serial0/0
C 10.0.4.0/24 is directly connected, Fastethernet0/0
C 10.0.8.0/24 is directly connected, Fastethernet0/1

12(config-router)#network 10.0.4.0 0.0.0.255 area 1
12(config-router)#network 10.0.5.0 0.0.0.255 area 1
12(config-router)#network 10.0.1.0 0.0.0.255 area 1
12(config-router)#
12<conf t
12<conf rmt
12<conf t
```

```

GS1>
GS1#en
GS1#conf t
Enter configuration commands, one per line. End with CNTL/Z.
GS1(config)#do show ip pro
GS1(config)router ospf 1
GS1(config-router)#do show ip route con
C 10.0.3.0/24 is directly connected, FastEthernet0/7
C 10.0.5.0/24 is directly connected, FastEthernet0/8
C 192.168.10.0/24 is directly connected, Vlan10
C 192.168.15.0/24 is directly connected, Vlan15
C 192.168.20.0/24 is directly connected, Vlan20
C 192.168.30.0/24 is directly connected, Vlan30
GS1(config-router)#network 192.168.10.0 0.0.0.255 area 1
GS1(config-router)#network 192.168.15.0 0.0.0.255 area 1
GS1(config-router)#network 192.168.20.0 0.0.0.255 area 1
GS1(config-router)#network 192.168.30.0 0.0.0.255 area 1
GS1(config-router)#network 10.0.2.0 0.0.0.255 area 1
GS1(config-router)#network 10.0.2.0 0.0.0.255 area 1
11:28:56: *OSPF-5-ADJCHG: Process 1, Nbr 10.0.3.2 on FastEthernet0/7 from LOADING to
FULL, Loading Done

GS1(config-router)#network 10.0.5.0 0.0.0.255 area 1
GS1(config-router)#exit
GS1(config)#
11:29:21: *OSPF-5-ADJCHG: Process 1, Nbr 10.0.5.2 on FastEthernet0/8 from LOADING to
FULL, Loading Done

```

```

GS2>en
GS2#conf t
Enter configuration commands, one per line. End with CNTL/Z.
GS2(config)#do show ip pro
GS2(config)router ospf 1
GS2(config-router)#do show ip route con
C 10.0.3.0/24 is directly connected, FastEthernet0/7
C 10.0.4.0/24 is directly connected, FastEthernet0/8
C 192.168.10.0/24 is directly connected, Vlan10
C 192.168.15.0/24 is directly connected, Vlan15
C 192.168.20.0/24 is directly connected, Vlan20
C 192.168.30.0/24 is directly connected, Vlan30
GS2(config-router)#network 10.0.3.0 0.0.0.255 area 1
GS2(config-router)#network 10.0.4.0 0.0.0.255 area 1
GS2(config-router)#
11:30:43: *OSPF-5-ADJCHG: Process 1, Nbr 10.0.3.2 on FastEthernet0/7 from LOADING to
FULL, Loading Done

GS2(config-router)#network 192.178.10.0 0.0.0.255 area 1
GS2(config-router)#network 192.178.15.0 0.0.0.255 area 1
GS2(config-router)#no network 192.178.15.0 0.0.0.255 area 1
GS2(config-router)#no network 192.178.10.0 0.0.0.255 area 1
GS2(config-router)#network 192.168.10.0 0.0.0.255 area 1
GS2(config-router)#network 192.168.15.0 0.0.0.255 area 1
GS2(config-router)#
11:31:48: *OSPF-5-ADJCHG: Process 1, Nbr 192.168.30.2 on Vlan10 from LOADING to FULL,
Loading Done

11:31:55: *OSPF-5-ADJCHG: Process 1, Nbr 192.168.30.2 on Vlan15 from LOADING to FULL,
Loading Done

```

```

C 192.168.30.0/24 is directly connected, Vlan30
GS2(config-router)#network 10.0.3.0 0.0.0.255 area 1
GS2(config-router)#network 10.0.4.0 0.0.0.255 area 1
GS2(config-router)#
11:30:43: *OSPF-5-ADJCHG: Process 1, Nbr 10.0.3.2 on FastEthernet0/7 from LOADING to
FULL, Loading Done

11:30:48: *OSPF-5-ADJCHG: Process 1, Nbr 10.0.5.2 on FastEthernet0/8 from LOADING to
FULL, Loading Done

GS2(config-router)#network 192.178.10.0 0.0.0.255 area 1
GS2(config-router)#network 192.178.15.0 0.0.0.255 area 1
GS2(config-router)#no network 192.178.15.0 0.0.0.255 area 1
GS2(config-router)#no network 192.178.10.0 0.0.0.255 area 1
GS2(config-router)#network 192.168.10.0 0.0.0.255 area 1
GS2(config-router)#network 192.168.15.0 0.0.0.255 area 1
GS2(config-router)#
11:31:48: *OSPF-5-ADJCHG: Process 1, Nbr 192.168.30.2 on Vlan10 from LOADING to FULL,
Loading Done

11:31:55: *OSPF-5-ADJCHG: Process 1, Nbr 192.168.30.2 on Vlan15 from LOADING to FULL,
Loading Done

GS2(config-router)#network 192.168.20.0 0.0.0.255 area 1
GS2(config-router)#network 192.168.30.0 0.0.0.255 area 1
GS2(config-router)#
11:32:13: *OSPF-5-ADJCHG: Process 1, Nbr 192.168.30.2 on Vlan20 from LOADING to FULL,
Loading Done

GS2(config-router)#network 192.168.30.0 0.0.0.255 area 1
11:32:18: *OSPF-5-ADJCHG: Process 1, Nbr 192.168.30.2 on Vlan30 from LOADING to FULL,
Loading Done

```

Block 2 (area 0)

- First, we configured the interfaces of the routers. Then we did the OSPF configuration.

```

Press RETURN to get started!

*LINK-5-CHANGED: Interface FastEthernet0/2, changed state to up
*LINKPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/2, changed state to up
*LINK-5-CHANGED: Interface FastEthernet0/0, changed state to up
*LINKPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/3, changed state to up
*LINK-5-CHANGED: Interface FastEthernet0/8, changed state to up
*LINKPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/8, changed state to up
*LINK-5-CHANGED: Interface FastEthernet0/1, changed state to up
*LINKPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to up

Switch>
Switch#en
Switch#conf t

Switch(config)#int range Fa0/2-3
Switch(config-if-range)#sv access vlan 7
% Access VLAN does not exist. Creating vlan 7
Switch(config-if-range)#exit
Switch(config)#int Fa0/8
Switch(config-if)#sv access vlan 99
% Access VLAN does not exist. Creating vlan 99
Switch(config-if)#exit
Switch(config)#

```

```

Router>en
Router#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#host ASBR
ASBR(config)#int Se0/0
ASBR(config-if)#no shut

*LINK-5-CHANGED: Interface Serial0/0, changed state to down
ASBR(config-if)#ip add 10.0.10.1 255.255.255.0
ASBR(config-if)#exit
ASBR(config)#int Se0/1
ASBR(config-if)#no shut

*LINK-5-CHANGED: Interface Serial0/1, changed state to down
ASBR(config-if)#ip add 10.0.11.1 255.255.255.0
ASBR(config-if)#exit
ASBR(config)#int Se1/0
ASBR(config-if)#no shut

ASBR(config-if)#
*LINK-5-CHANGED: Interface Serial1/0, changed state to up
ASBR(config-if)#
*LINKPROTO-5-UPDOWN: Line protocol on Interface Serial1/0, changed state to up

ASBR(config-if)#ip add 20.0.0.1 255.255.255.192
ASBR(config-if)#exit
ASBR(config)#int Se1/1
ASBR(config-if)#no shut

*LINK-5-CHANGED: Interface Serial1/1, changed state to down
ASBR(config-if)#ip add 20.0.0.65 255.255.255.192
ASBR(config-if)#exit
ASBR(config)#int Se1/2

```

```

ASBR(config)#int Se1/2
ASBR(config-if)#no shut

*LINK-5-CHANGED: Interface Serial1/2, changed state to down
ASBR(config-if)#ip add 200.168.10.2 255.255.255.240
ASBR(config-if)#exit
ASBR(config)#int Fa0/0
ASBR(config-if)#no shut

ASBR(config-if)#
*LINK-5-CHANGED: Interface FastEthernet0/0, changed state to up
*LINKPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
ASBR(config-if)#int Fa0/0.7
ASBR(config-subif)#
*LINK-5-CHANGED: Interface FastEthernet0/0.7, changed state to up
*LINKPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0.7, changed state to up
ASBR(config-subif)#encapsulation dot1q vlan 7
% Invalid input detected at `''' marker.

ASBR(config-subif)#encapsulation dot1q 7
ASBR(config-subif)#ip add 172.16.0.1 255.255.255.0
ASBR(config-subif)#exit
ASBR(config)#int Fa0/0.99
ASBR(config-subif)#
*LINK-5-CHANGED: Interface FastEthernet0/0.99, changed state to up
*LINKPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0.99, changed state to up
ASBR(config-subif)#ip add 192.168.99.1 255.255.255.0

```

```

R3#en
Router#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#host R3
R3(config)#int Fa0/0
R3(config-if)#no shut

R3(config-if)#
*LINK-5-CHANGED: Interface FastEthernet0/0, changed state to up
*LINKPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up

R3(config-if)#ip add 10.0.12.2 255.255.255.0
R3(config-if)#exit
R3(config)#int Fa0/1
R3(config-if)#no shut

R3(config-if)#
*LINK-5-CHANGED: Interface FastEthernet0/1, changed state to up
*LINKPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to up

R3(config-if)#ip add 10.0.13.2 255.255.255.0
R3(config-if)#exit
R3(config)#int Se0/0
R3(config-if)#no shut

R3(config-if)#
*LINK-5-CHANGED: Interface Serial0/0, changed state to up
R3(config-if)#
*LINKPROTO-5-UPDOWN: Line protocol on Interface Serial0/0, changed state to up

R3(config-if)#ip add 10.0.10.2 255.255.255.0

```

```
!username:config#show ip  
14(config)int Fa0/0  
14(config-if)#no shut  
  
14(config-if)#  
!LINK-5-CHANGED: Interface FastEthernet0/0, changed state to up  
  
!LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up  
  
14(config-if)#ip add 10.0.14.2 255.255.255.0  
14(config-if)#exit  
14(config)int Fa0/1  
14(config-if)#no shut  
  
14(config-if)#  
!LINK-5-CHANGED: Interface FastEthernet0/1, changed state to up  
  
!LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to up  
  
14(config-if)#ip add 10.0.15.2 255.255.255.0  
14(config-if)#exit  
14(config)int Se0/0  
14(config-if)#no shuy  
  
! Invalid input detected at '--' marker.  
  
14(config-if)#no shut  
  
14(config-if)#  
!LINK-5-CHANGED: Interface Serial0/0, changed state to up  
  
!LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/0, changed state to up  
  
14(config-if)#ip add 10.0.11.2 255.255.255.0
```

```
*LINK-5-CHANGED: Interface FastEthernet0/7, changed state to up
*LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/7, changed state to up
*LINK-5-CHANGED: Interface FastEthernet0/8, changed state to up
*LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/8, changed state to up

HS3>
HS3>en
HS3#conf t
Enter configuration commands, one per line. End with CNTL/Z.
HS3(config)#int Fa0/7
HS3(config-if)#no sv
HS3(config-if)#
*LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/7, changed state to down
*LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/7, changed stat to up

HS3(config-if)#no shut
HS3(config-if)#int fa0/7
HS3(config-if)#
HS3#show ip int brief
FastEthernet0/0: 10.0.0.1 SEE SEE SEE SEE
FastEthernet0/1: 10.0.0.2 SEE SEE SEE SEE
FastEthernet0/2: 10.0.0.3 SEE SEE SEE SEE
FastEthernet0/3: 10.0.0.4 SEE SEE SEE SEE
FastEthernet0/4: 10.0.0.5 SEE SEE SEE SEE
FastEthernet0/5: 10.0.0.6 SEE SEE SEE SEE
FastEthernet0/6: 10.0.0.7 SEE SEE SEE SEE
FastEthernet0/7: 10.0.0.8 SEE SEE SEE SEE
FastEthernet0/8: 10.0.0.9 SEE SEE SEE SEE
FastEthernet0/9: 10.0.0.10 SEE SEE SEE SEE
FastEthernet0/10: 10.0.0.11 SEE SEE SEE SEE
FastEthernet0/11: 10.0.0.12 SEE SEE SEE SEE
FastEthernet0/12: 10.0.0.13 SEE SEE SEE SEE
FastEthernet0/13: 10.0.0.14 SEE SEE SEE SEE
FastEthernet0/14: 10.0.0.15 SEE SEE SEE SEE
FastEthernet0/15: 10.0.0.16 SEE SEE SEE SEE
FastEthernet0/16: 10.0.0.17 SEE SEE SEE SEE
FastEthernet0/17: 10.0.0.18 SEE SEE SEE SEE
FastEthernet0/18: 10.0.0.19 SEE SEE SEE SEE
FastEthernet0/19: 10.0.0.20 SEE SEE SEE SEE
FastEthernet0/20: 10.0.0.21 SEE SEE SEE SEE
FastEthernet0/21: 10.0.0.22 SEE SEE SEE SEE
FastEthernet0/22: 10.0.0.23 SEE SEE SEE SEE
FastEthernet0/23: 10.0.0.24 SEE SEE SEE SEE
FastEthernet0/24: 10.0.0.25 SEE SEE SEE SEE
FastEthernet0/25: 10.0.0.26 SEE SEE SEE SEE
FastEthernet0/26: 10.0.0.27 SEE SEE SEE SEE
FastEthernet0/27: 10.0.0.28 SEE SEE SEE SEE
FastEthernet0/28: 10.0.0.29 SEE SEE SEE SEE
FastEthernet0/29: 10.0.0.30 SEE SEE SEE SEE
FastEthernet0/30: 10.0.0.31 SEE SEE SEE SEE
FastEthernet0/31: 10.0.0.32 SEE SEE SEE SEE
```

```

***** Inter configuration commands, one per line. End with CNTL/Z.
LSR# do show ip pr
LSR#router ospf 1
LSR#do show ip route connected
C 10.0.10.0/24 is directly connected, Serial0/0
C 10.0.11.0/24 is directly connected, Serial0/1
C 20.0.0.0/24 is directly connected, Serial1/0
C 172.16.0.0/24 is directly connected, FastEthernet0/0.7
C 192.168.99.0/24 is directly connected, FastEthernet0/0.99

LSR#LINK-5-CHANGED: Interface Serial1/1, changed state to up

LINEPROTO-5-UPDOWN: Line protocol on Interface Serial1/1, changed state to up

LSR#do show ip route connected
C 10.0.10.0/24 is directly connected, Serial0/0
C 10.0.11.0/24 is directly connected, Serial0/1
C 20.0.0.0/24 is directly connected, Serial1/0
C 172.16.0.0/24 is directly connected, Serial1/1
C 192.168.99.0/24 is directly connected, FastEthernet0/0.7
C 192.168.99.0/24 is directly connected, FastEthernet0/0.99

LSR#network 10.0.10.0 0.0.0.255 area 0
LSR#network 10.0.11.0 0.0.0.255 area 0
LSR#network 172.16.0.0 0.0.0.255 area 0
LSR#network 192.168.99.0 0.0.0.255 area 0
LSR#network 20.0.0.64 0.0.0.63 area 0
LSR#network 20.0.0.0 0.0.0.63 area 0
LSR#exit
LSR#config#
2:02:26: %OSPF-5-ADJCHG: Process 1, Nbr 20.0.0.2 on Serial0/0 from LOADING to FULL,
Loading Done

```

```

ress RETURN to get started.

3>
3>en
3>conf t
***** Inter configuration commands, one per line. End with CNTL/Z.
3>do show ip pr
3>router ospf 1
3>do show ip route con
C 10.0.10.0/24 is directly connected, Serial0/0/0
C 10.0.12.0/24 is directly connected, FastEthernet0/0
C 10.0.13.0/24 is directly connected, FastEthernet0/1

3>network 10.0.12.0 0.0.0.255 area 0
3>network 10.0.13.0 0.0.0.255 area 0
3>network 10.0.10.0 0.0.0.255 area 0
3>exit
3>config#
3>config#
0:58:51: %OSPF-5-ADJCHG: Process 1, Nbr 200.168.10.2 on Serial0/0/0 from LOADING to
FULL, Loading Done

```

```

24>en
24>conf t
***** Inter configuration commands, one per line. End with CNTL/Z.
24(config)#do show ip por
show ip por
^
* Invalid input detected at `--` marker.

24(config)#do show ip prp
show ip prp
^
* Invalid input detected at `--` marker.

24(config)#do show ip pro
24(config)#router ospf 1
24(config-router)#do show ip route con
C 10.0.11.0/24 is directly connected, Serial0/0
C 10.0.14.0/24 is directly connected, FastEthernet0/0
C 10.0.15.0/24 is directly connected, FastEthernet0/1

24(config-router)#network 10.0.14.0 0.0.0.255 area 0
24(config-router)#network 10.0.15.0 0.0.0.255 area 0
24(config-router)#network 10.0.11.0 0.0.0.255 area 0
24(config-router)#exit
24(config)#
32:07:44: %OSPF-5-ADJCHG: Process 1, Nbr 200.168.10.2 on Serial0/0 from LOADING to FULL,
Loading Done

```

```

***** Inter configuration commands, one per line. End with CNTL/Z.
MS4#do show ip pr
MS4#router ospf 1
MS4#do show ip route fcon
Translating "fcon"...domain server (255.255.255.255)
* Invalid input detected

MS4#do show ip route con
C 10.0.13.0/24 is directly connected, FastEthernet0/7
C 192.168.45.0/24 is directly connected, FastEthernet0/8
C 192.168.50.0/24 is directly connected, Vlan45
C 192.168.60.0/24 is directly connected, Vlan60

MS4#network 10.0.13.0 0.0.0.255 area 0
MS4#config#
02:15:05: %OSPF-5-ADJCHG: Process 1, Nbr 10.0.13.2 on FastEthernet0/7 from LOADING to
FULL, Loading Done

MS4#network 10.0.14.0 0.0.0.255 area 0
MS4#config#
02:15:19: %OSPF-5-ADJCHG: Process 1, Nbr 10.0.15.2 on FastEthernet0/8 from LOADING to
FULL, Loading Done

MS4#network 192.168.40.0 0.0.0.255 area 0
MS4#network 192.168.45.0 0.0.0.255 area 0
MS4#config#
02:15:23: %OSPF-5-ADJCHG: Process 1, Nbr 192.168.45.2 on Vlan45 from LOADING to FULL,
Loading Done
02:15:59: %OSPF-5-ADJCHG: Process 1, Nbr 192.168.60.2 on Vlan45 from LOADING to FULL,
Loading Done

```

```

C 192.168.50.0/24 is directly connected, Vlan50
C 192.168.60.0/24 is directly connected, Vlan60

MS4(config-router)#network 10.0.13.0 0.0.0.255 area 0
MS4(config-router)#
02:15:05: *OSPF-5-ADJCHG: Process 1, Nbr 10.0.13.2 on FastEthernet0/7 from LOADING to
FULL, Loading Done

MS4(config-router)#network 10.0.14.0 0.0.0.255 area 0
MS4(config-router)#
02:15:19: *OSPF-5-ADJCHG: Process 1, Nbr 10.0.15.2 on FastEthernet0/8 from LOADING to
FULL, Loading Done

MS4(config-router)#network 192.168.40.0 0.0.0.255 area 0
MS4(config-router)#network 192.168.45.0 0.0.0.255 area 0
MS4(config-router)#
02:15:53: *OSPF-5-ADJCHG: Process 1, Nbr 192.168.60.2 on Vlan40 from LOADING to FULL,
Loading Done

02:15:59: *OSPF-5-ADJCHG: Process 1, Nbr 192.168.60.2 on Vlan45 from LOADING to FULL,
Loading Done

MS4(config-router)#network 192.168.50.0 0.0.0.255 area 0
MS4(config-router)#network 192.168.60.0 0.0.0.255 area 0
MS4(config-router)#
MS4(config)#
Loading Done

02:16:26: *OSPF-5-ADJCHG: Process 1, Nbr 192.168.60.2 on Vlan60 from LOADING to FULL,
Loading Done

MS4(config)#
MS4(config)#

```

```

S3>conf t
Enter configuration commands, one per line. End with CNTL/Z.
S3(config)#do show ip pro
S3(config)#show ospf 1
S3(config)#show ip route con
C 10.0.12.0/24 is directly connected, FastEthernet0/7
C 10.0.15.0/24 is directly connected, FastEthernet0/8
C 192.168.40.0/24 is directly connected, Vlan40
C 192.168.45.0/24 is directly connected, Vlan45
C 192.168.50.0/24 is directly connected, Vlan50
C 192.168.60.0/24 is directly connected, Vlan60

S3(config-route)#
S3(config-route)#network 192.168.40.0 0.0.0.255 area 0
S3(config-route)#network 192.168.45.0 0.0.0.255 area 0
S3(config-route)#network 192.168.50.0 0.0.0.255 area 0
S3(config-route)#network 192.168.60.0 0.0.0.255 area 0
S3(config-route)#
S3(config-route)#network 10.0.12.0 0.0.0.255 area 0
S3(config-route)#
S3(config-route)#exit
S3(config)#
S3(config)#
Q13:46: #OSPF-5-ADJCHG: Process 1, Nbr 10.0.15.2 on FastEthernet0/8 from LOADING to
ULL, Leaking Data

I13:47: #OSPF-5-ADJCHG: Process 1, Nbr 10.0.13.2 on FastEthernet0/7 from LOADING to
ULL, Leaking Data

```

Block 3 (area 2)

- First, we configured the interfaces of the routers. Then we did the OSPF configuration.

```
Press RETURN to get started.

UBR2>
UBR2>en
UBR2>conf t
Enter configuration commands, one per line.  End with CNTL/Z.
UBR2(config)#int Se0/0
UBR2(config-if)#no shut

UBR2(config-if)#ip add 10.0.20.1 255.255.255.0
UBR2(config-if)#exit
UBR2(config)#int Se0/1
UBR2(config-if)#no shut

UBR2#LINK-5-CHANGED: Interface Serial0/1, changed state to down
UBR2(config-if)#ip add 10.0.21.1 255.255.255.0
UBR2(config-if)#exit
```

```
--- System Configuration Dialog ---\n\nWould you like to enter the initial configuration dialog? [yes/no]: no\n\nPress RETURN to get started!\n\n\nRouter#en\nRouter#conf t\n\nInter configuration commands, one per line. End with CNTL/Z.\nRouter(config)#int S0/0\nRouter(config)#no shutdown\n\nRouter(config-if)#\n\nLINK-5-CHANGED: Interface Serial1/0, changed state to up\n\n4:NETPROT0-5-UPDOWN: Line protocol on Interface Serial1/0, changed state to up\n\nRouter(config-if)#ip address 20.0.0.66 255.255.255.192\nRouter(config-if)#exit\nRouter(config)#
```

```

Router#en
Routerconf t
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#int S0/0/0
S5(config-if)#no shut

S5(config-if)#
:LINK-5-CHANGED: Interface Serial0/0/0, changed state to up

:LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/0/0, changed state to up
S5(config-if)#ip add 10.0.20.2 255.255.255.0
S5(config-if)#exit
S5(config)#int Fa0/0
S5(config-if)no shut

S5(config-if)#
:LINK-5-CHANGED: Interface FastEthernet0/0, changed state to up

:LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
S5(config-if)#ip add 10.0.22.2 255.255.255.0
S5(config-if)#exit
S5(config)#int Fa0/1
S5(config-if)no shut

S5(config-if)#
:LINK-5-CHANGED: Interface FastEthernet0/1, changed state to up

:LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to up
S5(config-if)#ip add 10.0.23.2 255.255.255.0
S5(config-if)#exit
S5(config)#

```

```

Router#en
Routerconf t
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#int S0/0
S6(config-if)no shut

S6(config-if)#
:LINK-5-CHANGED: Interface Serial0/0, changed state to up

:LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/0, changed state to up
S6(config-if)#ip add 10.0.21.2 255.255.255.0
S6(config-if)#exit
S6(config)#int Fa0/0
S6(config-if)no shut

S6(config-if)#
:LINK-5-CHANGED: Interface FastEthernet0/0, changed state to up

:LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
S6(config-if)#ip add 10.0.24.2 255.255.255.0
S6(config-if)#exit
S6(config)#int Fa0/1
S6(config-if)no shut

S6(config-if)#
:LINK-5-CHANGED: Interface FastEthernet0/1, changed state to up

:LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to up
S6(config-if)#ip add 10.0.25.2 255.255.255.0
S6(config-if)#exit
S6(config)#

```

```

DHCPCD-4-PING_CONFLICT: DHCP address conflict: server pinged 192.168.70.2.

:LINK-5-CHANGED: Interface FastEthernet0/7, changed state to up

:LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/7, changed state to up
:LINK-5-CHANGED: Interface FastEthernet0/8, changed state to up

:LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/8, changed state to up

SS5>
SS5>en
SS5conf t
Enter configuration commands, one per line. End with CNTL/Z.
SS5(config)#int Fa0/7
SS5(config-if)no sv
SS5(config-if)#
:LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/7, changed state to down

:LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/7, changed state to up
SS5(config-if)#ip add 10.0.22.1 255.255.255.0
SS5(config-if)#exit
SS5(config)#int Fa0/8
SS5(config-if)no sv
SS5(config-if)#
:LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/8, changed state to down

:LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/8, changed state to up
SS5(config-if)#ip add 10.0.25.1 255.255.255.0
SS5(config-if)#exit
SS5(config)#

```

```

-----+
Translating "efn"...domain server (255.255.255.255)
+ Unknown command or computer name, or unable to find computer address

S5#en
S5#conf t
Enter configuration commands, one per line. End with CNTL/Z.
S5(config)#int Fa0/8
S5(config-if)no shut
S5(config-if)no sw
S5(config-if)#
:LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/8, changed state to down

:LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/8, changed state to up
:LINK-5-UPDOWN: Interface FastEthernet0/8, changed state to down

:LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/8, changed state to down
:LINK-5-CHANGED: Interface FastEthernet0/8, changed state to up

:LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/8, changed state to up
S5(config-if)#ip add 10.0.24.1 255.255.255.0
S5(config-if)#exit
S5(config)#int Fa0/7
S5(config-if)no sv
S5(config-if)#
:LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/7, changed state to down

:LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/7, changed state to up
S5(config-if)#ip add 10.0.23.1 255.255.255.0
S5(config-if)#exit
S5(config)#

```

```

Press RETURN to get started.

AB92>en
AB92#conf t
Enter configuration commands, one per line. End with CNTL/Z.
AB92(config)#do show ip pro
AB92(config)#router ospf 1
AB92(config-router)#do show ip route con
C 10.0.20.0/24 is directly connected, Serial0/0
C 10.0.21.0/24 is directly connected, Serial0/1
C 10.0.64.2/24 is directly connected, Serial1/0

AB92(config-router)#network 20.0.0.64 0.0.0.63 area 0
02:28:55: %OSPF-5-ADJCHG: Process 1, Nbr 200.165.10.2 on Serial1/0 from LOADING to FULL,
AB92(config-router)#network 10.0.20.0 0.0.0.255 area 2
AB92(config-router)#network 10.0.21.0 0.0.0.255 area 2
AB92(config-router)#exit
*mon...*-->

```

```

Press RETURN to get started.

AB>en
AB#conf t
Enter configuration commands, one per line. End with CNTL/Z.
AB(config)#do show ip pro
AB(config)#router ospf 1
AB(config)#do show ip route con
C 10.0.20.0/24 is directly connected, Serial0/0
C 10.0.22.0/24 is directly connected, FastEthernet0/0
C 10.0.23.0/24 is directly connected, FastEthernet0/1
C 10.0.23.0/24 is directly connected, FastEthernet0/2

AB(config-router)#network 10.0.22.0 0.0.0.255 area 2
AB(config-router)#network 10.0.23.0 0.0.0.255 area 2
AB(config-router)#exit
*mon...*-->

```

```

*mon...*-->
6<config-if>
LINK-5-CHANGED: Interface FastEthernet0/1, changed state to up
LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to up
6<config-if>#ip add 10.0.25.2 255.255.255.0
6<config-if>#exit
6<config>
LINKPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to down
LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
6<config>
6<config>
6<config>
6<config>
6<config>
6<config>
6<config>#do show ip pr
6<config>#router ospf 1
6<config-router>#do show ip route con
C 10.0.21.0/24 is directly connected, Serial0/0
C 10.0.24.0/24 is directly connected, FastEthernet0/0
C 10.0.25.0/24 is directly connected, FastEthernet0/1

6<config-router>#network 10.0.24.0 0.0.0.255 area 2
6<config-router>#network 10.0.25.0 0.0.0.255 area 2
6<config-router>#network 10.0.21.0 0.0.0.255 area 2
6<config-router>#exit
2:32:52: %OSPF-5-ADJCHG: Process 1, Nbr 20.0.0.66 on Serial0/0 from LOADING to FULL,
loading Done

```

```

*mon...*-->
6<config>
6<config>
6<config>
6<config>
6<config>
6<config>
6<config>
6<config>#do show ip pr
6<config>#router ospf 1
6<config-router>#do show ip route con
C 10.0.22.0/24 is directly connected, FastEthernet0/0
C 10.0.25.0/24 is directly connected, FastEthernet0/1
C 192.168.70.0/24 is directly connected, Vlan70
C 192.168.75.0/24 is directly connected, Vlan75
C 192.168.80.0/24 is directly connected, Vlan80

6<config-router>#network 192.168.70.0 0.0.0.255 area 2
6<config-router>#network 192.168.75.0 0.0.0.255 area 2
6<config-router>#network 192.168.80.0 0.0.0.255 area 2
6<config-router>#network 10.0.22.0 0.0.0.255 area 2
6<config-router>#network 10.0.25.0 0.0.0.255 area 2
6<config-router>#exit
2:40:20: %OSPF-5-ADJCHG: Process 1, Nbr 10.0.23.2 on FastEthernet0/7 from LOADING to
FULL, Loading Done
2:40:30: %OSPF-5-ADJCHG: Process 1, Nbr 10.0.25.2 on FastEthernet0/8 from LOADING to
FULL, Loading Done
6<config>

```

```

*mon...*-->
6<config>#router ospf 1
6<config-router>#do show ip route con
C 10.0.23.0/24 is directly connected, FastEthernet0/7
C 10.0.24.0/24 is directly connected, FastEthernet0/8
C 192.168.70.0/24 is directly connected, Vlan70
C 192.168.75.0/24 is directly connected, Vlan75
C 192.168.80.0/24 is directly connected, Vlan80

6<config-router>#network 10.0.23.0 0.0.0.255 area 0
6<config-router>#network 10.0.24.0 0.0.0.255 area 0
6<config-router>#network 10.0.23.0 0.0.0.255 area 0
6<config-router>#network 10.0.23.0 0.0.0.255 area 2
6<config-router>#network 10.0.24.0 0.0.0.255 area 2
6<config-router>#exit
2:42:59: %OSPF-5-ADJCHG: Process 1, Nbr 10.0.23.2 on FastEthernet0/7 from LOADING to
FULL, Loading Done
2:43:02: %OSPF-5-ADJCHG: Process 1, Nbr 10.0.25.2 on FastEthernet0/8 from LOADING to
FULL, Loading Done
6<config-router>#network 192.168.70.0 0.0.0.255 area 2
6<config-router>#network 192.168.75.0 0.0.0.255 area 2
6<config-router>#exit
2:44:10: %OSPF-5-ADJCHG: Process 1, Nbr 192.168.80.2 on Vlan75 from LOADING to FULL,
loading Done
6<config-router>#network 192.168.80.0 0.0.0.255 area 2
6<config-router>#exit
2:44:13: %OSPF-5-ADJCHG: Process 1, Nbr 192.168.80.2 on Vlan70 from LOADING to FULL,
loading Done
6<config-router>#network 192.168.80.0 0.0.0.255 area 2
6<config-router>#exit
2:44:38: %OSPF-5-ADJCHG: Process 1, Nbr 192.168.80.2 on Vlan80 from LOADING to FULL,
loading Done

```

Load Balancing in OSPF:

Cisco IOS Software includes load balancing as a standard feature that is accessible on all router systems. It is built into the router's forwarding mechanism and allows it to employ numerous paths to a destination when forwarding packets. The number of paths that may be used is limited by the number of entries in the routing table that the routing protocol creates.

In OSPF, the cost (or metric) of an interface represents the overhead required to deliver packets via that interface. The cost of an interface is proportionate to the bandwidth it provides. A lower cost is associated with a higher bandwidth. In Cisco routers, an interface's cost is calculated by default according to its bandwidth. The command `Ip ospf cost [value]` in interface configuration mode can be used to force the cost of an interface.

Using “show ip route” command, you can find equal-cost routes. The Figure- below shows two equal-cost paths for each of the 192.168.10.0/24, 192.168.15.0/24, 192.168.20.0/24, 192.168.30.0/24 and 10.0.1.0/24 networks in the routing table of R1.

Block 1:

```
R1
Physical Config CLI Attributes
IOS Command Line Interface
10.0.0.0/8 is Variably subnetted, 3 subnets, 2 masks
C 10.0.0.0/24 is directly connected, FastEthernet0/0
O 10.0.1.0/24 [110/46] via 10.0.2.1, 00:00:00, FastEthernet0/0
    [110/65] via 10.0.3.1, 00:00:00, FastEthernet0/1
C 10.0.2.0/24 is directly connected, FastEthernet0/0
C 10.0.3.0/24 is directly connected, FastEthernet0/0
C 10.0.4.0/24 [110/2] via 10.0.2.1, 00:00:15, FastEthernet0/0
O 10.0.5.0/24 [110/2] via 10.0.2.1, 00:00:00, FastEthernet0/0
O IA 10.0.10.0/24 [110/192] via 10.0.0.1, 00:00:40, Serial0/0
O IA 10.0.11.0/24 [110/192] via 10.0.0.1, 00:00:40, Serial0/0
O IA 10.0.12.0/24 [110/193] via 10.0.0.1, 00:00:30, Serial0/0
O IA 10.0.13.0/24 [110/193] via 10.0.0.1, 00:00:30, Serial0/0
O IA 10.0.14.0/24 [110/193] via 10.0.0.1, 00:00:30, Serial0/0
O IA 10.0.15.0/24 [110/256] via 10.0.0.1, 00:00:30, Serial0/0
O IA 10.0.16.0/20 [110/256] via 10.0.0.1, 00:00:30, Serial0/0
O 20.0.0.0/26 is subnetted, 2 subnets
O IA 20.0.0.0 [110/128] via 10.0.0.1, 00:00:40, Serial0/0
O IA 20.0.0.64 [110/192] via 10.0.0.1, 00:00:40, Serial0/0
172.16.0.0/24 is subnetted, 1 subnets
O IA 172.16.0.0 [110/129] via 10.0.0.1, 00:00:40, Serial0/0
O 192.168.10.0/24 [110/2] via 10.0.2.1, 00:00:00, FastEthernet0/0
    [110/2] via 10.0.3.1, 00:00:00, FastEthernet0/0
O 192.168.15.0/24 [110/2] via 10.0.2.1, 00:00:00, FastEthernet0/0
    [110/2] via 10.0.3.1, 00:00:00, FastEthernet0/1
O 192.168.20.0/24 [110/2] via 10.0.2.1, 00:00:00, FastEthernet0/0
    [110/2] via 10.0.3.1, 00:00:00, FastEthernet0/1
O 192.168.30.0/24 [110/2] via 10.0.2.1, 00:00:00, FastEthernet0/0
    [110/2] via 10.0.3.1, 00:00:00, FastEthernet0/1
O IA 192.168.40.0/24 [110/194] via 10.0.0.1, 00:00:00, Serial0/0
O IA 192.168.45.0/24 [110/194] via 10.0.0.1, 00:00:00, Serial0/0
O IA 192.168.50.0/24 [110/194] via 10.0.0.1, 00:00:00, Serial0/0
O IA 192.168.60.0/24 [110/194] via 10.0.0.1, 00:00:00, Serial0/0
O IA 192.168.64.0/19 [110/258] via 10.0.0.1, 00:00:00, Serial0/0
O IA 192.168.99.0/24 [110/129] via 10.0.0.1, 00:00:40, Serial0/0
```

And we forced a cost on some of these paths to make only one main path for each of these networks.

IOS Command Line Interface

R1(config)#int Fa0/1
R1(config-if)#ip ospf cost
% Incomplete command.
R1(config-if)#ip ospf cost ?
<1-6535> Cost
R1(config-if)#ip ospf cost
% Incomplete command.
R1(config-if)#ip ospf cost 10
R1(config-if)#do show ip rout e

R1(config-if)# do show ip rout e
Codes: C - connected, S - static, I - ISGRP, 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, E - EGP
i - IS-IS, 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

Gateway of last resort is not set

10.0.0.0/8 is variably subnetted, 13 subnets, 2 masks
C 10.0.0.0/24 is directly connected, Serial0/0
C 10.0.1.0/24 [110/66] via 10.0.2.1, 00:00:04, FastEthernet0/0
C 10.0.2.0/24 is directly connected, FastEthernet0/0
C 10.0.3.0/24 is directly connected, FastEthernet0/1
C 10.0.4.0/24 [110/3] via 10.0.2.1, 00:00:04, FastEthernet0/0
C 10.0.5.0/24 [110/2] via 10.0.2.1, 00:00:44, FastEthernet0/0
O IA 10.0.10.0/24 [110/192] via 10.0.0.1, 00:01:09, Serial0/0
O IA 10.0.11.0/24 [110/192] via 10.0.0.1, 00:01:09, Serial0/0
O IA 10.0.12.0/24 [110/193] via 10.0.0.1, 00:01:09, Serial0/0
O IA 10.0.13.0/24 [110/193] via 10.0.0.1, 00:01:09, Serial0/0

P - periodic downloaded static route

Gateway of last resort is not set

10.0.0.0/8 is variably subnetted, 13 subnets, 2 masks
C 10.0.0.0/24 is directly connected, Serial0/0
C 10.0.1.0/24 [110/66] via 10.0.2.1, 00:00:04, FastEthernet0/0
C 10.0.2.0/24 is directly connected, FastEthernet0/0
C 10.0.3.0/24 is directly connected, FastEthernet0/1
C 10.0.4.0/24 [110/3] via 10.0.2.1, 00:00:04, FastEthernet0/0
C 10.0.5.0/24 [110/2] via 10.0.2.1, 00:00:44, FastEthernet0/0
O IA 10.0.10.0/24 [110/192] via 10.0.0.1, 00:01:09, Serial0/0
O IA 10.0.11.0/24 [110/192] via 10.0.0.1, 00:01:09, Serial0/0
O IA 10.0.12.0/24 [110/193] via 10.0.0.1, 00:01:09, Serial0/0
O IA 10.0.13.0/24 [110/193] via 10.0.0.1, 00:01:09, Serial0/0

We did the same process for each router in the block 1.

The figure below shows the routing table of R2 before forcing the cost on some of the interfaces.

Physical		Config	CLI	Attributes
IOS Command Line Interface				
O	10.0.0.0/24	[110/166] via 10.0.0.1, 00:02:22, FastEthernet0/0		
O	10.0.0.0/24	[110/167] via 10.0.0.1, 00:02:22, FastEthernet0/1		
O	10.0.0.1/24	is directly connected, Serial0/0		
O	10.0.2.0/24	[110/2] via 10.0.5.1, 00:03:02, FastEthernet0/1		
O	10.0.3.0/24	[110/3] via 10.0.4.1, 00:03:02, FastEthernet0/0		
O	10.0.4.0/24	is directly connected, FastEthernet0/0		
O	10.0.5.0/24	is directly connected, FastEthernet0/1		
O	10.0.10.0/24	[110/192] via 10.0.1.1, 00:03:27, Serial0/0		
O	10.0.11.0/24	[110/192] via 10.0.1.1, 00:03:27, Serial0/0		
O	10.0.12.0/24	[110/193] via 10.0.1.1, 00:03:27, Serial0/0		
O	10.0.13.0/24	[110/193] via 10.0.1.1, 00:03:27, Serial0/0		
O	10.0.14.0/24	[110/193] via 10.0.1.1, 00:03:27, Serial0/0		
O	10.0.15.0/24	[110/193] via 10.0.1.1, 00:03:27, Serial0/0		
O	10.0.16.0/20	[110/266] via 10.0.1.1, 00:03:27, Serial0/0		
O	20.0.0.0/26	is subnetted, 2 subnets		
O	20.0.0.0/24	[110/128] via 10.0.1.1, 00:03:27, Serial0/0		
O	20.0.0.64/24	[110/192] via 10.0.1.1, 00:03:27, Serial0/0		
O	172.16.0.0/24	is subnetted, 1 subnets		
O	172.16.0.0/24	[110/129] via 10.0.1.1, 00:03:27, Serial0/0		
O	192.168.10.0/24	[110/2] via 10.0.4.1, 00:02:22, FastEthernet0/0		
O	192.168.10.0/24	[110/2] via 10.0.5.1, 00:02:22, FastEthernet0/1		
O	192.168.15.0/24	[110/2] via 10.0.5.1, 00:00:07, FastEthernet0/0		
O	192.168.20.0/24	[110/2] via 10.0.4.1, 00:02:22, FastEthernet0/0		
O	192.168.20.0/24	[110/2] via 10.0.5.1, 00:02:22, FastEthernet0/1		
O	192.168.30.0/24	[110/2] via 10.0.5.1, 00:02:22, FastEthernet0/0		
O	192.168.40.0/24	[110/194] via 10.0.1.1, 00:02:42, Serial0/0		
O	192.168.45.0/24	[110/194] via 10.0.1.1, 00:02:42, Serial0/0		
O	192.168.50.0/24	[110/194] via 10.0.1.1, 00:02:42, Serial0/0		
O	192.168.60.0/24	[110/194] via 10.0.1.1, 00:02:42, Serial0/0		
O	192.168.64.0/19	[110/258] via 10.0.1.1, 00:02:42, Serial0/0		
O	192.168.99.0/24	[110/129] via 10.0.1.1, 00:03:27, Serial0/0		

After we forced the cost 10 in interface Fa0/1.

R2#

R2(config)#int Fa0/1

R2(config-if)#ip ospf cost 10

R2(config-if)#do show ip route

Codes: C - connected, S - static, I - IGRP, 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, E - EGP
i - IS-IS level-1, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter areas
P - candidate default, U - per-user static route, o - ODR
P - periodic downloaded static route

Gateway of last resort is not set

10.0.0.0/8 is variably subnetted, 13 subnets, 2 masks

O 10.0.0.0/24 [110/66] via 10.0.4.1, 00:00:08, FastEthernet0/0

C 10.0.1.0/24 is directly connected, Serial0/0

O 10.0.2.0/24 [110/3] via 10.0.4.1, 00:00:03, FastEthernet0/0

O 10.0.3.0/24 [110/1] via 10.0.4.1, 00:00:03, FastEthernet0/0

C 10.0.4.0/24 is directly connected, FastEthernet0/0

C 10.0.5.0/24 is directly connected, FastEthernet0/1

O IA 10.0.10.0/24 [110/192] via 10.0.1.1, 00:04:34, Serial0/0

O IA 10.0.11.0/24 [110/192] via 10.0.1.1, 00:04:34, Serial0/0

O IA 10.0.12.0/24 [110/193] via 10.0.1.1, 00:04:34, Serial0/0

O IA 10.0.13.0/24 [110/193] via 10.0.1.1, 00:04:34, Serial0/0

O IA 10.0.14.0/24 [110/193] via 10.0.1.1, 00:04:34, Serial0/0

O IA 10.0.15.0/24 [110/193] via 10.0.1.1, 00:04:34, Serial0/0

O IA 10.0.16.0/20 [110/256] via 10.0.1.1, 00:04:34, Serial0/0

20.0.0.0/24 is subnetted, 2 subnets

O IA 20.0.0.0/24 [110/128] via 10.0.1.1, 00:04:34, Serial0/0

O IA 20.0.0.64 [110/192] via 10.0.1.1, 00:04:34, Serial0/0

172.16.0.0/24 is subnetted, 1 subnets

O IA 172.16.0.0 [110/129] via 10.0.1.1, 00:04:34, Serial0/0

^

R2#

R2(config)#int Fa0/1

R2(config-if)#ip ospf cost 10

R2(config-if)#do show ip route

Codes: C - connected, S - static, I - IGRP, 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, E - EGP
i - IS-IS level-1, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter areas
P - candidate default, U - per-user static route, o - ODR
P - periodic downloaded static route

Gateway of last resort is not set

10.0.0.0/8 is variably subnetted, 13 subnets, 2 masks

O 10.0.0.0/24 [110/66] via 10.0.4.1, 00:00:03, FastEthernet0/0

C 10.0.1.0/24 is directly connected, Serial0/0

O 10.0.2.0/24 [110/3] via 10.0.4.1, 00:00:03, FastEthernet0/0

O 10.0.3.0/24 [110/1] via 10.0.4.1, 00:04:09, FastEthernet0/0

C 10.0.4.0/24 is directly connected, FastEthernet0/0

C 10.0.5.0/24 is directly connected, FastEthernet0/1

O IA 10.0.10.0/24 [110/192] via 10.0.1.1, 00:04:34, Serial0/0

O IA 10.0.11.0/24 [110/192] via 10.0.1.1, 00:04:34, Serial0/0

O IA 10.0.12.0/24 [110/193] via 10.0.1.1, 00:04:34, Serial0/0

O IA 10.0.13.0/24 [110/193] via 10.0.1.1, 00:04:34, Serial0/0

O IA 10.0.14.0/24 [110/193] via 10.0.1.1, 00:04:34, Serial0/0

O IA 10.0.15.0/24 [110/193] via 10.0.1.1, 00:04:34, Serial0/0

O IA 10.0.16.0/20 [110/256] via 10.0.1.1, 00:04:34, Serial0/0

20.0.0.0/26 is subnetted, 2 subnets

O IA 20.0.0.0/26 [110/128] via 10.0.1.1, 00:04:34, Serial0/0

O IA 20.0.0.64 [110/192] via 10.0.1.1, 00:04:34, Serial0/0

172.16.0.0/24 is subnetted, 1 subnets

O IA 172.16.0.0 [110/129] via 10.0.1.1, 00:04:34, Serial0/0

O 192.168.10.0/24 [110/2] via 10.0.4.1, 00:00:03, FastEthernet0/0

O 192.168.15.0/24 [110/2] via 10.0.4.1, 00:00:03, FastEthernet0/0

O 192.168.20.0/24 [110/2] via 10.0.4.1, 00:00:03, FastEthernet0/0

O 192.168.25.0/24 [110/2] via 10.0.4.1, 00:00:03, FastEthernet0/0

O IA 192.168.40.0/24 [110/194] via 10.0.1.1, 00:03:49, Serial0/0

O IA 192.168.45.0/24 [110/194] via 10.0.1.1, 00:03:49, Serial0/0

O IA 192.168.50.0/24 [110/194] via 10.0.1.1, 00:03:49, Serial0/0

O IA 192.168.60.0/24 [110/194] via 10.0.1.1, 00:03:49, Serial0/0

O IA 192.168.64.0/19 [110/258] via 10.0.1.1, 00:03:49, Serial0/0

O IA 192.168.89.0/24 [110/129] via 10.0.1.1, 00:04:34, Serial0/0

R2(config-if)#

The figure below shows the routing table of ABR1 before forcing the cost on some of the interfaces.

```

ROUTER# show ip route
Physical Config CLI Attributes
IOS Command Line Interface

10.0.0.0/8 is variably subnetted, 15 subnets, 3 masks
: 10.0.0.0/24 is directly connected, Serial0/0/0
: 10.0.0.1/32 is directly connected, Serial0/0/0
: 10.0.0.2/32 is directly connected, Serial0/0/0
: 10.0.1.1/32 is directly connected, Serial0/0/1
: 10.0.2.0/24 [110/65] via 10.0.0.2, 00:07:53, Serial0/0/0
: 10.0.3.0/24 [110/66] via 10.0.1.2, 00:07:18, Serial0/0/1
: 10.0.4.0/24 [110/67] via 10.0.1.2, 00:07:18, Serial0/0/1
: 10.0.5.0/24 [110/68] via 10.0.0.2, 00:07:53, Serial0/0/0
: 10.0.10.0/24 [110/128] via 20.0.0.2, 00:08:23, Serial0/0/0
: 10.0.11.0/24 [110/128] via 20.0.0.2, 00:08:23, Serial0/0/0
: 10.0.12.0/24 [110/129] via 20.0.0.1, 00:07:48, Serial0/0/0
: 10.0.13.0/24 [110/129] via 20.0.0.1, 00:07:48, Serial0/0/0
: 10.0.14.0/24 [110/129] via 20.0.0.1, 00:07:48, Serial0/0/0
: 10.0.15.0/24 [110/129] via 20.0.0.1, 00:07:48, Serial0/0/0
: 10.0.16.0/20 [110/192] via 20.0.0.1, 00:08:23, Serial0/1/0
20.0.0.0/8 is variably subnetted, 3 subnets, 3 masks
: 20.0.0.0/24 is directly connected, Serial0/1/0
: 20.0.0.2/32 is directly connected, Serial0/1/0
: 20.0.0.64/24 [110/128] via 20.0.0.1, 00:08:23, Serial0/1/0
172.16.0.0/24 is subnetted, 1 subnets
: 172.16.0.0/24 [110/128] via 20.0.0.1, 00:08:23, Serial0/1/0
192.168.10.0/24 [110/66] via 10.0.1.2, 00:02:53, Serial0/0/1
[110/66] via 10.0.0.2, 00:02:53, Serial0/0/0
192.168.15.0/24 [110/66] via 10.0.1.2, 00:07:18, Serial0/0/1
[110/66] via 10.0.0.2, 00:07:18, Serial0/0/0
192.168.20.0/24 [110/66] via 10.0.1.2, 00:07:18, Serial0/0/1
[110/66] via 10.0.0.2, 00:07:18, Serial0/0/0
192.168.30.0/24 [110/66] via 10.0.1.2, 00:07:53, Serial0/0/1
[110/66] via 10.0.0.2, 00:07:53, Serial0/0/0
192.168.40.0/24 [110/130] via 20.0.0.1, 00:07:23, Serial0/0/0
192.168.45.0/24 [110/130] via 20.0.0.1, 00:07:23, Serial0/0/0
192.168.50.0/24 [110/130] via 20.0.0.1, 00:07:23, Serial0/0/0
192.168.60.0/24 [110/130] via 20.0.0.1, 00:07:23, Serial0/0/0
: 1A 192.168.64.0/19 [110/194] via 20.0.0.1, 00:07:48, Serial0/1/0
: 192.168.90.0/24 [110/65] via 20.0.0.1, 00:08:23, Serial0/1/0

```

After we forced the cost 100 in interface Se.

```

ROUTER# show ip route
Physical Config CLI Attributes
IOS Command Line Interface

ABR1(config-if)#
ABR1(config-if)#
ABR1(config-if)#
ABR1(config-if)#no ip ospf cost 86
ABR1(config-if)#ip ospf cost
% Incomplete command.
ABR1(config-if)#ip ospf cost ?
<1-65535> Cost
ABR1(config-if)#ip ospf cost 100
ABR1(config-if)#
show 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, E - EGP
i - IS-IS level-1, 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

Gateway of last resort is not set

10.0.0.0/8 is variably subnetted, 15 subnets, 3 masks
C 10.0.0.0/24 is directly connected, Serial0/0/0
L 10.0.0.1/32 is directly connected, Serial0/0/0
C 10.0.0.2/32 is directly connected, Serial0/0/1
L 10.0.0.2/32 is directly connected, Serial0/0/1
O 10.0.2.0/24 [110/65] via 10.0.0.2, 00:09:48, Serial0/0/0
O 10.0.3.0/24 [110/67] via 10.0.0.2, 00:00:02, Serial0/0/0
O 10.0.4.0/24 [110/67] via 10.0.0.2, 00:00:02, Serial0/0/0
O 10.0.5.0/24 [110/66] via 10.0.0.2, 00:05:39, Serial0/0/0
O 10.0.10.0/24 [110/128] via 20.0.0.1, 00:10:10, Serial0/1/0
O 10.0.11.0/24 [110/128] via 20.0.0.1, 00:10:10, Serial0/1/0
O 10.0.12.0/24 [110/129] via 20.0.0.1, 00:09:35, Serial0/1/0
O 10.0.13.0/24 [110/129] via 20.0.0.1, 00:09:35, Serial0/1/0
O 10.0.14.0/24 [110/129] via 20.0.0.1, 00:09:35, Serial0/1/0
O 10.0.15.0/24 [110/129] via 20.0.0.1, 00:09:35, Serial0/1/0
O 10.0.16.0/20 [110/192] via 20.0.0.1, 00:10:10, Serial0/1/0

```

ABR1

Physical Config CLI Attributes

IOS Command Line Interface

```

10.0.0.0/8 is variably subnetted, 15 subnets, 3 masks
C   10.0.0.0/24 is directly connected, Serial0/0/0
L   10.0.0.1/32 is directly connected, Serial0/0/0
C   10.0.1.0/24 is directly connected, Serial0/0/1
L   10.0.1.1/32 is directly connected, Serial0/0/1
O   10.0.2.0/24 [110/65] via 10.0.0.2, 00:09:40, Serial0/0/0
O   10.0.3.0/24 [110/65] via 10.0.0.3, 00:09:40, Serial0/0/0
O   10.0.4.0/24 [110/67] via 10.0.0.4, 00:00:02, Serial0/0/0
O   10.0.5.0/24 [110/66] via 10.0.0.5, 00:05:39, Serial0/0/0
O   10.0.10.0/24 [110/128] via 20.0.0.1, 00:10:10, Serial0/1/0
O   10.0.11.0/24 [110/128] via 20.0.0.1, 00:10:10, Serial0/1/0
O   10.0.12.0/24 [110/129] via 20.0.0.1, 00:09:38, Serial0/1/0
O   10.0.13.0/24 [110/129] via 20.0.0.1, 00:09:38, Serial0/1/0
O   10.0.14.0/24 [110/129] via 20.0.0.1, 00:09:38, Serial0/1/0
O   10.0.15.0/24 [110/129] via 20.0.0.1, 00:09:38, Serial0/1/0
O IA 10.0.16.0/20 [110/192] via 20.0.0.1, 00:10:10, Serial0/1/0
20.0.0.0/8 is variably subnetted, 2 subnets
C   20.0.0.1/24 is directly connected, Serial0/1/0
L   20.0.0.2/32 is directly connected, Serial0/1/0
O   20.0.0.64/26 [110/128] via 20.0.0.1, 00:10:10, Serial0/1/0
172.16.0.0/24 is subnetted, 1 subnets
O   172.16.0.0/24 [110/65] via 20.0.0.1, 00:10:10, Serial0/1/0
O   192.168.10.0/24 [110/66] via 10.0.0.2, 00:00:02, Serial0/0/0
O   192.168.15.0/24 [110/66] via 10.0.0.2, 00:00:02, Serial0/0/0
O   192.168.20.0/24 [110/66] via 10.0.0.2, 00:00:02, Serial0/0/0
O   192.168.30.0/24 [110/66] via 10.0.0.2, 00:00:02, Serial0/0/0
O   192.168.40.0/24 [110/130] via 20.0.0.1, 00:09:10, Serial0/1/0
O   192.168.45.0/24 [110/130] via 20.0.0.1, 00:09:10, Serial0/1/0
O   192.168.50.0/24 [110/130] via 20.0.0.1, 00:09:10, Serial0/1/0
O   192.168.60.0/24 [110/130] via 20.0.0.1, 00:09:10, Serial0/1/0
O IA 192.168.64.0/18 [110/194] via 20.0.0.1, 00:09:38, Serial0/1/0
O   192.168.99.0/24 [110/65] via 20.0.0.1, 00:10:10, Serial0/1/0

```

Block 2

We did the same process for each router in the block 2.

The figure below shows the routing table of R3 before forcing the cost on some of the interfaces.

R3

Physical Config CLI Attributes

IOS Command Line Interface

```

Gateway of last resort is not set

10.0.0.0/8 is variably subnetted, 11 subnets, 3 masks
O IA 10.0.0.0/24 [110/192] via 10.0.10.1, 00:03:32, Serial0/0/0
C   10.0.10.0/24 is directly connected, Serial0/0/0
L   10.0.10.2/32 is directly connected, Serial0/0/0
O   10.0.11.0/24 [110/66] via 10.0.12.1, 00:13:38, FastEthernet0/0
[110/66] via 10.0.13.1, 00:13:38, FastEthernet0/1
C   10.0.12.0/24 is directly connected, FastEthernet0/0
L   10.0.12.2/32 is directly connected, FastEthernet0/0
C   10.0.13.0/24 is directly connected, FastEthernet0/1
L   10.0.13.2/32 is directly connected, FastEthernet0/1
O   10.0.14.0/24 [110/21] via 10.0.13.1, 00:13:35, FastEthernet0/1
O   10.0.15.0/24 [110/21] via 10.0.12.1, 00:13:35, FastEthernet0/0
O IA 10.0.16.0/20 [110/192] via 10.0.10.1, 00:14:00, Serial0/0/0
20.0.0.0/16 is subnetted, 2 subnets
O   20.0.0.0/26 [110/128] via 10.0.10.1, 00:14:10, Serial0/0/0
O   20.0.0.64/26 [110/128] via 10.0.10.1, 00:14:10, Serial0/0/0
172.16.0.0/24 is subnetted, 1 subnets
O   172.16.0.0/24 [110/65] via 10.0.10.1, 00:14:10, Serial0/0/0
O IA 192.168.10.0/24 [110/21] via 10.0.12.1, 00:13:00, FastEthernet0/0
[110/21] via 10.0.13.1, 00:13:00, FastEthernet0/1
O   192.168.40.0/24 [110/2] via 10.0.12.1, 00:13:00, FastEthernet0/0
[110/2] via 10.0.13.1, 00:13:00, FastEthernet0/1
O   192.168.45.0/24 [110/2] via 10.0.12.1, 00:13:00, FastEthernet0/0
[110/2] via 10.0.13.1, 00:13:00, FastEthernet0/1
O   192.168.50.0/24 [110/21] via 10.0.12.1, 00:13:00, FastEthernet0/0
[110/21] via 10.0.13.1, 00:13:00, FastEthernet0/1
O   192.168.60.0/24 [110/2] via 10.0.12.1, 00:11:30, FastEthernet0/0
[110/21] via 10.0.13.1, 00:11:30, FastEthernet0/1
O IA 192.168.64.0/18 [110/194] via 10.0.10.1, 00:13:28, Serial0/0/0
O   192.168.99.0/24 [110/65] via 10.0.10.1, 00:14:10, Serial0/0/0

```

After we forced the cost 10 in interface Fa0/1.

Physical Config CLI Attributes

IOS Command Line Interface

```
# show ip route

      2.0.0.0/24 [110/192] via 10.0.10.1, 00:05:18, Serial10/0/0
      1 - IS-IS, 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

Gateway of last resort is not set

      10.0.0.0/8 is variably subnetted, 11 subnets, 3 masks
o IA 10.0.0.0/24 [110/192] via 10.0.10.1, 00:05:18, Serial10/0/0
o C 10.0.10.0/24 is directly connected, Serial10/0/0
L 10.0.10.2/24 is directly connected, Serial10/0/0
o 10.0.11.0/24 [110/661] via 10.0.12.1, 00:00:00, FastEthernet0/0
C 10.0.12.0/24 is directly connected, FastEthernet0/0
L 10.0.12.2/24 is directly connected, FastEthernet0/0
o 10.0.13.0/24 [110/662] via 10.0.12.1, 00:00:00, FastEthernet0/0
L 10.0.13.2/24 is directly connected, FastEthernet0/0
o 10.0.14.0/24 [110/93] via 10.0.12.1, 00:00:00, FastEthernet0/0
o 10.0.15.0/24 [110/21] via 10.0.12.1, 00:15:21, FastEthernet0/0
o IA 10.0.16.0/20 [110/1921] via 10.0.10.1, 00:15:46, Serial10/0/0
      20.0.0.0/26 is subnetted, 2 subnets
o 20.0.0.0/26 [110/128] via 10.0.10.1, 00:15:46, Serial10/0/0
o 20.0.0.64/26 [110/128] via 10.0.10.1, 00:15:46, Serial10/0/0
      172.16.0.0/24 is subnetted, 1 subnets
o 172.16.0.0/24 [110/65] via 10.0.10.1, 00:15:56, Serial10/0/0
o IA 192.16.48.0/24 [110/194] via 10.0.10.1, 00:15:56, Serial10/0/0
o 192.16.48.40/24 [110/72] via 10.0.12.1, 00:00:00, FastEthernet0/0
o 192.16.48.45/24 [110/73] via 10.0.12.1, 00:00:00, FastEthernet0/0
o 192.16.88.50/24 [110/22] via 10.0.12.1, 00:00:00, FastEthernet0/0
o 192.16.88.60/24 [110/21] via 10.0.12.1, 00:00:00, FastEthernet0/0
o IA 192.16.88.64/24 [110/194] via 10.0.10.1, 00:15:11, Serial10/0/0
o 192.16.99.0/24 [110/65] via 10.0.10.1, 00:15:56, Serial10/0/0

R3(config-if)#  
R3(config-if)#  
R3(config-if)#
```

The figure below shows the routing table of R4 before forcing the cost on some of the interfaces.

```

Physical Config CLI Attributes
IOS Command Line Interface
i - IS-IS, 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

Gateway of last resort is not set

10.0.0.0/8 is variably subnetted, 8 subnets, 3 masks
o IA 10.0.0.0/21 [110/193] via 10.0.11.1, 00:01:03, Serial0/0
o 10.0.10.0/24 [110/66] via 10.0.14.1, 00:16:24, FastEthernet0/0
[110/66] via 10.0.15.1, 00:16:24, FastEthernet0/1
c 10.0.11.0/24 is directly connected, Serial0/0
o 10.0.12.0/24 [110/21] via 10.0.15.1, 00:16:24, FastEthernet0/1
o 10.0.13.0/24 [110/21] via 10.0.15.1, 00:16:24, FastEthernet0/0
c 10.0.14.0/24 is directly connected, FastEthernet0/0
c 10.0.15.0/24 is directly connected, FastEthernet0/1
o IA 10.0.16.0/20 [110/192] via 10.0.11.1, 00:17:04, Serial0/0
20.0.0.0/26 is subnetted, 2 subnets
o 20.0.0.0 [110/128] via 10.0.11.1, 00:17:14, Serial0/0
o 20.0.0.64 [110/128] via 10.0.11.1, 00:17:14, Serial0/0
172.16.0.0/24 is subnetted 1 subnets
o 172.16.0.0 [110/65] via 10.0.11.1, 00:17:14, Serial0/0
o IA 192.168.0.0/24 [110/194] via 10.0.11.1, 00:16:24, Serial0/0
[110/2] via 10.0.14.1, 00:14:34, FastEthernet0/0
[110/2] via 10.0.15.1, 00:14:34, FastEthernet0/1
o 192.168.48.0/24 [110/21] via 10.0.15.1, 00:16:04, FastEthernet0/0
o 192.168.50.0/24 [110/21] via 10.0.15.1, 00:16:04, FastEthernet0/0
o 192.168.60.0/24 [110/21] via 10.0.15.1, 00:16:24, FastEthernet0/0
[110/2] via 10.0.15.1, 00:16:24, FastEthernet0/1
o IA 192.168.64.0/19 [110/194] via 10.0.11.1, 00:16:24, Serial0/0
o 192.168.99.0/24 [110/65] via 10.0.11.1, 00:17:14, Serial0/0
R4(config)#

```

After we forced the cost 10 in interface Fa0/1.

```

Physical Config CLI Attributes
IOS Command Line Interface
R4(config)#int Fa0/1
R4(config-if)#ip ospf cost 10
R4(config-if)#do show ip route
Codes: C - connected, S - static, I - IGRP, 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, E - EGP
i - IS-IS, 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

Gateway of last resort is not set

10.0.0.0/8 is variably subnetted, 8 subnets, 3 masks
o IA 10.0.0.0/21 [110/193] via 10.0.11.1, 00:01:56, Serial0/0
o 10.0.10.0/24 [110/66] via 10.0.14.1, 00:00:02, FastEthernet0/0
c 10.0.11.0/24 is directly connected, Serial0/0
o 10.0.12.0/24 [110/21] via 10.0.15.1, 00:17:16, FastEthernet0/0
o 10.0.13.0/24 [110/21] via 10.0.14.1, 00:17:16, FastEthernet0/0
c 10.0.14.0/24 is directly connected, FastEthernet0/0
c 10.0.15.0/24 is directly connected, FastEthernet0/1
o IA 10.0.16.0/20 [110/192] via 10.0.11.1, 00:17:56, Serial0/0
20.0.0.0/26 is subnetted, 2 subnets
o 20.0.0.0 [110/128] via 10.0.11.1, 00:18:06, Serial0/0
o 20.0.0.64 [110/128] via 10.0.11.1, 00:18:06, Serial0/0
172.16.0.0/24 is subnetted 1 subnets
o 172.16.0.0 [110/65] via 10.0.11.1, 00:18:06, Serial0/0
o IA 192.168.0.0/19 [110/194] via 10.0.11.1, 00:17:16, Serial0/0
[110/2] via 10.0.14.1, 00:00:02, FastEthernet0/0
o 192.168.48.0/24 [110/21] via 10.0.14.1, 00:00:02, FastEthernet0/0
o 192.168.50.0/24 [110/21] via 10.0.14.1, 00:00:02, FastEthernet0/0
o 192.168.60.0/24 [110/21] via 10.0.14.1, 00:00:02, FastEthernet0/0
[110/2] via 10.0.15.1, 00:17:16, Serial0/0
o IA 192.168.64.0/19 [110/194] via 10.0.11.1, 00:17:16, Serial0/0
o 192.168.99.0/24 [110/65] via 10.0.11.1, 00:18:06, Serial0/0
R4(config)#

```

The figure below shows the routing table of ASBR before forcing the cost on some of the interfaces.

ASBR

Physical Config CLI Attributes

IOS Command Line Interface

p = periodic downloaded static route

Gateway of last resort is not set

```
10.0.0.0/8 is variably subnetted, 8 subnets, 3 masks
o IA 10.0.0.0/21 [110/123] via 20.0.0.2, 00:02:36, Serial1/0
c 10.0.0.0/24 is directly connected, Serial1/0
c 10.0.11.0/24 is directly connected, Serial1/1
o IA 10.0.12.0/24 [110/65] via 10.0.10.2, 00:17:52, Serial1/0
o IA 10.0.12.0/24 [110/66] via 10.0.11.2, 00:02:56, Serial1/0
o IA 10.0.14.0/24 [110/65] via 10.0.11.2, 00:17:52, Serial1/0
o IA 10.0.18.0/24 [110/66] via 10.0.10.2, 00:00:48, Serial1/0
o IA 10.0.16.0/20 [110/128] via 20.0.0.66, 00:18:42, Serial1/1
20.0.0.0/26 is subnetted, 2 subnets
c 20.0.0.0 is directly connected, Serial1/0
c 20.0.0.64 is directly connected, Serial1/1
172.16.0.0/24 is subnetted, 1 subnets
c 172.16.0.0 is directly connected, FastEthernet0/0.7
A T 192.168.0.0/24 [110/66] via 10.0.10.2, 00:17:42, Serial1/0
o 192.168.40.0/24 [110/66] via 10.0.11.2, 00:17:42, Serial1/0
c 192.168.45.0/24 [110/66] via 10.0.10.2, 00:17:42, Serial1/0
o 192.168.50.0/24 [110/66] via 10.0.11.2, 00:17:42, Serial1/0
o 192.168.60.0/24 [110/66] via 10.0.10.2, 00:17:52, Serial1/0
o 192.168.68.0/24 [110/130] via 20.0.0.66, 00:17:52, Serial1/1
C 192.168.99.0/24 is directly connected, FastEthernet0/0.99
200.165.10.0/28 is subnetted, 1 subnets
c 200.165.10.0 is directly connected, Serial1/2

ASBR(config)#
ASBR(config)#

```

After we forced the cost 100 in interface Se0/1.

```
ASBR# show ip route | include 192.168.10.0
 200.168.10.0 is subnetted, 1 subnets
C 200.168.10.0 is directly connected, Serial1/2

ASBR(config)# int Se0/1
ASBR(config-if)# ip ospf cost 100
ASBR(config-if)# do show ip route
Codes: C - connected, S - static, I - IGRP, 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, E - EGP
      i - IS-IS, 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

Gateway of last resort is not set

 10.0.0.0/8 is variably subnetted, 8 subnets, 3 masks
C 10.0.0.0/21 [110/128] via 20.0.0.2, 00:03:55, Serial1/0
C 10.10.0.10/24 [110/66] is directly connected, Serial0/0
C 10.10.0.11/24 [110/66] is directly connected, Serial0/1
C 10.10.12.0/24 [110/68] via 10.0.10.2, 00:19:11, Serial0/0
C 10.10.13.0/24 [110/66] via 10.0.10.2, 00:19:11, Serial0/1
C 10.10.14.0/24 [110/66] via 10.0.10.2, 00:19:11, Serial0/1
C 10.10.15.0/24 [110/66] via 10.0.10.2, 00:02:07, Serial1/0
C 10.10.16.0/20 [110/128] via 20.0.0.66, 00:20:01, Serial1/1
C 20.0.0.0/26 is subnetted, 2 subnets
C 20.0.0.0 is directly connected, Serial1/0
C 20.0.0.64 is directly connected, Serial1/1
C 172.16.0.0/24 is subnetted, 1 subnets
C 172.16.0.0 is directly connected, FastEthernet0/0.7
C 192.168.0.0/19 [110/130] via 20.0.0.2, 00:19:11, Serial1/0
```

The screenshot shows the Cisco IOS Command Line Interface (CLI) running on an ASBR. The interface is titled 'ASBR' and has tabs for Physical, Config, CLI, and Attributes. The 'CLI' tab is selected. The output displays the routing table:

```

ASBR# show ip route
Gateway of last resort is not set

10.0.0.0/8 is variably subnetted, 8 subnets, 3 masks
O IA 10.0.0.0/21 [110/128] via 20.0.0.2, 00:04:20, Serial1/0
C 10.0.10.0/24 is directly connected, Serial1/0
C 10.0.11.0/24 is directly connected, Serial1/0
O 10.0.12.0/24 [110/65] via 10.0.10.2, 00:19:36, Serial1/0
O 10.0.13.0/24 [110/67] via 10.0.10.2, 00:00:24, Serial1/0
O 10.0.14.0/24 [110/67] via 10.0.10.2, 00:00:24, Serial1/0
O 10.0.15.0/24 [110/66] via 10.0.10.2, 00:02:32, Serial1/0
O IA 10.0.16.0/20 [110/128] via 20.0.0.66, 00:20:26, Serial1/1
  20.0.0.0/24 is subnetted, 2 subnets
C 20.0.0.0 is directly connected, Serial1/0
C 20.0.16.0/24 is directly connected, Serial1/1
  172.16.0.0/24 is subnetted, 1 subnets
C 172.16.0.0 is directly connected, FastEthernet0/0.7
O IA 192.168.0.0/19 [110/130] via 20.0.0.3, 00:19:36, Serial1/0
O 192.168.40.0/24 [110/66] via 10.0.10.2, 00:00:24, Serial1/0
O 192.168.45.0/24 [110/66] via 10.0.10.2, 00:00:24, Serial1/0
O 192.168.50.0/24 [110/66] via 10.0.10.2, 00:00:24, Serial1/0
O 192.168.60.0/24 [110/66] via 10.0.10.2, 00:00:24, Serial1/0
O IA 192.168.64.0/19 [110/130] via 20.0.0.66, 00:19:36, Serial1/1
C 192.168.99.0/24 is directly connected, FastEthernet0/0.99
  200.168.10.0/28 is subnetted, 1 subnets
C 200.168.10.0 is directly connected, Serial1/2
ASBR(config-if)#

```

Block 3

We did the same process for each router in the block 3

The figure below shows the routing table of R5 before forcing the cost on some of the interfaces.

The screenshot shows the Cisco IOS Command Line Interface (CLI) running on router R5. The interface is titled 'R5' and has tabs for Physical, Config, CLI, and Attributes. The 'CLI' tab is selected. The output displays the routing table:

```

R5# show ip route
Gateway of last resort is not set

10.0.0.0/8 is variably subnetted, 13 subnets, 2 masks
O IA 10.0.0.0/21 [110/257] via 10.0.20.1, 00:08:04, Serial10/0/0
O IA 10.0.10.0/24 [110/192] via 10.0.20.1, 00:23:55, Serial10/0/0
O IA 10.0.11.0/24 [110/228] via 10.0.20.1, 00:03:58, Serial10/0/0
O IA 10.0.12.0/24 [110/193] via 10.0.20.1, 00:23:55, Serial10/0/0
O IA 10.0.13.0/24 [110/198] via 10.0.20.1, 00:03:58, Serial10/0/0
O IA 10.0.14.0/24 [110/198] via 10.0.20.1, 00:03:58, Serial10/0/0
O IA 10.0.15.0/24 [110/1941] via 10.0.20.1, 00:06:06, Serial10/0/0
O 10.0.21.0/24 [110/66] via 10.0.22.1, 00:23:30, FastEthernet0/0
C 10.0.22.0/24 is directly connected, FastEthernet0/0
C 10.0.23.0/24 is directly connected, FastEthernet0/1
O 10.0.24.0/24 [110/2] via 10.0.23.1, 00:23:40, FastEthernet0/1
O 10.0.25.0/24 [110/21] via 10.0.22.1, 00:23:40, FastEthernet0/0
  20.0.0.0/24 is subnetted, 2 subnets
O IA 20.0.0.0/21 [110/192] via 10.0.20.1, 00:23:55, Serial10/0/0
O IA 20.0.0.64 [110/128] via 10.0.20.1, 00:24:05, Serial10/0/0
  172.16.0.0/24 is subnetted, 1 subnets
O IA 172.16.0.0/11 [110/258] via 10.0.20.1, 00:23:55, Serial10/0/0
O IA 192.168.40.0/24 [110/194] via 10.0.20.1, 00:23:20, Serial10/0/0
O IA 192.168.45.0/24 [110/194] via 10.0.20.1, 00:23:20, Serial10/0/0
O IA 192.168.50.0/24 [110/194] via 10.0.20.1, 00:23:20, Serial10/0/0
O IA 192.168.60.0/24 [110/194] via 10.0.20.1, 00:23:20, Serial10/0/0
O 192.168.70.0/24 [110/2] via 10.0.22.1, 00:22:35, FastEthernet0/0
  [110/2] via 10.0.23.1, 00:22:35, FastEthernet0/1
O 192.168.75.0/24 [110/2] via 10.0.22.1, 00:22:35, FastEthernet0/0
O 192.168.80.0/24 [110/2] via 10.0.22.1, 00:22:35, FastEthernet0/0
  [110/2] via 10.0.23.1, 00:22:35, FastEthernet0/1
O IA 192.168.99.0/24 [110/129] via 10.0.20.1, 00:23:55, Serial10/0/0
R5(config)#

```

After we forced the cost 10 in interface Fa0/1.

```
R5(config)#  
R5(config)#  
R5(config)#  
R5(config)#  
R5(config-if)#int Fa0/1  
R5(config-if)#ip ospf cost  
% Incomplete command.  
R5(config-if)#ip ospf cost 10  
R5(config-if)#show ip route  
Codes: C - connected, L1 - loopback, R - router, N - neighbor, S - static  
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, E - EGP  
i - IS-IS, 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  
Gateway of last resort is not set  
10.0.0.0/8 is variably subnetted, 13 subnets, 2 masks  
O IA 10.0.0.0/21 [110/257] via 10.0.20.1, 00:09:29, Serial0/0/0  
O IA 10.0.10.0/24 [110/192] via 10.0.20.1, 00:26:20, Serial0/0/0  
O IA 10.0.11.0/24 [110/228] via 10.0.20.1, 00:05:23, Serial0/0/0  
O IA 10.0.12.0/24 [110/193] via 10.0.20.1, 00:26:20, Serial0/0/0  
O IA 10.0.13.0/24 [110/195] via 10.0.20.1, 00:05:23, Serial0/0/0  
O IA 10.0.14.0/24 [110/198] via 10.0.20.1, 00:05:23, Serial0/0/0  
O IA 10.0.15.0/24 [110/194] via 10.0.20.1, 00:07:31, Serial0/0/0  
C 10.0.20.0/24 is directly connected, Serial0/0/0  
O 10.0.21.0/24 [110/66] via 10.0.22.1, 00:00:08, FastEthernet0/0  
C 10.0.22.0/24 is directly connected, FastEthernet0/0  
C 10.0.23.0/24 is directly connected, FastEthernet0/1  
O 10.0.24.0/24 [110/3] via 10.0.22.1, 00:00:03, FastEthernet0/0  
O 10.0.25.0/24 [110/21] via 10.0.22.1, 00:26:05, FastEthernet0/0  
20.0.0.0/26 is subnetted, 2 subnets  
O TA 20.0.0.0 [110/192] via 10.0.20.1 00:26:20, Serial0/0/0
```

```
R5(config)#  
R5(config)#  
R5(config)#  
R5(config)#  
R5(config-if)#int Fa0/1  
R5(config-if)#ip ospf cost  
% Incomplete command.  
R5(config-if)#ip ospf cost 10  
R5(config-if)#show ip route  
Codes: C - connected, L1 - loopback, R - router, N - neighbor, S - static  
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, E - EGP  
i - IS-IS, 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  
Gateway of last resort is not set  
10.0.0.0/8 is variably subnetted, 13 subnets, 2 masks  
O IA 10.0.0.0/21 [110/257] via 10.0.20.1, 00:09:29, Serial0/0/0  
O IA 10.0.10.0/24 [110/192] via 10.0.20.1, 00:26:20, Serial0/0/0  
O IA 10.0.11.0/24 [110/228] via 10.0.20.1, 00:05:23, Serial0/0/0  
O IA 10.0.12.0/24 [110/193] via 10.0.20.1, 00:26:20, Serial0/0/0  
O IA 10.0.13.0/24 [110/195] via 10.0.20.1, 00:05:23, Serial0/0/0  
O IA 10.0.14.0/24 [110/196] via 10.0.20.1, 00:05:23, Serial0/0/0  
O IA 10.0.15.0/24 [110/194] via 10.0.20.1, 00:07:31, Serial0/0/0  
C 10.0.20.0/24 is directly connected, Serial0/0/0  
O 10.0.21.0/24 [110/66] via 10.0.22.1, 00:00:08, FastEthernet0/0  
C 10.0.22.0/24 is directly connected, FastEthernet0/0  
C 10.0.23.0/24 is directly connected, FastEthernet0/1  
O 10.0.24.0/24 [110/3] via 10.0.22.1, 00:00:03, FastEthernet0/0  
O 10.0.25.0/24 [110/2] via 10.0.22.1, 00:26:05, FastEthernet0/0  
20.0.0.0/26 is subnetted, 2 subnets  
O IA 20.0.0.0 [110/192] via 10.0.20.1 00:26:20, Serial0/0/0  
O IA 20.0.0.64 [110/258] via 10.0.20.1, 00:25:30, Serial0/0/0  
172.16.0.0/24 is subnetted, 1 subnets  
O IA 172.16.0.0 [110/129] via 10.0.20.1, 00:25:20, Serial0/0/0  
O IA 192.168.0.0/19 [110/258] via 10.0.20.1, 00:24:45, Serial0/0/0  
O IA 192.168.40.0/24 [110/194] via 10.0.20.1, 00:24:45, Serial0/0/0  
O IA 192.168.45.0/24 [110/194] via 10.0.20.1, 00:24:45, Serial0/0/0  
O IA 192.168.50.0/24 [110/194] via 10.0.20.1, 00:24:45, Serial0/0/0  
O IA 192.168.60.0/24 [110/194] via 10.0.20.1, 00:24:45, Serial0/0/0  
O 192.168.70.0/24 [110/2] via 10.0.22.1, 00:00:03, FastEthernet0/0  
O 192.168.75.0/24 [110/2] via 10.0.22.1, 00:00:03, FastEthernet0/0  
O 192.168.80.0/24 [110/2] via 10.0.22.1, 00:00:03, FastEthernet0/0  
O IA 192.168.99.0/24 [110/129] via 10.0.20.1, 00:28:20, Serial0/0/0
```

The figure below shows the routing table of R6 after forcing the cost 10 the interfaces Fa0/1.

```

R6(config)#
R6(config)#
R6(config)#
R6(config)#
R6(config-if)# int Fa0/1
R6(config-if)# ip ospf cost 10
R6(config-if)# sdo show ip route
Codes: C - connected, S - static, I - IGRP, 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, E - EGP
       i - IS-IS, 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

Gateway of last resort is not set

10.0.0.8 is variably subnetted, 13 subnets, 2 masks
O IA 10.0.0.0/21 [110/257] via 10.0.21.1, 00:12:50, Serial0/0
O IA 10.0.10.0/24 [110/192] via 10.0.21.1, 00:28:41, Serial0/0
O IA 10.0.11.0/24 [110/228] via 10.0.21.1, 00:08:44, Serial0/0
O IA 10.0.12.0/24 [110/193] via 10.0.21.1, 00:28:41, Serial0/0
O IA 10.0.13.0/24 [110/198] via 10.0.21.1, 00:08:44, Serial0/0
O IA 10.0.14.0/24 [110/195] via 10.0.21.1, 00:08:44, Serial0/0
O IA 10.0.15.0/24 [110/194] via 10.0.21.1, 00:10:52, Serial0/0
O IA 10.0.20.0/24 [110/66] via 10.0.24.1, 00:00:01, FastEthernet0/0
C 10.0.21.0/24 is directly connected, Serial0/0
O IA 10.0.22.0/24 [110/3] via 10.0.24.1, 00:00:01, FastEthernet0/0
O IA 10.0.23.0/24 [110/2] via 10.0.24.1, 00:28:21, FastEthernet0/0
C 10.0.24.0/24 is directly connected, FastEthernet0/0
C 10.0.25.0/24 is directly connected, FastEthernet0/1

20.0.0.0/26 is subnetted, 2 subnets
O IA 20.0.0.0 [110/192] via 10.0.21.1, 00:28:41, Serial0/0
O IA 20.0.0.64 [110/128] via 10.0.21.1, 00:28:51, Serial0/0

```

```

Physical Config CLI Attributes
IOS Command Line Interface
# periodic downloaded static route

Gateway of last resort is not set

10.0.0.8 is variably subnetted, 13 subnets, 2 masks
O IA 10.0.0.0/21 [110/257] via 10.0.21.1, 00:12:50, Serial0/0
O IA 10.0.10.0/24 [110/192] via 10.0.21.1, 00:28:41, Serial0/0
O IA 10.0.11.0/24 [110/228] via 10.0.21.1, 00:08:44, Serial0/0
O IA 10.0.12.0/24 [110/193] via 10.0.21.1, 00:28:41, Serial0/0
O IA 10.0.13.0/24 [110/198] via 10.0.21.1, 00:08:44, Serial0/0
O IA 10.0.14.0/24 [110/195] via 10.0.21.1, 00:08:44, Serial0/0
O IA 10.0.15.0/24 [110/194] via 10.0.21.1, 00:10:52, Serial0/0
O IA 10.0.20.0/24 [110/66] via 10.0.24.1, 00:00:01, FastEthernet0/0
C 10.0.21.0/24 is directly connected, Serial0/0
O IA 10.0.22.0/24 [110/3] via 10.0.24.1, 00:00:01, FastEthernet0/0
O IA 10.0.23.0/24 [110/2] via 10.0.24.1, 00:28:21, FastEthernet0/0
C 10.0.24.0/24 is directly connected, FastEthernet0/0
C 10.0.25.0/24 is directly connected, FastEthernet0/1

20.0.0.0/26 is subnetted, 2 subnets
O IA 20.0.0.0 [110/192] via 10.0.21.1, 00:28:41, Serial0/0
O IA 20.0.0.64 [110/128] via 10.0.21.1, 00:28:51, Serial0/0
172.16.0.0/24 is subnetted, 1 subnets
O IA 172.16.0.0/19 [110/129] via 10.0.21.1, 00:28:41, Serial0/0
O IA 192.168.0.0/19 [110/258] via 10.0.21.1, 00:28:06, Serial0/0
O IA 192.168.40.0/24 [110/194] via 10.0.21.1, 00:28:06, Serial0/0
O IA 192.168.45.0/24 [110/194] via 10.0.21.1, 00:28:06, Serial0/0
O IA 192.168.50.0/24 [110/194] via 10.0.21.1, 00:28:06, Serial0/0
O IA 192.168.60.0/24 [110/194] via 10.0.21.1, 00:28:06, Serial0/0
O IA 192.168.70.0/24 [110/2] via 10.0.24.1, 00:00:01, FastEthernet0/0
O IA 192.168.75.0/24 [110/2] via 10.0.24.1, 00:00:01, FastEthernet0/0
O IA 192.168.80.0/24 [110/2] via 10.0.24.1, 00:00:01, FastEthernet0/0
O IA 192.168.99.0/24 [110/129] via 10.0.21.1, 00:28:41, Serial0/0

R6(config-if)#
R6(config-if)#

```

The figure below shows the routing table of ABR2 before forcing the cost on some of the interfaces.

```

Gateway of last resort is not set
10.0.0.0/8 is variably subnetted, 13 subnets, 2 masks
o IA 10.0.0.0/21 [110/188] via 20.0.0.65, 00:14:15, Serial1/0
o 10.0.10.0/24 [110/128] via 20.0.0.65, 00:30:11, Serial1/0
o 10.0.11.0/24 [110/164] via 20.0.0.65, 00:10:09, Serial1/0
o 10.0.12.0/24 [110/129] via 20.0.0.65, 00:29:31, Serial1/0
o 10.0.13.0/24 [110/131] via 20.0.0.65, 00:10:09, Serial1/0
o 10.0.14.0/24 [110/131] via 20.0.0.65, 00:10:09, Serial1/0
o 10.0.15.0/24 [110/130] via 20.0.0.65, 00:12:17, Serial1/0
c 10.0.20.0/24 is directly connected, Serial0/0
c 10.0.21.0/24 is directly connected, Serial0/1
o 10.0.22.0/24 [110/65] via 10.0.21.2, 00:29:46, Serial0/0
o 10.0.23.0/24 [110/66] via 10.0.21.2, 00:04:44, Serial0/1
o 10.0.24.0/24 [110/65] via 10.0.21.2, 00:19:36, Serial0/1
o 10.0.25.0/24 [110/66] via 10.0.20.2, 00:01:21, Serial0/0
20.0.0.0/26 is subnetted, 2 subnets
o 20.0.0.0 [110/128] via 20.0.0.65, 00:30:11, Serial1/0
c 20.0.0.64 is directly connected, Serial1/0
172.16.0.0/24 is subnetted, 1 subnets
o 172.16.0.0 [110/65] via 20.0.0.65, 00:30:11, Serial1/0
o IA 192.168.0.0/19 [110/194] via 20.0.0.65, 00:29:31, Serial1/0
o 192.168.0.0/24 [110/130] via 20.0.0.65, 00:29:11, Serial1/0
o 192.168.48.0/24 [110/130] via 20.0.0.65, 00:29:11, Serial1/0
o 192.168.60.0/24 [110/130] via 20.0.0.65, 00:28:11, Serial1/0
o 192.168.60.0/24 [110/130] via 20.0.0.65, 00:28:11, Serial1/0
o 192.168.70.0/24 [110/66] via 10.0.21.2, 00:28:36, Serial0/1
o 192.168.75.0/24 [110/66] via 10.0.20.2, 00:28:36, Serial0/0
o 192.168.80.0/24 [110/66] via 10.0.21.2, 00:28:36, Serial0/1
o 192.168.80.0/24 [110/66] via 10.0.20.2, 00:28:46, Serial0/0
o 192.168.99.0/24 [110/65] via 20.0.0.65, 00:30:11, Serial1/0

```

After we forced the cost 100 in interface Se0/1.

```

ABR2# int Se0/1
ABR2# ip ospf cost 100
ABR2# sdo show ip route
Codes: 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, E - EGP
      i - IS-IS, 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

Gateway of last resort is not set
10.0.0.0/8 is variably subnetted, 13 subnets, 2 masks
o IA 10.0.0.0/21 [110/188] via 20.0.0.65, 00:15:28, Serial1/0
o 10.0.10.0/24 [110/128] via 20.0.0.65, 00:31:24, Serial1/0
o 10.0.11.0/24 [110/164] via 20.0.0.65, 00:11:22, Serial1/0
o 10.0.12.0/24 [110/129] via 20.0.0.65, 00:30:44, Serial1/0
o 10.0.13.0/24 [110/131] via 20.0.0.65, 00:11:22, Serial1/0
o 10.0.14.0/24 [110/131] via 20.0.0.65, 00:11:22, Serial1/0
o 10.0.15.0/24 [110/130] via 20.0.0.65, 00:18:30, Serial1/0
c 10.0.20.0/24 is directly connected, Serial0/0
c 10.0.21.0/24 is directly connected, Serial0/1
o 10.0.22.0/24 [110/67] via 10.0.20.2, 00:31:59, Serial0/0
o 10.0.23.0/24 [110/67] via 10.0.20.2, 00:00:12, Serial0/0
o 10.0.24.0/24 [110/67] via 10.0.20.2, 00:00:12, Serial0/0
o 10.0.25.0/24 [110/66] via 10.0.20.2, 00:02:34, Serial0/0
20.0.0.0/26 is subnetted, 2 subnets
o 20.0.0.0 [110/128] via 20.0.0.65, 00:31:24, Serial1/0
c 20.0.0.64 is directly connected, Serial1/0

```

```

Physical Config CLI Attributes
IOS Command Line Interface
P - periodic downloaded static route
Gateway of last resort is not set

10.0.0.0/8 is variably subnetted, 13 subnets, 2 masks
O IA 10.0.0.0/21 [110/193] via 20.0.0.65, 00:15:28, Serial1/0
O 10.0.10.0/24 [110/128] via 20.0.0.65, 00:31:24, Serial1/0
O 10.0.11.0/24 [110/164] via 20.0.0.65, 00:11:22, Serial1/0
O 10.0.12.0/24 [110/140] via 20.0.0.65, 00:11:24, Serial1/0
O 10.0.13.0/24 [110/131] via 20.0.0.65, 00:11:24, Serial1/0
O 10.0.14.0/24 [110/131] via 20.0.0.65, 00:11:22, Serial1/0
O 10.0.15.0/24 [110/130] via 20.0.0.65, 00:19:30, Serial1/0
C 10.0.20.0/24 is directly connected, Serial1/0
C 10.0.21.0/24 is directly connected, Serial1/0
O 10.0.22.0/24 [110/65] via 10.0.20.2, 00:30:59, Serial1/0
O 10.0.23.0/24 [110/67] via 10.0.20.2, 00:00:12, Serial1/0
O 10.0.24.0/24 [110/67] via 10.0.20.2, 00:00:12, Serial1/0
O 10.0.25.0/24 [110/66] via 10.0.20.2, 00:02:34, Serial1/0
20.0.0.0/24 is subnetted, 2 subnets
O 20.0.0.0/24 [110/128] via 20.0.0.65, 00:31:24, Serial1/0
C 20.0.0.65/24 is subnetted, 1 subnets
C 172.16.0.0 [110/65] via 20.0.0.65, 00:31:24, Serial1/0
O IA 192.168.0.0/19 [110/194] via 20.0.0.65, 00:30:44, Serial1/0
O 192.168.40.0/24 [110/130] via 20.0.0.65, 00:30:24, Serial1/0
O 192.168.45.0/24 [110/130] via 20.0.0.65, 00:30:24, Serial1/0
O 192.168.50.0/24 [110/130] via 20.0.0.65, 00:30:24, Serial1/0
O 192.168.60.0/24 [110/130] via 20.0.0.65, 00:30:34, Serial1/0
O 192.168.70.0/24 [110/66] via 10.0.20.2, 00:00:12, Serial1/0
O 192.168.75.0/24 [110/66] via 10.0.20.2, 00:00:12, Serial1/0
O 192.168.80.0/24 [110/66] via 10.0.20.2, 00:00:12, Serial1/0
O 192.168.99.0/24 [110/65] via 20.0.0.65, 00:31:24, Serial1/0
ABR2(config-if)#

```

- Now for the ASBR router which is acts as the gateway for our topology we created a default route at the interface Se1/2, and we redistributed it to all OSPF networks.

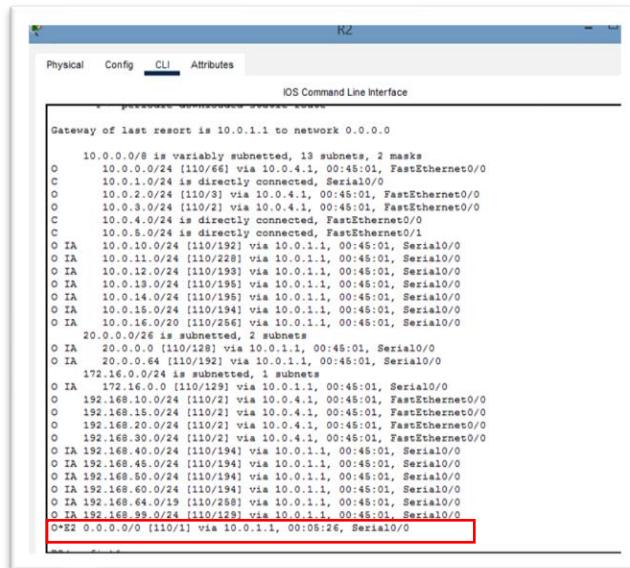
```

Physical Config CLI Attributes
IOS Command Line Interface
O IA 20.0.0.16.0/24 [110/129] via 20.0.0.65, 00:31:28, Serial1/1
20.0.0.0/24 is subnetted, 2 subnets
C 20.0.0.64 is directly connected, Serial1/0
C 172.16.0.0/24 is subnetted, 1 subnets
C 172.16.0.0 is directly connected, FastEthernet0/0.7
O IA 192.168.0.0/19 [110/130] via 10.0.2.2, 00:37:33, Serial1/0
O 192.168.40.0/24 [110/66] via 10.0.10.2, 00:37:33, Serial1/0
O 192.168.45.0/24 [110/66] via 10.0.10.2, 00:07:29, Serial1/0
O 192.168.50.0/24 [110/66] via 10.0.10.2, 00:37:33, Serial1/0
O 192.168.60.0/24 [110/66] via 10.0.10.2, 00:07:29, Serial1/0
O IA 192.168.64.0/19 [110/130] via 20.0.0.66, 00:37:33, Serial1/1
C 192.168.99.0/24 is directly connected, FastEthernet0/0.99
200.168.10.0/28 is subnetted, 1 subnets
C 200.168.10.0 is directly connected, Serial1/2
S* 0.0.0.0/0 is directly connected, Serial1/2

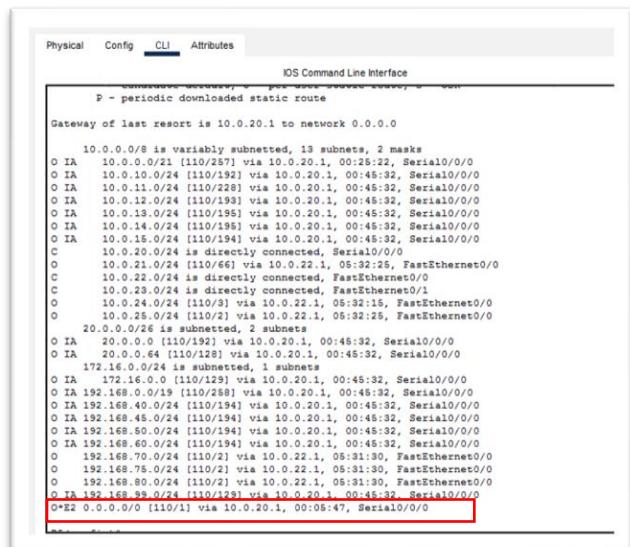
ASBR(config)#
ASBR(config)#
ASBR(config)#do show run | sec ospf
ip ospf cost 100
router ospf 1
log-adjacency-changes
network 10.0.10.0 0.0.0.255 area 0
network 10.0.11.0 0.0.0.255 area 0
network 172.16.0.0 0.0.0.255 area 0
network 192.168.99.0 0.0.0.255 area 0
network 20.0.0.64 0.0.0.63 area 0
network 20.0.0.0 0.0.0.63 area 0
ASBR(config)#
ASBR(config)#
ASBR(config)#
ASBR(config)#router ospf 1
ASBR(config-router)#default-information originate
ASBR(config-router)#
ASBR(config-router)#

```

- And to validate our configuration, we checked the routing table of the routers in each block.
 - Routing table of R2 in the block 1.



- Routing table of R5 in the block 3.



Step 7: Network Address Translation (NAT) and DMZ configuration:

❖ Enterprise Edge configuration

Network Address Translation is a term used to describe several mechanisms used to switch network identifiers, such as an Internet protocol address or port numbers, in network data packets moves between two different address ranges called internal and external range. This mechanism was developed as part of a short-term strategy to address the problem of IP address exhaustion.

NAT is not a protocol, but rather a working mechanism, which takes place in a router that connects two address ranges. Address translation is preceded by an initialization of the router, in which it may be provided with identifier binaries, including part of the inner scope and part of the outer scope, and may provide a policy and specific conditions for forming the binaries automatically and specify the direction in which to allow the creation of the translation session. The router then monitors the traffic between the two domains and starts creating a translation session according to the conditions whenever a packet's identifiers match one of the binaries, and then the translation process continues session packets flowing in all directions, the session is later closed, and the translation process stops after that.

NATing Types:

- *Static Address Translation (Static NAT)*

This type of NAT it chooses for each Private IP a Public IP when it goes out to another network or to the Internet, provided that every device on the network has a real Internet address, meaning that this real address is static.

- *Dynamic Address Translation (Dynamic NAT)*

The dynamic NAT assigns a local address to a global address dynamically. This means that the router dynamically selects an address from the currently unspecified public address pool. Dynamic input remains in the NAT translation table as long as traffic is exchanged. The entry deadline expires after a period of inactivity and the global IP address can be used for new translations.

- *NAT Overloading*

NAT overload, also known as port address translation (PAT) is designed to map multiple private IP addresses to a single (multi-to-one) public IP address using different ports. In other words, one public IP can be used for many internal private IP addresses, hence the term overload. Interestingly, this is the most dominant and the default form of NAT implementation in today's networks where it can connect to thousands of users to the internet using just one public IP address. NAT overload is one of the main reasons why IPv4 address space persists for so long.

A brief description of how NAT works:

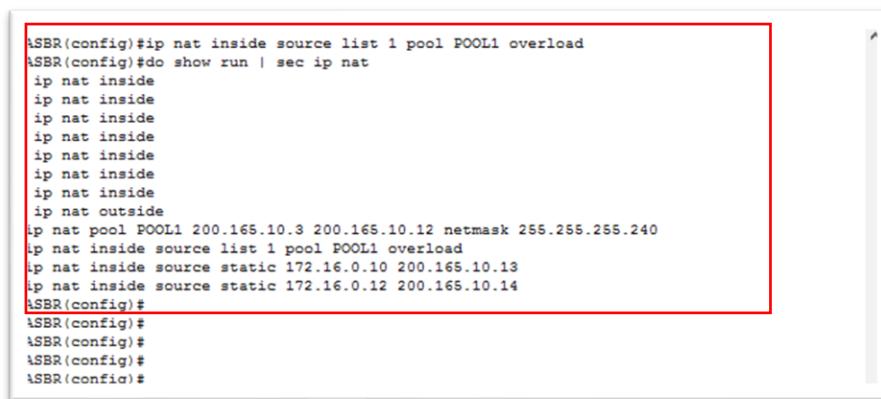
At least two interfaces are available on a NAT-enabled device, one on the inside network and one on the outside network. NAT is setup between a stub domain and the backbone at the exit device. NAT converts the locally significant source address into a globally unique address when a packet leaves the domain. NAT converts the globally unique destination address into a local address when a packet enters the domain. Each NAT must have the same translation table if there are multiple exit points. If NAT is unable to allocate an address due to a lack of addresses, the packet is dropped. The destination then receives an Internet Control Message Protocol (ICMP) host unreachable packet from NAT.

NATing configuration:

In our topology we used Dynamic NAT, and since we have only one exit point (ASBR router) we have setup NAT configuration at this router.

The configuration of dynamic NAT involves four steps:

1. Identify the inside and outside interfaces.
 2. Identify IP addresses (private IP addresses) that require translation and create an access list for them.
 3. All global IP addresses available for translation should be grouped together in a pool.
 4. After that, map the access list with the pool.
- The figure below shows the configuration of identifying the inside and outside interfaces, the creating of the standard ACL and the NAT pool.
 - We also configured a static NAT translation for the servers in the DMZ so that it will be accessed by external users.



```
ASBR(config)#ip nat inside source list 1 pool POOL1 overload
ASBR(config)#do show run | sec ip nat
ip nat inside
ip nat outside
ip nat pool POOL1 200.165.10.3 200.165.10.12 netmask 255.255.255.240
ip nat inside source list 1 pool POOL1 overload
ip nat inside source static 172.16.0.10 200.165.10.13
ip nat inside source static 172.16.0.12 200.165.10.14
ASBR(config)#
ASBR(config)#
ASBR(config)#
ASBR(config)#
ASBR(config)#
```

```
LSBR>
LSBR>
LSBR>en
LSBR#conf t
Enter configuration commands, one per line. End with CNTL/Z.
LSBR(config)#ip access-list extended DMZ
LSBR(config-ext-nacl)#permit udp any host 200.165.10.13 eq domain
LSBR(config-ext-nacl)#permit tcp any host 200.165.10.14 eq 80
LSBR(config-ext-nacl)#permit ip any 200.165.10.0 0.0.0.15
LSBR(config-ext-nacl)#exit
LSBR(config) #
```

```
FastEthernet0/1      unassigned      YES unset administratively down down
Serial0/0            10.0.10.1     YES manual up          up
Serial0/1            10.0.11.1     YES manual up          up
Serial0/0            20.0.0.1      YES manual up          up
Serial1/1            20.0.0.65     YES manual up          up
Serial1/2            200.165.10.2   YES manual up          up
Serial1/3            unassigned     YES unset administratively down down
LSBR(config)#int Sel/2
LSBR(config-if)#ip access-group DMZ in
LSBR(config-if)#exit
LSBR(config)#int S0/0
LSBR(config-if)#ip access-group DMZ out
LSBR(config-if)#exit
LSBR(config-if)#int Se0/1
LSBR(config-if)#ip access-group DMZ out
LSBR(config-if)#exit
LSBR(config)#int Sel/0
LSBR(config-if)#ip access-group DMZ out
LSBR(config-if)#exit
^
! Invalid input detected at '^' marker.

LSBR(config-if)#exit
LSBR(config)#int Sel/0/1
LSBR(config-if)#exit
LSBR(config)#int Sel/1
LSBR(config-if)#ip access-group DMZ out
LSBR(config-if)#exit
LSBR(config-if)#int Fa0/0.7
LSBR(config-subif)#ip access-group DMZ out
LSBR(config-subif)#exit
LSBR(config)#int Fa0/0.99
LSBR(config-subif)#ip access-group DMZ out
LSBR(config-subif)#exit
```

Step 8: Border Gateway Protocol (BGP):

- *Exterior Routing Protocols*

Exterior routing protocols, also known as exterior gateway protocols, are used to convey routing information between autonomous systems. An autonomous system is a collection of routers under a single technical administration. Route packets to other Autonomous System is an exterior gateway protocol

- *Exterior Gateway Protocol*

A gateway running EGP declares that it can communicate with networks within its autonomous system. It makes no claim to being able to connect to networks outside of its autonomous system. The systems first exchange EGP Hello and I-Heard-You (I-H-U) messages before exchanging routing information. These signals open a channel of communication between two EGP gateways.

After acquiring a neighbor, a poll is used to obtain routing information. The responding neighbor sends an update, which is a packet of reachability data. The routes from the update are stored in the local routing database of the local system. If the neighbor does not answer to three polls in a row, the system concludes the neighbor is down and removes the neighbor's routes from its table. When an EGP neighbor sends a poll, the system answers with its own update packet.

EGP does not try to pick the "best" path. EGP updates include distance-vector data, however this data is not evaluated by EGP. Different autonomous systems' routing metrics are not directly comparable. These values may be developed using different criteria by each AS. As a result, EGP delegated the task of selecting the "optimal" route to someone else.

EGP has three primary purposes:

1. Create a group of neighbors.
2. Determine whether your neighbors are alive and reachable.
3. Inform your neighbors about the networks that are accessible from their AS.

On the Internet the EGP gained widespread acceptance

Because the protocol does not respond to flaws within the Autonomous system, the routing table remains stable with few changes is a simple reachability protocol that is limited to tree-like topologies and does not support multipath networking environments, making it inefficient compared to distance-vector and path-vector protocols. Because this routing protocol is designed to be centrally managed, it has limited scalability, which is a significant disadvantage in today's rapidly expanding Internet.

Another factor is that the commercialized Internet is not governed by any central body. The Internet is made up of several different networks. Autonomous systems in a distributed architecture require routing protocols that can make intelligent routing decisions. As a result, EGP is no longer widely used.

- *Border Gateway Protocol (BGP)*

As a result, in our project, we used The Border Gateway Protocol (BGP) which is the protocol almost exclusively used, it is designed to exchange routing and reachability information among autonomous systems (AS) on the Internet.

It is the language used by Internet routers to determine how packets can be transferred from one router to another to reach their destination. BGP has performed admirably and remains the protocol that keeps the Internet running. Internal BGP, or iBGP, is when BGP is used to route within a single AS. External BGP, or eBGP, is a protocol that connects one AS to another.

It's a path-vector routing protocol that decides on routes based on path. If one internet path goes down, BGP provides network stability by ensuring that routers can rapidly adapt to transmit messages through another link. BGP makes best-path judgments based on current reachability, hop counts, and other path parameters, as well as paths, rules, or network policies defined by a network administrator.

BGP policies convey an organization's preferences for which path traffic should take in and out, much like they do within a big hosting facility. BGP community tags can be used to regulate how peers broadcast routes. A standard routing table is maintained by each BGP router and is used to steer packets in transit. BGP communicates routing information via client-server topology, with the client-server initiating a BGP session by sending a request to the server.

TCP/IP is the basis of BGP in networking. The current version of BGP-4, which controls the Network Layer via the OSI Transport Layer, supports both IPv6 and Classless Inter-Domain Routing (CIDR), allowing IPv4 to remain viable.

The configuration of the BGP:

We created three Autonomous Systems and configured the BGP (inter-domain routing protocol). In the AS 2000 we configured the EIGRP (internal routing protocol).

The BGP configuration:

ISP

Entry 1

Entry 2

ISP Z

```

Cisco 2811 (MWC860) processor (revision 0x200) with 60416K/5120K bytes of memory
Processor board ID JD05190MZ (4292891498)
2 FastEthernet interface(s)
2 Low-speed serial(sync/async) network interface(s)
DRAM configuration is 64 bits wide with parity disabled.
256K bytes of non-volatile configuration memory.
249856K bytes of ATA System CompactFlash 0 (Read/Write)

Press RETURN to get started!

*BGP-4-NORTRID: BGP could not pick a router-id. Please configure manually.

*LINK-5-CHANGED: Interface Serial0/0/0, changed state to up
*LINK-5-CHANGED: Interface Serial0/0/1, changed state to up
*LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/0/1, changed state to up
*LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/0/0, changed state to up
*BGP-5-ADJCHANGE: neighbor 200.165.20.2 Up

Router>
Router>en
Router#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#do show run | sec pop
Router(config)#do show run | sec bgp
router bgp 1000
  bgp router-id 1.1.1.1
  bgp log-neighbor-changes
  no synchronization
  neighbor 200.165.20.2 remote-as 2000
  network 200.165.10.0 mask 255.255.255.240
Router(config)#

```

```

3 Gigabit Ethernet interfaces
2 Low-speed serial(sync/async) network interface(s)
DRAM configuration is 64 bits wide with parity disabled.
256K bytes of non-volatile configuration memory.
249856K bytes of ATA System CompactFlash 0 (Read/Write)

Press RETURN to get started!

*BGP-4-NORTRID: BGP could not pick a router-id. Please configure manually.

*LINK-5-CHANGED: Interface Serial0/2/0, changed state to up
*LINK-5-CHANGED: Interface Serial0/2/1, changed state to up
*LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/2/1, changed state to up
*LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/2/0, changed state to up
*BGP-5-ADJCHANGE: neighbor 200.165.20.1 Up

*DUAL-5-NBRCHANGE: IP-EIGRP 100: Neighbor 200.165.30.1 (Serial0/2/1) is up: new adjacency

Router>
Router>en
Router#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#do show run | sec bgp
  redistribute bgp 2000 metric 10000 10 255 1 1500
router bgp 2000
  bgp router-id 2.2.2.2
  bgp log-neighbor-changes
  no synchronization
  neighbor 200.165.20.1 remote-as 1000
  network 200.165.50.0 mask 255.255.255.252
Router(config)#

```

```

* Low-speed serial(sync/async) network interface(s)
DRAM configuration is 64 bits wide with parity disabled.
256K bytes of non-volatile configuration memory.
249856K bytes of ATA System CompactFlash 0 (Read/Write)

Press RETURN to get started!

*BGP-4-NORTRID: BGP could not pick a router-id. Please configure manually.

*LINK-5-CHANGED: Interface Serial0/2/1, changed state to up
*LINK-5-CHANGED: Interface Serial0/2/0, changed state to up
*LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/2/0, changed state to up
*LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/2/1, changed state to up
*DUAL-5-NBRCHANGE: IP-EIGRP 100: Neighbor 200.165.40.1 (Serial0/2/1) is up: new adjacency
*BGP-5-ADJCHANGE: neighbor 200.165.50.1 Up

Router>
Router>en
Router#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#do show run | sec bgp
  redistribute bgp 2000 metric 10000 10 255 1 1500
router bgp 2000
  bgp router-id 4.4.4.4
  bgp log-neighbor-changes
  no synchronization
  neighbor 200.165.50.1 remote-as 3000
  network 200.165.10.0 mask 255.255.255.240
  network 200.165.50.0 mask 255.255.255.252
Router(config)#

```

```

A summary of U.S. laws governing Cisco cryptographic products may be found at:
http://www.cisco.com/wl/export/crypto/tool/stqrg.html

If you require further assistance please contact us by sending email to
export@cisco.com.

Cisco CISCO2911/W3 (revision 1.0) with 491520K/32768K bytes of memory.
Processor board ID PTX153400KS
3 Gigabit Ethernet interfaces
2 Low-speed serial(sync/async) network interface(s)
DRAM configuration is 64 bits wide with parity disabled.
256K bytes of non-volatile configuration memory.
249856K bytes of ATA System CompactFlash 0 (Read/Write)

Press RETURN to get started!

*BGP-4-NORTRID: BGP could not pick a router-id. Please configure manually.

*LINK-5-CHANGED: Interface Serial0/2/0, changed state to up
*LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/2/0, changed state to up
*BGP-5-ADJCHANGE: neighbor 200.165.50.2 Up

Router>
Router>en
Router#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#do show run | sec bgp
router bgp 3000
  bgp router-id 5.5.5.5
  bgp log-neighbor-changes
  no synchronization
  neighbor 200.165.50.2 remote-as 2000
Router(config)#

```

- Checking the routing tables.

R1 Router#

```
%LINK-5-CHANGED: Interface Serial0/2/0, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/2/0, changed state to up
*BGP-5-ADJCHANGE: neighbor 200.165.50.2 Up

Router>
Router>en
Router#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#do show run i sec bgp
router bgp 3000
  bgp router-id 5.5.5.5
  bgp log-neighbor-changes
  no synchronization
  neighbor 200.165.50.2 remote-as 2000
Router(config)#do show 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, E - EGP
      i - IS-IS, 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

Gateway of last resort is not set

  200.165.10.0/28 is subnetted, 1 subnets
B    200.165.10.0/28 [20/0] via 200.165.50.2, 00:00:00
  200.165.50.0/24 is variably subnetted, 2 subnets, 2 masks
C    200.165.50.0/30 is directly connected, Serial0/2/0
L      200.165.50.1/32 is directly connected, Serial0/2/0

```

R2 Router#

```
Router>en
Router#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#do show run i sec bgp
redistribute bgp 2000 metric 10000 10 255 1 1500
router bgp 2000
  bgp router-id 4.4.4.4
  bgp log-neighbor-changes
  no synchronization
  neighbor 200.165.50.1 remote-as 3000
  network 200.165.10.0 mask 255.255.255.240
  network 200.165.50.0 mask 255.255.255.252
Router(config)#do show 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, E - EGP
      i - IS-IS, 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

Gateway of last resort is not set

  200.165.10.0/28 is subnetted, 1 subnets
D EX  200.165.10.0/28 [170/2197486] via 200.165.40.1, 00:19:34, Serial0/2/1
  200.165.40.0/24 is variably subnetted, 2 subnets, 2 masks
D  200.165.40.0/24 is variably subnetted, 2 subnets, 2 masks
C  200.165.40.0/30 is directly connected, Serial0/2/1
L  200.165.40.2/32 is directly connected, Serial0/2/1
  200.165.50.0/24 is variably subnetted, 2 subnets, 2 masks
C  200.165.50.0/30 is directly connected, Serial0/2/0
L  200.165.50.1/32 is directly connected, Serial0/2/0

```

R1 Router#

```
%DUAL-5-NBRCHANGE: IP-EIGRP 100: Neighbor 200.165.40.2 (Serial0/2/1) is up: new adjacency
%LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/2/0, changed state to up
%DUAL-5-NBRCHANGE: IP-EIGRP 100: Neighbor 200.165.30.2 (Serial0/2/0) is up: new adjacency

Router>
Router>en
Router#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#do show 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, E - EGP
      i - IS-IS, 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

Gateway of last resort is not set

  200.165.10.0/28 is subnetted, 1 subnets
D EX  200.165.10.0/28 [170/2195466] via 200.165.30.2, 00:20:07, Serial0/2/0
  200.165.30.0/24 is variably subnetted, 2 subnets, 2 masks
C  200.165.30.0/30 is directly connected, Serial0/2/0
L  200.165.30.1/32 is directly connected, Serial0/2/0
  200.165.40.0/24 is variably subnetted, 2 subnets, 2 masks
C  200.165.40.0/30 is directly connected, Serial0/2/1
L  200.165.40.1/32 is directly connected, Serial0/2/1
  200.165.50.0/30 is subnetted, 1 subnets
D EX  200.165.50.0/30 [170/2195466] via 200.165.40.2, 00:20:08, Serial0/2/1

```

- The configuration of the EIGRP routing protocol inside the AS 200.

Entry 1		ROUTER I	
Physical	Config	CLI	Attributes
IOS Command Line Interface			
#DUAL-5-NBRCHANGE: IP-EIGRP 100: Neighbor 200.165.30.2 (Serial0/2/0) is up: new adjacency			
Router(config)#	Router(config)#	Router>	Router#
Router(config)#	Router(config)#	Router#	Router#
Router(config)#do show ip route	Router(config)#do show ip route	Router>	Router#
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP	Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP	Router#	Router#
D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area	D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area	Router#	Router#
NI - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2	NI - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2	Router#	Router#
E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP	E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP	Router#	Router#
i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area	i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area	Router#	Router#
* - candidate default, U - per-user static route, o - ODR	* - candidate default, U - per-user static route, o - ODR	Router#	Router#
P - periodic downloaded static route	P - periodic downloaded static route	Router#	Router#
Gateway of last resort is not set			
200.165.10.0/28 is subnetted, 1 subnets	200.165.10.0/28 is subnetted, 1 subnets	Gateway of last resort is not set	
B 200.165.10.0/28 [20/0] via 200.165.20.1, 00:00:00	B 200.165.10.0/28 [20/0] via 200.165.20.1, 00:00:00	200.165.10.0/28 is subnetted, 1 subnets	
200.165.20.0/24 is variably subnetted, 2 subnets, 2 masks	200.165.20.0/24 is variably subnetted, 2 subnets, 2 masks	D 200.165.10.0/28 [170/2198466] via 200.165.30.2, 00:20:07, Serial0/2/0	D 200.165.10.0/28 [170/2198466] via 200.165.30.2, 00:20:07, Serial0/2/0
C 200.165.20.0/30 is directly connected, Serial0/2/0	C 200.165.20.0/30 is directly connected, Serial0/2/0	B 200.165.30.0/24 is variably subnetted, 2 subnets, 2 masks	B 200.165.30.0/24 is variably subnetted, 2 subnets, 2 masks
L 200.165.20.2/32 is directly connected, Serial0/2/0	L 200.165.20.2/32 is directly connected, Serial0/2/0	C 200.165.30.0/30 is directly connected, Serial0/2/0	C 200.165.30.0/30 is directly connected, Serial0/2/0
200.165.30.0/24 is variably subnetted, 2 subnets, 2 masks	200.165.30.0/24 is variably subnetted, 2 subnets, 2 masks	L 200.165.30.1/32 is directly connected, Serial0/2/0	L 200.165.30.1/32 is directly connected, Serial0/2/0
C 200.165.30.0/30 is directly connected, Serial0/2/1	C 200.165.30.0/30 is directly connected, Serial0/2/1	200.165.40.0/30 is subnetted, 1 subnets	200.165.40.0/30 is subnetted, 1 subnets
L 200.165.30.2/32 is directly connected, Serial0/2/1	L 200.165.30.2/32 is directly connected, Serial0/2/1	D 200.165.40.0/30 [90/2681866] via 200.165.30.1, 00:20:45, Serial0/2/1	D 200.165.40.0/30 [90/2681866] via 200.165.30.1, 00:20:44, Serial0/2/1
200.165.40.0/30 is subnetted, 1 subnets	200.165.40.0/30 is subnetted, 1 subnets	B 200.165.50.0/30 is subnetted, 1 subnets	B 200.165.50.0/30 is subnetted, 1 subnets
D 200.165.40.0/30 [90/2681866] via 200.165.30.1, 00:20:45, Serial0/2/1	D 200.165.40.0/30 [90/2681866] via 200.165.30.1, 00:20:44, Serial0/2/1	C 200.165.50.0/30 is directly connected, Serial0/2/1	C 200.165.50.0/30 is directly connected, Serial0/2/1
200.165.50.0/30 is subnetted, 1 subnets	200.165.50.0/30 is subnetted, 1 subnets	L 200.165.50.1/32 is directly connected, Serial0/2/1	L 200.165.50.1/32 is directly connected, Serial0/2/1
D EX 200.165.50.0/30 [170/2707456] via 200.165.30.1, 00:20:44, Serial0/2/1	D EX 200.165.50.0/30 [170/2707456] via 200.165.30.1, 00:20:44, Serial0/2/1	200.165.50.0/30 is subnetted, 1 subnets	200.165.50.0/30 is subnetted, 1 subnets
Router(config)#	Router(config)#	Router(config)#	Router(config)#
Router(config)#	Router(config)#	Router(config)#	Router(config)#
Router(config)#do show run sec ei	Router(config)#do show run sec ei	Router(config)#	Router(config)#
router eigrp 100	router eigrp 100	Router(config)#	Router(config)#
redistribute bgp 2000 metric 10000 10 255 1 1500	redistribute bgp 2000 metric 10000 10 255 1 1500	Router(config)#	Router(config)#
network 200.165.30.0 0.0.0.3	network 200.165.30.0 0.0.0.3	Router(config)#	Router(config)#
bgp log-neighbor-changes	bgp log-neighbor-changes	Router(config)#	Router(config)#
neighbor 200.165.20.1 remote-as 1000	neighbor 200.165.20.1 remote-as 1000	Router(config)#	Router(config)#

CHAPTER6:

ADDRESSING

6.1 Block IP Addresses:

6.1.1 BLOCK 1

VLAN	DEPARTMENT	NETWORK ADDRESS	FIRST ADDRESS	LAST ADDRESS	BROADCAST ADDRESS	SUBNET MASK
10	Managers	192.168.10.0	192.168.10.1	192.168.10.254	192.168.10.255	255.255.255.0
15	IP-Tele	192.168.15.0	192.168.15.1	192.168.15.254	192.168.15.255	255.255.255.0
20	Logistic	192.168.20.0	192.168.20.1	192.168.20.254	192.168.20.255	255.255.255.0
30	HR	192.168.30.0	192.168.30.1	192.168.30.254	192.168.30.255	255.255.255.0

TABLE 2 LIST OF BLOCK1 IP ADDRESSES

6.1.2 BLOCK 2

VLAN	DEPARTMENT	NETWORK ADDRESS	FIRST ADDRESS	LAST ADDRESS	BROADCAST ADDRESS	SUBNET MASK
40	Finance	192.168.40.0	192.168.40.1	192.168.40.254	192.168.40.255	255.255.255.0
45	IP-Tele	192.168.45.0	192.168.45.1	192.168.45.254	192.168.45.255	255.255.255.0
50	Marketing	192.168.50.0	192.168.50.1	192.168.50.254	192.168.50.255	255.255.255.0
60	Training	192.168.60.0	192.168.60.1	192.168.60.254	192.168.60.255	255.255.255.0
99	Management	192.168.99.0	192.168.99.1	192.168.99.254	192.168.99.255	255.255.255.0
7	Room Server	172.16.0.0	172.16.0.1	172.16.0.254	172.16.0.255	255.255.255.0

TABLE 3 LIST OF BLOCK2 IP ADDRESSES

6.1.3 BLOCK 3

VLAN	DEPARTMENT	NETWORK ADDRESS	FIRST ADDRESS	LAST ADDRESS	BROADCAST ADDRESS	SUBNET MASK
70	Support	192.168.70.0	192.168.70.1	192.168.70.254	192.168.70.255	255.255.255.0
75	IP-Tele	192.168.75.0	192.168.75.1	192.168.75.254	192.168.75.255	255.255.255.0
80	Researchers	192.168.80.0	192.168.80.1	192.168.80.254	192.168.80.255	255.255.255.0

TABLE 4 LIST OF BLOCK3 IP ADDRESSES

6.2 The Network IP Addresses

Location	VLANs	Address	Gateway	DNS-Server
Block 1	10	192.168.10.0/24	192.168.10.1/24	172.16.0.10/24
	15	192.168.15.0/24	192.168.15.1/24	
	20	192.168.20.0/24	192.168.20.1/24	
	30	192.168.30.0/24	192.168.30.1/24	
Block 2	7	172.16.0.0/24	172.16.0.1/24	172.16.0.10/24
	45	192.168.40.0/24	192.168.40.1/24	
	50	192.168.45.0/24	192.168.45.1/24	
	60	192.168.50.0/24	192.168.50.1/24	
	99	192.168.60.0/24	192.168.60.1/24	
		192.168.99.0/24	192.168.99.1/24	
Block 3	70	192.168.70.0/24	192.168.70.1/24	172.16.0.10/24
	75	192.168.75.0/24	192.168.75.1/24	
	80	192.168.80.0/24	192.168.80.1/24	

TABLE 5 LIST OF NETWORK IP ADDRESSES

6.3 BGP IP Addresses

Router ID	Protocol ID	Network	Subnet Mask/Wildcard	Neighbor
1.1.1.1 (ISP)	BGP 1000	200.165.10.0	255.255.255.240	200.165.10.2
2.2.2.2	EIGRP 100	200.165.30.0	0.0.0.3	-
	BGP 2000	200.165.50.0	255.255.255.252	200.165.20.1
3.3.3.3	EIGRP 100	200.165.40.0	0.0.0.3	-
		200.165.30.0	0.0.0.3	-
4.4.4.4	EIGRP 100	200.165.40.0	0.0.0.3	-
		200.165.10.0	255.255.255.240	200.165.50.1
		200.165.50.0	255.255.255.252	200.165.50.1
5.5.5.5	-	-	-	200.165.50.2

TABLE 6 LIST OF BGP IP ADDRESSES

CHAPTER7: IMPLEMENTATION

7.1 Introduction

This chapter will describe the implementation process of the Enterprise Campus Network. The first section presents a brief description of the tools used to deploy the network. In the second section, we present the devices and their capabilities for each layer in the network. In the third section, the implementation specification is presented for the main functions of Enterprise Campus Network with the related configuration protocols.

7.2 Tool Used

In the following sections, we present a simple explanation of the tools that helped us during the implementation phase.

7.2.1 General Tools

I. Microsoft Office

Microsoft office pack includes many useful desktop applications. Microsoft Word has been used to write and edit project document.

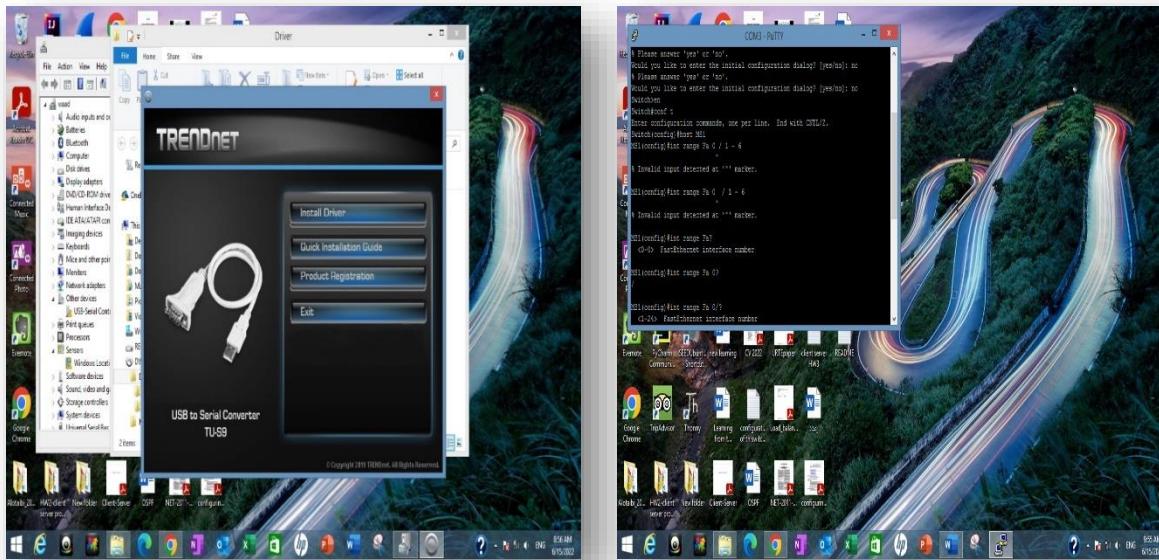
II. Microsoft Teams:

Microsoft Teams is a real time interactive app for organizations— Microsoft Teams has been used in communication between the teams' members, meetings, file sharing and records the configurations.

7.2.2 Specific Tools

I. Putty

“Putty is an open-source software lets admins connect safely to remote systems, it allows users to connect to routers, switches, and servers. We use it in our project to configures various protocols to the routers and multi-switches, and connect remotely to any computer starting from the Windows operating system to run it easily from our device



7.3 Network Devices

In this section, we present the devices and their capabilities for each layer that has been used in our network.

DEVICE	CAPABILITIES	LAYER	FIGURE
Cisco Catalyst 3560 Series Switches	Provide availability and security. Provide a quality of service (QoS) to enhance network operations. Provide multicast management. Provide high performance IP routing	Distribution Layer	 A blue Cisco Catalyst 3560 Series switch with multiple ports and a label.
Cisco Catalyst 2950 Series Switches	Provide superior redundancy for fault backup Provide wide security features. Provide a quality of service (QoS) Provide superior manageability.	Access Layer	 A grey Cisco Catalyst 2950 Series switch with multiple ports and a label.
Cisco Catalyst 2960 Series Switches	Enhanced troubleshooting for problem solving. Limited lifetime hardware warranty. Enforcing basic security policies. Implementing quality of service (QoS).	Access Layer	 A grey Cisco Catalyst 2960 Series switch with multiple ports and a label.
Cisco 2811 Router	Deliver multiple high-quality simultaneous services at wire speed up to multiple T1/E1/xDSL connections. Offers embedded encryption acceleration and on the motherboard voice digital-signal-processor slots. Integrated call processing and voice mail support. Provide high-density interfaces for a wide range of sufficient performance.	Core Layer	 A black Cisco 2811 router with multiple ports and a label.

DEVICE	CAPABILITIES	LAYER	FIGURE
Cisco 1841 Router	<p>Provide high-Performance processor.</p> <p>Integrated hardware-based encryption acceleration</p> <p>Integrated dual high-speed ethernet LAN Ports</p>	Core Layer	 A blue Cisco 1841 router with two Ethernet ports visible on the left side.
Cisco 2621XM Router	<p>Provides flexible LAN and WAN configurations.</p> <p>Provides multiple security options.</p> <p>Provides voice/data integration.</p> <p>Provides a range of high-performance processors.</p>	Core Layer	 A dark grey Cisco 2621XM router with multiple Ethernet ports and a power input on the left side.
Cisco 2621 Router	<p>Provides flexible LAN and WAN configurations.</p> <p>Provides multiple security options.</p> <p>Provides voice/data integration.</p> <p>Provides a range of high-performance processors.</p>	Core Layer	 A black Cisco 2621 router with multiple Ethernet ports and a power input on the left side.

TABLE 7 DEVICES CAPABILITIES AND LAYERS

7.4 Network Implementation

In this section we present the most important configuration of our network.

7.4.1 Block 1 Configuration:

- #### ❖ Access and Distribution layers Configuration

Step 1: EtherChannel:

We started with the multi-layer switch, and we named it MS1.

```
COM3-PUTTY
00:57:49: WLINE-5-CHANGED: Interface FastEthernet0/4, changed state to administratively down
HSI(config-if-range)>#channel-group 2
% Incomplete command.

HSI(config-if-range)>#channel-group 2 mode active
Creating a port-channel interface Port-Channel 2

HSI(config-if-range)># shut
HSI(config-if-range)>#exit
00:58:33: WLINE-3-PROTOK: Interface FastEthernet0/3, changed state to up
00:58:33: WLINE-3-PROTOK: Interface FastEthernet0/4, changed state to up
HSI(config)port-channel
00:58:43: WLINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/4, changed state to up
00:58:44: WLINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/3, changed state to up
% Incomplete command.

HSI(config)port-channel 2
HSI(config-if-range)># trunk encapsulation dot1q
HSI(config-if-range)>#exit
00:58:53: WDC-5-CANNOT_BUNDLE: Fa0/3 is not compatible with Fa0/4 and will be suspended (trunk encap of Fa0/3 is auto, Fa0/4 is doing)2
HSI(config-if-range)>#exit
00:59:07: WDC-5-COMPATIBLE: Fa0/3 is compatible with port-channel members
HSI(config-if-range)>#exit
Command rejected. An interface whose trunk encapsulation is "Auto" can not be configured to "trunk" mode.

HSI(config-if-range)>exit
HSI(config)port-channel 2
HSI(config-if-range)># trunk encapsulation dot1q
HSI(config-if-range)>#exit
HSI(config-if-range)>#new mode trunk
HSI(config-if-range)>#exit
HSI(config-if-range)>#exit
% Invalid input detected at "" marker.

HSI(config-if-range)>#new mode trunk
HSI(config-if-range)>#exit
HSI(config-if-range)>#exit
00:59:27: WLINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/3, changed state to down
00:59:27: WLINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/4, changed state to down
00:59:27: WLINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/3, changed state to up
00:59:27: WLINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/4, changed state to up
HSI(config-if-range)>#Fa0/5 +4
HSI(config-if-range)>#channel-
HSI(config-if-range)>#exit
00:59:58: WLINE-5-CHANGED: Interface FastEthernet0/5, changed state to administratively down
00:59:58: WLINE-5-CHANGED: Interface FastEthernet0/6, changed state to administratively down
00:59:58: WLINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/5, changed state to down
```

- Then, we configured the second multi-layer switch in this block, and we named it MS2
 - After that, we configured the next switch, which is the layer 2 switch, we gave it a name S1.
 - The configuration of the second layer 2 switch in this block (S2).

```

COM3 - PUTTY

S2(config-if-range)#channel-group 2 mode active
Creating a port-channel interface Port-channel 2

S2(config-if-range)#no shut
S2(config-if-range)#
S2(config-if-range)#
01:13:27 %LINK-5-UPDOWN: Interface FastEthernet0/3, changed state to up
01:13:27 %LINK-5-UPDOWN: Interface FastEthernet0/4, changed state to up
S2(config-if-range)#
S2(config-if-range)#
01:13:33 %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/3, changed state to up
01:13:34 %LINK-5-UPDOWN: Interface Port-channel2, changed state to up
01:13:34 %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/4, changed state to up
01:13:35 %LINEPROTO-5-UPDOWN: Line protocol on Interface Port-channel2, changed state to up
S2(config-if-range)#exit
S2(config)#
S2(config)#int port-channel 2
S2(config-if-range)#new mode trunk
S2(config-if-range)#
S2(config)#
S2(config)#int range Fa0/5 - 6
S2(config-if-range)#shut
S2(config-if-range)#
S2(config-if-range)#
01:13:14 %LINK-5-CHANGED: Interface FastEthernet0/5, changed state to administratively down
01:13:15 %LINK-5-CHANGED: Interface FastEthernet0/6, changed state to administratively down
01:13:15 %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/5, changed state to down
01:13:16 %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/6, changed state to down
S2(config-if-range)#chane-group 3
channe-group 3
      ^
% Invalid input detected at `''' marker.

% Invalid input detected at `''' marker.

S2(config-if-range)#channel-group 3 mode active
Creating a port-channel interface Port-channel 3

S2(config-if-range)#no shut
S2(config-if-range)#
S2(config-if-range)#
01:13:46 %LINK-5-UPDOWN: Interface FastEthernet0/5, changed state to up
01:13:46 %LINK-5-UPDOWN: Interface FastEthernet0/6, changed state to down
01:13:48 %LINK-5-UPDOWN: Interface FastEthernet0/5, changed state to up
01:13:52 %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/5, changed state to up
01:13:53 %LINK-5-UPDOWN: Interface Port-channel3, changed state to up
01:13:54 %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/6, changed state to up
01:13:54 %LINEPROTO-5-UPDOWN: Line protocol on Interface Port-channel3, changed state to up
S2(config-if-range)#exit

```

```

Switch#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Switch(config)#host S2
S2(config)#
S2(config)#
S2(config)#
S2(config)# int range Fa0/1 - 6
S2(config-if-range)# switchport mode trunk
S2(config-if-range)#exit
S2(config)#
S2(config)# int range Fa0/1 - 2
S2(config-if-range)#shut
S2(config-if-range)#shut

01:10:53: :LINK-5-CHANGED: Interface FastEthernet0/1, changed state to administratively down
01:10:53: :LINK-5-CHANGED: Interface FastEthernet0/2, changed state to administratively down
01:10:54: :LINK-5-UNKNOWN: Line protocol on Interface FastEthernet0/1, changed state to down
01:10:54: :LINK-5-UNKNOWN: Line protocol on Interface FastEthernet0/2, changed state to down
S2(config-if-range)#channel-group 1 mode active
Creating a port-channel interface Port-channel 1

S1(config-if-range)#no shut
S1(config-if-range)#
01:11:14: :LINK-5-DECODED: Interface FastEthernet0/1, changed state to up
01:11:15: :LINK-5-DECODED: Interface FastEthernet0/2, changed state to up
S1(config-if-range)#
01:11:20: :LINK-ROT-5-UNKNOWN: Line protocol on Interface FastEthernet0/1, changed state to up
01:11:20: :LINK-ROT-5-UNKNOWN: Line protocol on Interface FastEthernet0/2, changed state to up
01:11:21: :LINK-5-DECODED: Interface Port-channel 1, changed state to up
01:11:22: :LINK-ROT-5-UNKNOWN: Line protocol on Interface Port-channel 1, changed state to up
S1(config-if-range)#exit
S1(config)#
S1(config)# port-channel 1
S1(config-if)#switchport mode trunk
S1(config-if)#exit

S2(config)#
S2(config)# int range Fa0/3 - 4
S2(config-if-range)#shut
S2(config-if-range)#
01:12:04: :LINK-5-CHANGED: Interface FastEthernet0/3, changed state to administratively down
01:12:04: :LINK-5-CHANGED: Interface FastEthernet0/4, changed state to administratively down
01:12:05: :LINK-5-UNKNOWN: Line protocol on Interface FastEthernet0/3, changed state to down
S2(config-if-range)#
01:12:05: :LINK-5-UNKNOWN: Line protocol on Interface FastEthernet0/4, changed state to down
S2(config-if-range)#channel-group 2
channel-group 2
% Incomplete command.

S1(config)#

```

```
COM3 - PuTTY
Switch>
Switch#
Switch#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Switch(config)#int MS1/0/1
MS1(config)#int range Fa0/1 ~ 6
MS1(config)#sw trunk encapsulation dot1q
               .
               .
% Invalid input detected at `''' marker.

MS1(config-if-range)#sw trunk encapsulation dot1q
               .
               .
% Invalid input detected at `''' marker.

MS1(config-if-range)#sw trunk encapsulation dot1q
               .
               .
% Invalid input detected at `''' marker.

MS1(config-if-range)#sw trunk encapsulation dot1q
MS1(config-if-range)#sw mode trunk
MS1(config-if-range)#exit
01:11:50: WLNREHUT0-5-UKNOWN: line protocol on Interface FastEthernet0/1, changed state to down
01:11:50: WLNREHUT0-5-UKNOWN: line protocol on Interface FastEthernet0/2, changed state to down
MS1(config)#
01:11:53: WLNREHUT0-5-UKNOWN: Line protocol on Interface FastEthernet0/1, changed state to up
01:11:53: WLNREHUT0-5-UKNOWN: Line protocol on Interface FastEthernet0/2, changed state to up
MS1(config)#int Fa0/1 ~ 2
               .
               .
% Invalid input detected at `''' marker.

MS1(config)#int range Fa0/1 ~ 2
MS1(config-if-range)#dot1q
MS1(config-if-range)#channel-
01:12:23: WLNK-5-CHANGED: Interface FastEthernet0/1, changed state to administratively down
01:12:23: WLNK-5-CHANGED: Interface FastEthernet0/2, changed state to administratively down
01:12:30: WLNREHUT0-5-UKNOWN: line protocol on Interface FastEthernet0/1, changed state to down
01:12:30: WLNREHUT0-5-UKNOWN: line protocol on Interface FastEthernet0/2, changed state to down
               .
               .
% Incomplete command.

MS1(config-if-range)#channel-group 1 mode active
```

- We used “show ether summary” command in each switch to check the configuration.

```

MS1#conf t
Enter configuration commands, one per line. End with CNTL/Z.
MS1(config)#do show ether summary
Flags: D - down          P - in port-channel
      I - stand-alone s - suspended
      H - Hot-standby (LACP only)
      R - Layer3           S - Layer2
      U - in use            f - failed to allocate aggregator
      u - unsuitable for bundling
      w - waiting to be aggregated
      d - default port

Number of channel-groups in use: 3
Number of aggregators:           3

Group Port-channel Protocol Ports
-----+-----+-----+
1     Po1(SD)       LACP    Fa0/1(I)   Fa0/2(I)
2     Po2(SD)       LACP    Fa0/3(I)   Fa0/4(I)
3     Po3(SU)        LACP    Fa0/5(P)   Fa0/6(P)

```

```
MS2(config)#  
MS2(config)#int Port-channel 3  
MS2(config-if)#sw trunk encapsulation dot1q  
MS2(config-if)#sw mode trunk  
MS2(config-if)#  
MS2(config-if)#do show ether summary  
Flags: D - down P - in port-channel  
I - stand-alone S - suspended  
H - Hot-standby (LACP only)  
R - Layer3 S - Layer2  
U - in use f - failed to allocate aggregator  
u - unsuitable for bundling  
w - waiting to be aggregated  
d - default port  
  
Number of channel-groups in use: 3  
Number of aggregators: 3  
  
Group Port-channel Protocol Ports  
-----+-----+-----+-----  
1 Po1 (SD) LACP Fa0/1 (I) Fa0/2 (I)  
2 Po2 (SD) LACP Fa0/3 (I) Fa0/4 (I)  
3 Po3 (SU) LACP Fa0/5 (P) Fa0/6 (P)
```

```
S2(config-if-range)#exit
S2(config)#int port-channel 3
S2(config-if)#sw mode trunk
S2(config-if)#
S2(config-if)#exit
S2(config)#do show ether summary
Flags: D - down      P - in port-channel
      I - stand-alone  s - suspended
      H - Hot-standby (LACP only)
      R - Layer3        S - Layer2
      u - unsuitable for bundling
      U - in use        f - failed to allocate aggregator
      d - default port

Number of channel-groups in use: 3
Number of aggregators:          3

Group Port-channel Protocol Ports
-----+-----+-----+
1    Po1(SU)      LACP    Fa0/1(Pd)  Fa0/2(P)
2    Po2(SU)      LACP    Fa0/3(Pd)  Fa0/4(P)
3    Po3(SU)      LACP    Fa0/5(Pd)  Fa0/6(P)
```

Step 2: VTP Configuration:

- We configured MS1 and MS2 in the server mode. For VTP setting for this block (VTP domain: net, VTP password 2022).

```
MS1(config)#vtp domain net
Changing VTP domain name from NULL to net
MS1(config)#vtp password 2022
00:02:20: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/8, changed state to down
00:02:22: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/8, changed state to up
Setting device VLAN database password to 2022
MS1(config)#do show vtp status
VTP Version : 2
Configuration Revision : 5
Maximum VLANs supported locally : 1005
Number of existing VLANs : 8
VTP Operating Mode : Server
VTP Domain Name : net
VTP Pruning Mode : Disabled
VTP V2 Mode : Disabled
VTP Traps Generation : Disabled
MD5 digest : 0x13 0x8D 0x1A 0x4C 0x7C 0xF5 0x64 0x85
Configuration last modified by 0.0.0.0 at 3-1-93 00:12:56
Local updater ID is 0.0.0.0 (no valid interface found)
MS1(config)#do show vlan
VLAN Name Status Ports
```

```
MS2(config)#do show vtp status
VTP Version : 2
Configuration Revision : 5
Maximum VLANs supported locally : 1005
Number of existing VLANs : 8
VTP Operating Mode : Server
VTP Domain Name : net
VTP Pruning Mode : Disabled
VTP V2 Mode : Disabled
VTP Traps Generation : Disabled
MD5 digest : 0x13 0x8D 0x1A 0x4C 0x7C 0xF5 0x64 0x85
Configuration last modified by 0.0.0.0 at 3-1-93 00:12:56
Local updater ID is 0.0.0.0 (no valid interface found)
```

```
S1(config)#do show vtp status
VTP Version : 2
Configuration Revision : 5
Maximum VLANs supported locally : 255
Number of existing VLANs : 8
VTP Operating Mode : Client
VTP Domain Name : net
VTP Pruning Mode : Disabled
VTP V2 Mode : Disabled
VTP Traps Generation : Disabled
MD5 digest : 0x13 0x8D 0x1A 0x4C 0x7C 0xF5 0x64 0x85
Configuration last modified by 0.0.0.0 at 3-1-93 00:12:56
S1(config)#
S1 /AAA#
```

```
Setting device to VTP CLIENT mode.
S2(config)#vtp domain net
Domain name already set to net.
S2(config)#vtp password 2022
Setting device VLAN database password to 2022
S2(config)#
S2(config)#do show vtp status
VTP Version : 2
Configuration Revision : 5
Maximum VLANs supported locally : 128
Number of existing VLANs : 8
VTP Operating Mode : Client
VTP Domain Name : net
VTP Pruning Mode : Disabled
VTP V2 Mode : Disabled
VTP Traps Generation : Disabled
MD5 digest : 0x13 0x8D 0x1A 0x4C 0x7C 0xF5 0x64 0x85
Configuration last modified by 0.0.0.0 at 3-1-93 00:12:56
S2(config)#
S2 /AAA#
```

Step 3: Spanning Tree Protocol (STP).

Configurations:

- we added and named the VLANs of this block.
 - We configured Per VLAN Spanning Tree (PVST), we chose MS1 as the primary Root Bridge for all the four VLANs and MS2 as the secondary Root Bridge for the four VLANs.

Command we used:

- In MS1: spanning-tree vlan 10,15,20,30 root primary.
 - In MS1: spanning-tree vlan 10,15,20,30 root secondary.

```

[H3C]#config# 
[H3C]#config# 
[H3C]#config# 
[H3C]#config# 
[H3C]#config# 
[H3C]#config# 
[H3C]#config# 
[H3C]#config# 
[H3C]#config#>#vlan 10
[H3C]#config#>#show Managers
[H3C]#config#>#vlan 20
[H3C]#config#>#show lacp
[H3C]#config#>#show interfaces
[H3C]#config#>#show ir
[H3C]#config#>#do show vlan

VLAN Name          Status    Ports
----- 
1 default         active   Fa0/1, Fa0/2, Fa0/3, Fa0/10
                      Fa0/11, Fa0/12, Fa0/13, Fa0/14
                      Fa0/15, Fa0/16, Fa0/17, Fa0/18
                      Fa0/19, Fa0/20, Fa0/21, Fa0/22
                      Fa0/23, Fa0/24, So0/1, So0/2

10 Managers        active
100 GigabitEth0
1000 GigabitEth0
1003 times-ring-default
1004 Sfnet-default
1005 times-default

VLAN Type  SADN  INT  Parent  Height  BridgePd  Sdg  BridgeId  Tenant  TenantX
----- 
  1 smc  10001  150  -     -     -     -     0      0
  2 smc  10002  250  -     -     -     -     0      0
  3 smc  10003  350  -     -     -     -     0      0
  3002 fddi 10002  150  -     -     -     -     0      0
  1003 tr 10003  150  -     -     -     -     0      0
  1004 times 10004  150  -     -     -     1000  0      0
  1005 times 10005  150  -     -     -     1000  0      0

Reactive SRW VLANs
----- 

Primary Secondary Type    Ports
----- 

```

```

[2]
MS1(config-vlan)#
MS1(config-vlan)#do show vlan

VLAN Name          Status    Ports
----- -----
1  default         active    Fa0/7, Fa0/8, Fa0/9, Fa0/10
                           Fa0/11, Fa0/12, Fa0/13, Fa0/14
                           Fa0/15, Fa0/16, Fa0/17
                           Fa0/18, Fa0/19, Fa0/20, Fa0/21, Fa0/22
                           Fa0/23, Fa0/24, Gi0/1, Gi6/2

10 Managers        active
20 EthTrunk0       active
30 HR              active
4002 fddi-default  act/unsup
1000 token-ring-default act/unsup
1004 token-ring-default act/unsup
1005 ttnet-default  act/unsup
                           act/unsup

VLAN Type SAID    MTU Parent RingNo BridgeID Stp  BridgMode Transl Transl
----- -----
1  enet 100001     1500 -      -      -      -      -      0      0
15  enet 100010     1500 -      -      -      -      -      0      0
20  enet 100020     1500 -      -      -      -      -      0      0
30  enet 100030     1500 -      -      -      -      -      0      0
4002 fddi 100002    1500 -      -      -      -      -      0      0
1004 token 100032   1500 -      -      -      -      -      0      0
1004 token 10004     1500 -      -      -      se0e -      0      0
1005 ttnet 10005    1500 -      -      -      ihm -      0      0

Remote SPAN VLANs

----- -----
Primary Secondary Type          Ports
----- -----
MS1(config-vlan)#
MS1(config-vlan)#do show span

VLAN0005
  Spanning tree enabled protocol ieee
    Root ID    Priority 32769
    Address   000e.b7f6d.52c0
    Cost      19

```

```

[+] COM3 - PuTTY

HSI(config-vlan)#
HSI(config-vlan)#show span

VLAN0001
  Spanning tree enabled protocol ieee
    Root ID      Priority 32769
      Address 00ba.87d6.52c0
      Cost        19
      Port       3 (FastEthernet0/1)
      Hello Time  2 sec Max Age 20 sec Forward Delay 15 sec

  Bridge ID  Priority 32769 (priority 32768 sys-id-ext 1)
    Address 0004.1e1f.f000
    Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
    Aging Time 300

Interface      Role Sts Cost   Prio/Mbr Type
-----+-----+-----+-----+-----+
Fa0/1          Root  FWD 19    128.3  P2p
Fa0/2          Listen  BDP 19    128.3  P2p
Fa0/3          Designated  BDP 19    128.5  P2p
Fa0/4          Designated  BDP 19    128.6  P2p
Fa0/7          Designated  BDP 19    128.9  P2p
Fa0/8          Designated  BDP 19    128.10  P2p
Lo0            Designated  BDP 19    128.12  P2p

VLAN0010
  Spanning tree enabled protocol ieee
    Root ID      Priority 32778
      Address 00ba.87d6.52c0
      Cost        19
      Port       3 (FastEthernet0/1)
      Hello Time  2 sec Max Age 20 sec Forward Delay 15 sec

  Bridge ID  Priority 32778 (priority 32768 sys-id-ext 10)
    Address 0004.1e1f.f000
    Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
    Aging Time 300

Interface      Role Sts Cost   Prio/Mbr Type
-----+-----+-----+-----+-----+
Fa0/1          Root  FWD 19    128.3  P2m
```

```

NS1(config-Vlan1)#
NS1(config-Vlan1)#span vlan 10,20,30 root primary
      .
      %

% Invalid input detected at '^' marker.

NS1(config-Vlan1)#exit
NS1(config)#span vlan 10,20,30 root primary
      .
      %

% Invalid input detected at '^' marker.

NS1(config)#span vlan 10,20,30 root primary
NS1(config)#do show span

[VLAN0001]
  Spanning tree enabled protocol ieee
  Root ID Priority 32768
    Address 000c.4e1f.0000
    Cost 19
    Port 3 (FastEthernet0/1)
  Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec

  Bridge ID Priority 32768 (priority 32768 sys-id-ext 1)
    Address 000c.4e1f.0000
    Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
    Aging Time 300

Interface Role Sts Cost Fwdt.Mbr Type
-----+
Fa0/1 Root BD 19 128.3 Fdp
Fa0/2 Alt BD 19 128.4 Fdp
Fa0/3 Designated BD 19 128.5 Fdp
Fa0/4 Designated BD 19 128.6 Fdp
Fa0/7 Designated BD 19 128.9 Fdp
Fa0/8 Designated BD 19 128.10 Fdp
Po3 Designated BD 19 128.72 Fdp

[VLAN0010]
  Spanning tree enabled protocol ieee
  Root ID Priority 24544
    Address 001a.8765.5207
    This bridge is the root
  Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec

```

COM3 - Putty					
VLAN000					
Spanning tree enabled protocol ieee					
Root ID	Priority	24596			
	Address	0004.1e01.firebaseio.com			
This bridge is the root					
	Hello Time	2 sec	Max Age	20 sec	Forward Delay
					15 sec
Bridge ID Priority 24596 (priority 24576 sys-id-ext 10)					
Bridge ID	Priority	24596	(priority 24576	sys-id-ext 10)	
	Address	0004.1e01.firebaseio.com			
	Hello Time	2 sec	Max Age	20 sec	Forward Delay
					15 sec
	Aging Time	15			
Interface	Role	Sts	Cost	Prio/Rtr	Type
<hr/>					
Fa0/1	Designated	FWD	19	128.3	Rp
Fa0/2	Designated	LIS	19	128.4	Rp
Fa0/3	Designated	FWD	19	128.5	Rp
Fa0/4	Designated	FWD	19	128.6	Rp
Fo0	Designated	FWD	12	128.72	Rp
<hr/>					
VLAN000					
Spanning tree enabled protocol ieee					
Root ID	Priority	24596			
	Address	0004.1e01.firebaseio.com			
This bridge is the root					
	Hello Time	2 sec	Max Age	20 sec	Forward Delay
					15 sec
Bridge ID Priority 24596 (priority 24576 sys-id-ext 20)					
Bridge ID	Priority	24596	(priority 24576	sys-id-ext 20)	
	Address	0004.1e01.firebaseio.com			
	Hello Time	2 sec	Max Age	20 sec	Forward Delay
					15 sec
	Aging Time	300			
Interface	Role	Sts	Cost	Prio/Rtr	Type
<hr/>					
Fa0/1	Designated	FWD	19	128.3	Rp
Fa0/2	Designated	LIS	19	128.4	Rp
Fa0/3	Designated	FWD	19	128.5	Rp
Fa0/4	Designated	FWD	19	128.6	Rp
Fo0	Designated	FWD	12	128.72	Rp
<hr/>					
VLAN000					

MS2:

- Then we configured the ports of the access layer switches, each port with the appropriate VLAN access, and for those ports (which are not participate on SPT operations) we enabled the BPDU guard.

Configuration:

- First, we enabled routing functionality on the Layer 3 switch using “ip routing” command inside the configuration mode of the MS.
 - We created an interface for each VLAN and assigned to it IP address from the local subnet of the VLAN.
 - Under the VLAN interface configuration we implemented the HSRP configuration
For the MS1 we gave it higher priority 150 and we left the MS2 with the default priority.

Step 5: Dynamic Host Configuration Protocol (DHCP):

- In the MS1 we created and DHCP pool for each VLAN.

Note: use the appropriate VIP for the default-router in each pool

❖ Assign IP addresses for router interfaces

MS1& MS2:

```

MS1>en
MS1>conf t
Enter configuration commands, one per line. End with CNTL/Z.
MS1(config)#ip routing
MS1(config)#
00:51:26 %IP-4-UPDAD0: Duplicate address 192.168.20.1 on Vlan20, sourced by 70b5.e85b.9020
MS1(config)#int range Fa0/0-8
MS1(config-if-range)#no sw
MS1(config-if-range)#
00:54:50 %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/7, changed state to down
00:54:50 %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/8, changed state to down
00:55:01 %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/7, changed state to up
00:55:01 %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/8, changed state to up
MS1(config-if-range)no shut
MS1(config-if-range)exit
MS1(config)#
MS1(config-if)no shut
MS1(config-if)#
MS1(config-if)ip add 10.0.2.1 255.255.255.0
MS1(config-if)exit
MS1(config)#
MS1(config-if)int fa0/0
MS1(config-if)#
MS1(config-if)no shut
MS1(config-if)#
MS1(config-if)ip add 10.0.5.1 255.255.255.0
MS1(config-if)exit
  
```



```

MS2>en
MS2>conf t
Enter configuration commands, one per line. End with CNTL/Z.
MS2(config)#ip routing
MS2(config)#int rang e
^
% Invalid input detected at '^' marker.

MS2(config)int range Fa0/7 -8
MS2(config-if-range)no sw
MS2(config-if-range)#
00:58:53 %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/7, changed state to down
00:58:53 %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/8, changed state to down
00:58:56 %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/7, changed state to up
00:58:56 %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/8, changed state to up
MS2(config-if-range)exit
MS2(config)int Fa0/7
MS2(config-if)no shut
MS2(config-if)ip add 10.0.4.1 255.255.255.0
MS2(config-if)exit
MS2(config)do show ip int bri
show ip int bri
^
% Invalid input detected at '^' marker.

MS2(config)do show ip int bri
Interface          IP-Address      OK? Method Status      Protocol
Vlan1              unassigned      YES NVRAM up           up
Vlan10             192.168.10.3   YES NVRAM up           up
Vlan20             192.168.20.3   YES NVRAM up           up
Vlan30             192.168.30.3   YES NVRAM up           up
FastEthernet0/1    unassigned      YES unset up          up
FastEthernet0/2    unassigned      YES unset up          up
FastEthernet0/3    unassigned      YES unset up          up
FastEthernet0/4    unassigned      YES unset up          up
FastEthernet0/5    unassigned      YES unset up          up
FastEthernet0/6    unassigned      YES unset up          up
FastEthernet0/7    10.0.3.1       YES manual up         up
FastEthernet0/8    10.0.4.1       YES manual up         up
FastEthernet0/9    unassigned      YES unset down        down
  
```

R1&R2:

```

Router# 
Router#host R1
Router#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#host R1
Router(config)#int Fa0/0
Router(config-if)#no shut
Router(config-if)#
01:02:48 %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to up
Router(config-if)#
01:02:50 %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
Router(config-if)ip add 10.0.2.2 255.255.255.0
Router(config-if)exit
Router(config)#int Fa0/1
Router(config-if)#no shut
Router(config-if)#
01:03:38 %LINK-3-UPDOWN: Interface FastEthernet0/1, changed state to up
Router(config-if)ip add 10.0.3.2 255.255.255.0
Router(config-if)exit
Router(config)do show ip int bri
Router(config)#
Router#show
01:04:21 %SYS-5-CONFIG_I: Configured from console by console
? Type "show ?" for a list of subcommands
?show ip int bri
Interface          IP-Address      OK? Method Status      Protocol
FastEthernet0/0    10.0.2.2       YES manual up          up
Serial0/0          unassigned     YES unset administratively down down
FastEthernet0/1    10.0.3.2       YES manual up          up
  
```



```

Router# 
Router#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)int Fa0/0
Router(config-if)#no shut
Router(config-if)#
Mar 1 01:06:13.978: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to up
Router(config-if)ip add
Mar 1 01:06:16.511: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
Router(config)#
Router(config-if)#
Router(config-if)ip add 10.0.4.2 255.255.255.0
Router(config-if)exit
Router(config)int Fa0/1
Router(config-if)#no shut
Router(config-if)#
Mar 1 01:06:47.779: %LINK-3-UPDOWN: Interface FastEthernet0/1, changed state to up
Mar 1 01:06:50.299: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to up
Router(config-if)ip add 10.0.5.2 255.255.255.0
Router(config-if)exit
Router(config)exit
Router#show in
Mar 1 01:07:09.911: %SYS-5-CONFIG_I: Configured from console ip bri
Router(config)#
Router#show ip int bri
Interface          IP-Address      OK? Method Status      Protocol
FastEthernet0/0    10.0.4.2       YES manual up          up
Serial0/0          unassigned     YES unset administratively down down
FastEthernet0/1    10.0.5.2       YES manual up          up
Serial1/0          unassigned     YES unset administratively down down
Serial1/1          unassigned     YES unset administratively down down
Serial1/2          unassigned     YES unset administratively down down
Serial1/3          unassigned     YES unset administratively down down
  
```

ABR1

```
[W]
#SRI(config)#int 9e/0/2
#SRI(config-if)#no shut
#SRI(config-if)#
*Jan 1 01:19:55.319: %LINK-3-UPDOWN: Interface Serial0/0/2, changed state to up
*Jan 1 01:19:56.319: %LINEPROTO-3-UPDOWN: Line protocol on Interface Serial0/0/2, changed state to up
#SRI(config-if)#ip add 20.0.0.2 255.255.255.192
#SRI(config-if)#
#SRI(config)#
#SRI(config)#do show ip int bri
#SRI(config)#

```

Interface	IP-Address	OKT Method	Status	Protocol
FastEthernet0/0	unassigned	YES NVRAM	administratively down	down
FastEthernet0/1	unassigned	YES NVRAM	administratively down	down
Serial0/0/0	10.0.0.1	YES manual	down	down
Serial0/0/1	10.0.1.1	YES manual	up	
Serial0/0/2	20.0.0.2	YES manual	up	
Serial0/0/3	unassigned	YES NVRAM	administratively down	down
SSLVENV-T1P0	unassigned	NO unset	up	

Step 6: Open Shortest Path First (OSPF) Protocol:

❖ Connectivity Between the Blocks

- We connected the routers of the three blocks using the OSPF protocol, our network is divided into three area, area 0 (block 2), area 1 (block 1) and area 3 (block 3).

```
ABR1(config)#  
ABR1>  
ABR1#  
ABR1>  
ABR1<br/>  
ABR1>en  
ABR1<br/>  
ABR1>  
ABR1<br/>  
ABR1>conf t  
Enter configuration commands, one per line. End with CNTL/Z.  
ABR1(config)#do show ip pro  
% Ambiguous command: "show ip pro"  
ABR1(config)#exit  
ABR1>  
ABR1>sh  
*Jan 1 01:15:12.823: %SYS-5-CONFIG_I: Configured from console by console  
% Type "show ?" for a list of subcommands  
ABR1>show ip pro  
% Ambiguous command: "show ip pro"  
ABR1>show ip protocol  
ABR1(config)#  
ABR1(config)t  
Enter configuration commands, one per line. End with CNTL/Z.  
ABR1(config)#router ospf 1  
ABR1(config-router)#do show ip route conn  
10.0.0.0/24 is subnetted, 1 subnets  
C 10.0.0.0 is directly connected, Serial0/0/0  
C 10.0.0.0/24 is subnetted, 2 subnets  
C 10.0.1.0 is directly connected, Serial0/0/1  
C 10.0.1.0/24 is subnetted, 1 subnets  
C 10.0.1.0 is directly connected, Serial0/0/1  
ABR1(config-router)#network 20.0.0.0 0.0.0.63 area 0  
ABR1(config-router)#network 10.0.0.0 0.0.0.255 area 1  
ABR1(config-router)#network 10.0.1.0 0.0.0.255 area 1  
ABR1(config)#end  
ABR1(config)#wr  
Building configuration...  
(OK)  
ABR1(config)
```

```
R1>  
R1>en  
R1#conf t  
Enter configuration commands, one per line. End with CNTL/Z.  
R1(config)#do show ip protocol  
R1(config)#router ospf 1  
R1(config-router)#do show ip route conn  
10.0.0.0/24 is subnetted, 3 subnets  
C 10.0.2.0 is directly connected, FastEthernet0/0  
C 10.0.3.0 is directly connected, FastEthernet0/1  
C 10.0.0.0 is directly connected, Serial10/0/0  
R1(config-router)#network 10.0.2.0 0.0.0.255 area 1  
R1(config-router)#network 10.0.3.0 0.0.0.255 area 1  
R1(config-router)#network 10.0.0.0 0.0.0.255 area 1  
R1(config-router)#  
*Jan 1 01:22:18.011: %OSPF-5-ADCNH: Process 1, Nbr 20.0.0.2 on Serial10/0/0 from LOADING to FULL, Loading Done  
R1(config-router)
```

```
M2#  
M2(config-if)#exit  
M2(config)#int Fa0/7  
M2(config-if)#ip address 10.0.3.1 255.255.255.0  
M2(config-if)#exit  
M2(config)#int Fa0/8  
M2(config-if)#no shut  
M2(config-if)#ip address 10.0.4.1 255.255.255.0  
M2(config)#exit  
M2(config)#do show ip int bri  
Interface IP-Address OK? Method Status Protocol  
Vlan1 unassigned YES NVRAM up up  
Vlan10 192.168.10.3 YES NVRAM up up  
Vlan20 192.168.20.3 YES NVRAM up up  
Vlan30 192.168.30.3 YES NVRAM up up  
FastEthernet0/1 unassigned YES unset up up  
FastEthernet0/2 unassigned YES unset up up  
FastEthernet0/3 unassigned YES unset up up  
FastEthernet0/4 unassigned YES unset up up  
FastEthernet0/5 unassigned YES unset up up  
FastEthernet0/6 unassigned YES unset up up  
FastEthernet0/7 10.0.3.1 YES manual up up  
FastEthernet0/8 10.0.4.1 YES manual up up  
FastEthernet0/9 unassigned YES unset down down  
FastEthernet0/10 unassigned YES unset down down  
FastEthernet0/11 unassigned YES unset down down  
FastEthernet0/12 unassigned YES unset down down  
FastEthernet0/13 unassigned YES unset down down  
FastEthernet0/14 unassigned YES unset down down  
FastEthernet0/15 unassigned YES unset down down  
FastEthernet0/16 unassigned YES unset down down  
FastEthernet0/17 unassigned YES unset down down  
FastEthernet0/18 unassigned YES unset down down  
FastEthernet0/19 unassigned YES unset down down  
FastEthernet0/20 unassigned YES unset down down  
FastEthernet0/21 unassigned YES unset down down  
FastEthernet0/22 unassigned YES unset down down  
FastEthernet0/23 unassigned YES unset down down  
FastEthernet0/24 unassigned YES unset down down  
S0/0/0/0/1 unassigned YES unset down down  
S0/0/0/0/2 unassigned YES unset down down  
Port-channel1 unassigned YES unset up up
```

```
R2#conf t  
Enter configuration commands, one per line. End with CNTL/Z.  
R2(config)#do show ip protocol  
R2(config)#router ospf 1  
% Ambiguous command: "route ospf 1"  
R2(config)# route ospf 1  
% Ambiguous command: "route ospf 1"  
R2(config)#router ospf 1  
R2(config-router)#do show ip route conn  
10.0.0.0/24 is subnetted, 3 subnets  
C 10.0.1.0 is directly connected, Serial0/0  
C 10.0.4.0 is directly connected, FastEthernet0/0  
C 10.0.5.0 is directly connected, FastEthernet0/1  
R2(config-router)#network 10.0.4.0 0.0.0.255 area 1  
R2(config-router)#network 10.0.5.0 0.0.0.255 area 1  
R2(config-router)#network 10.0.1.0 0.0.0.255 area 1  
R2(config-router)#  
*Mar 1 01:24:30.011: %OSPF-5-ADCNH: Process 1, Nbr 20.0.0.2 on Serial10/0/0 from LOADING to FULL, Loading Done  
R2(config-router)#exit  
R2(config)#do wr  
Building configuration...  
(OK)  
R2(config)
```

```

S2(config)#router ospf 1
S2(config-router)#do show ip route conn
<
  * 192.168.30.0/24 is directly connected, Vlan30
  * 192.168.10.0/24 is directly connected, Vlan10
  * 192.168.20.0/24 is directly connected, Vlan20
  10.0.0.0/24 is subnetted, 2 subnets
    * 10.0.3.0 is directly connected, FastEthernet0/7
    * 10.0.4.0 is directly connected, FastEthernet0/8
S2(config-router)#network 192.168.10.0 0.0.0.255 area 1
S2(config-router)#network 192.168.20.0 0.0.0.255 area 1
S2(config-router)#network 192.168.30.0 0.0.0.255 area 1
S2(config-router)#network 10.0.3.0 0.0.0.255 area 1
S2(config-router)#network 10/6
31:38:17: %OSPF-5-ADJCHG: Process 1, Nbr 10.0.3.2 on FastEthernet0/7 from LOADING to FULL, Loading Done
          ^
< Invalid input detected at '^' marker.

S2(config-router)#network 10.0.4.0 0.0.0.255 area 1
S2(config-router)#
31:38:50: %OSPF-5-ADJCHG: Process 1, Nbr 10.0.5.2 on FastEthernet0/8 from LOADING to FULL, Loading Done
S2(config-router)#exit
S2(config)#do wr
Building configuration...
[OK]
S2(config)#do show ip route
Codes: 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 - OSP, P - periodic downloaded static route

Gateway of last resort is not set

<
  * 192.168.30.0/24 is directly connected, Vlan30
  20.0.0.0/26 is subnetted, 1 subnets
    > Ia 20.0.0.0 [110/451] via 10.0.3.2, 00:00:08, FastEthernet0/7
        [110/451] via 10.0.3.2, 00:00:08, FastEthernet0/7
  * 192.168.10.0/24 is directly connected, Vlan10
  * 192.168.20.0/24 is directly connected, Vlan20
  10.0.0.0/24 is subnetted, 6 subnets
    > Ia 10.0.2.0 [110/2] via 10.0.3.2, 00:00:08, FastEthernet0/7

```

```
COM3 - PUTTY

10.0.0.0/24 is subnetted, 2 subnets
   10.0.3.0 is directly connected, FastEthernet0/7
   10.0.4.0 is directly connected, FastEthernet0/8
MS2 (config-router) network 192.168.10.0 0.0.0.255 area 1
MS2 (config-router) network 192.168.20.0 0.0.0.255 area 1
MS2 (config-router) network 192.168.30.0 0.0.0.255 area 1
MS2 (config-router) network 10.0.3.0 0.0.0.255 area 1
MS2 (config-router) network 10/0
MS2 (config-router) end
D1:5817# WOSPF-5-ADJDNS: Process 1, Nbr 10.0.3.2 on FastEthernet0/7 from LOADING to FULL, Loading Done

! Invalid input detected at `***' marker.

MS2 (config-router) network 10.0.4.0 0.0.0.255 area 1
MS2 (config-router) end
D1:5817# WOSPF-5-ADJDNS: Process 1, Nbr 10.0.5.2 on FastEthernet0/8 from LOADING to FULL, Loading Done
MS2 (config-router) exit
MS2 (config)# do wr
Building configuration...
[OK]
MS2 (config)# show ip route
Codes: 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 - OSPF, P - periodic downloaded static route

Gateway of last resort is not set

* 192.168.30.0/24 is directly connected, Vlan30
  20.0.0.0/26 is subnetted, 1 subnets
  1  IA 20.0.0.0 [110/46] via 10.0.4.2, 00:00:08, FastEthernet0/8
    [110/46] via 10.0.3.2, 00:00:08, FastEthernet0/7
* 192.168.10.0/24 is directly connected, Vlan10
* 192.168.20.0/24 is directly connected, Vlan20
  10.0.0.0/24 is subnetted, 6 subnets
  10.0.2.0 [110/2] via 10.0.3.2, 00:00:08, FastEthernet0/7
  10.0.3.0 is directly connected, FastEthernet0/7
  10.0.0.0 [110/65] via 10.0.3.2, 00:00:09, FastEthernet0/7
  10.0.1.0 [110/65] via 10.0.4.2, 00:00:09, FastEthernet0/8
  10.0.4.0 is directly connected, FastEthernet0/8
  10.0.5.0 [110/2] via 10.0.4.2, 00:00:09, FastEthernet0/8
MS2 (config)
```

```

!BR1>
!BR1#en
!BR1#conf t
*Inter configuration commands, one per line. End with CNTL/Z.
!BR1(config)#do show ip route
Codes: 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

Gateway of last resort is not set

) 192.168.30.0/24 [110/398] via 10.0.1.2, 00:15:37, Serial0/0/1
   [110/398] via 10.0.0.2, 00:16:15, Serial0/0/0
; 20.0.0.0/26 is subnetted, 1 subnets
;   20.0.0.0 is directly connected, Serial0/0/2
) 192.168.10.0/24 [110/398] via 10.0.1.2, 00:15:37, Serial0/0/1
   [110/398] via 10.0.0.2, 00:16:15, Serial0/0/0
) 192.168.20.0/24 [110/398] via 10.0.1.2, 00:15:37, Serial0/0/1
   [110/398] via 10.0.0.2, 00:16:15, Serial0/0/0
10.0.0.0/24 is subnetted, 6 subnets
) 10.0.2.0 [110/397] via 10.0.0.2, 00:33:03, Serial0/0/0
) 10.0.3.0 [110/397] via 10.0.0.2, 00:33:03, Serial0/0/0
; 10.0.0.0 is directly connected, Serial10/0/0
; 10.0.1.0 is directly connected, Serial0/0/1
) 10.0.4.0 [110/397] via 10.0.1.2, 00:27:42, Serial0/0/1
) 10.0.5.0 [110/397] via 10.0.1.2, 00:27:43, Serial0/0/1
!BR1(config)#
!BR1(config)#

```

```
MS1(config)#  
MS1(config)router config 1  
MS1(config-router)#do show ip route conn  
C 192.168.30.0/24 is directly connected, Vlan30  
C 192.168.10.0/24 is directly connected, Vlan10  
C 192.168.20.0/24 is directly connected, Vlan20  
10.0.0.0/24 is subnetted, 2 subnets  
    10.0.1.0/24 is directly connected, FastEthernet0/7  
    10.0.5.0 is directly connected, FastEthernet0/8  
MS1(config-router)#network 192.168.10.0 0.0.0.255 area 1  
MS1(config-router) #  
00:24:09: NSCP-5-ADCNHS: Process 1, Nbr 192.168.30.3 on Vlan10 from LOADING to FULL, Loading Done  
MS1(config-router)#network 192.168.20.0 0.0.0.255 area 1  
MS1(config-router) #  
00:24:09: NSCP-5-ADCNHS: Process 1, Nbr 192.168.30.3 on Vlan20 from LOADING to FULL, Loading Done  
MS1(config-router)#network 192.168.30.0 0.0.0.255 area 1  
MS1(config-router) #  
00:25:09: NSCP-5-ADCNHS: Process 1, Nbr 192.168.30.3 on Vlan30 from LOADING to FULL, Loading Done  
MS1(config-router)#network 10.0.2.0 0.0.0.255 area 1  
MS1(config-router) #  
00:25:09: NSCP-5-ADCNHS: Process 1, Nbr 10.0.0.2 on FastEthernet0/7 from LOADING to FULL, Loading Done  
MS1(config-router)#network 10.0.5.0 0.0.0.255 area 1  
MS1(config-router) #  
00:25:48: NSCP-5-ADCNHS: Process 1, Nbr 10.0.5.2 on FastEthernet0/8 from LOADING to FULL, Loading Done
```

Step 7: Load Balancing in OSPF and Area Summarization:

```

Gateway of last resort is not set

  0  192.168.30.0/24 [110/398] via 10.0.1.2, 03:14:12, Serial0/0/1
      [110/398] via 10.0.0.2, 03:14:50, Serial0/0/0
  0 IA 192.168.60.0/24 [110/1184] via 20.0.0.1, 02:08:38, Serial0/0/2
  20.0.0.0/26 is subnetted, 2 subnets
C    20.0.0.0 is directly connected, Serial0/0/2
  0  20.0.0.64 [110/792] via 20.0.0.1, 02:54:43, Serial0/0/3
  0  192.168.10.0/24 [110/398] via 10.0.1.2, 03:14:12, Serial0/0/1
      [110/398] via 10.0.0.2, 03:14:50, Serial0/0/0
  0  192.168.40.0/24 [110/794] via 20.0.0.1, 02:36:24, Serial0/0/2
  0  192.168.20.0/24 [110/398] via 10.0.1.2, 03:14:13, Serial0/0/1
      [110/398] via 10.0.0.2, 03:14:51, Serial0/0/0
  10.0.0.0/24 is subnetted, 18 subnets
  0  10.0.1.0 [110/792] via 20.0.0.1, 02:53:00, Serial0/0/2
  0  10.0.1.10 [110/792] via 20.0.0.1, 02:53:47, Serial0/0/2
  0  10.0.14.0 [110/793] via 20.0.0.1, 02:42:35, Serial0/0/2
  0  10.0.15.0 [110/793] via 20.0.0.1, 02:42:18, Serial0/0/2
  0  10.0.12.0 [110/793] via 20.0.0.1, 02:48:09, Serial0/0/2
  0  10.0.13.0 [110/793] via 20.0.0.1, 02:47:44, Serial0/0/2
  0  10.0.2.0 [110/397] via 10.0.0.2, 03:31:41, Serial10/0/0
  0  10.0.3.0 [110/397] via 10.0.0.2, 03:31:41, Serial10/0/0
  0  10.0.0.0 is directly connected, Serial0/0/0
  0  10.0.1.0 is directly connected, Serial0/0/1
  0  10.0.4.0 [110/397] via 10.0.1.2, 03:26:19, Serial10/0/1
  0  10.0.5.0 [110/397] via 10.0.1.2, 03:26:19, Serial10/0/1
  0 IA 10.0.24.0 [110/1185] via 20.0.0.1, 02:14:33, Serial10/0/2
  0 IA 10.0.25.0 [110/1185] via 20.0.0.1, 02:14:33, Serial10/0/2
  0 IA 10.0.22.0 [110/1185] via 20.0.0.1, 02:19:52, Serial10/0/2
  0 IA 10.0.23.0 [110/1185] via 20.0.0.1, 02:19:52, Serial10/0/2
  0 IA 10.0.20.0 [110/1182] via 20.0.0.1, 02:25:02, Serial10/0/2
  0 IA 10.0.21.0 [110/1182] via 20.0.0.1, 02:25:25, Serial10/0/2
  0  192.168.50.0/24 [110/794] via 20.0.0.1, 00:02:39, Serial10/0/2
  0  192.168.70.0/24 [110/1184] via 20.0.0.1, 02:09:11, Serial10/0/2
BBR1(config)#

```

```

COM3 - PuTTY

ABR1(config-if)#show ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
      D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
      N1 - OSPF external type 1, N2 - OSPF external type 2
      E1 - OSPF ext router type 1, E2 - OSPF ext router type 2
      i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
      is - IS-IS inter area, * - candidate default, U - per-user static route
      o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

o 192.168.30.0/24 [110/102] via 10.0.1.2, 00:00:05, Serial0/0/1
o 192.168.30.0/24 [110/118] via 20.0.0.1, 00:04:06, Serial0/0/2
C 192.168.30.0/24 [110/102] via 10.0.1.2, 00:00:05, Serial0/0/1
  20.0.0.0/8 is directly connected, Serial0/0/2
o 20.0.0.6/8 [110/792] via 20.0.0.1, 00:04:06, Serial0/0/2
o 192.168.10.0/24 [110/102] via 10.0.1.2, 00:00:57, Serial0/0/1
o 192.168.10.0/24 [110/103] via 20.0.0.1, 00:04:06, Serial0/0/2
o 192.168.30.0/24 [110/102] via 10.0.1.2, 00:00:05, Serial0/0/1
  50.0.0.0/8 is variably subnetted, 19 subnets, 2 masks
o 10.0.10.0/24 [110/792] via 20.0.0.1, 00:04:07, Serial0/0/2
o 10.0.11.0/24 [110/792] via 20.0.0.1, 00:04:07, Serial0/0/2
o 10.0.12.0/24 [110/793] via 20.0.0.1, 00:04:07, Serial0/0/2
o 10.0.13.0/24 [110/793] via 20.0.0.1, 00:04:07, Serial0/0/2
o 10.0.15.0/24 [110/793] via 20.0.0.1, 00:04:07, Serial0/0/2
o 10.0.16.0/24 [110/793] via 20.0.0.1, 00:04:07, Serial0/0/2
o 10.0.2.0/24 [110/103] via 10.0.1.2, 00:00:59, Serial0/0/1
o 10.0.2.0/24 [110/103] via 20.0.0.1, 00:04:09, Serial0/0/1
o 10.0.0.0/24 [110/103] via 10.0.1.2, 00:00:09, Serial0/0/1
o 10.0.0.0/24 [110/103] via 20.0.0.1, 00:04:09, Serial0/0/1
o 10.0.0.0/24 is directly connected, Serial0/0/0
o 10.0.0.0/24 is a summary, 00:01:00, Null0
o 10.0.10.0/24 [110/103] via 10.0.1.2, 00:01:00, Serial0/0/1
o 10.0.11.0/24 [110/103] via 10.0.1.2, 00:01:00, Serial0/0/1
IA 10.0.12.0/24 [110/1183] via 20.0.0.1, 00:04:09, Serial0/0/2
IA 10.0.25.0/24 [110/1183] via 20.0.0.1, 00:04:09, Serial0/0/2
o 10.0.22.0/24 [110/1183] via 20.0.0.1, 00:04:09, Serial0/0/2
IA 10.0.25.0/24 [110/1183] via 20.0.0.1, 00:04:09, Serial0/0/2
o 10.0.22.0/24 [110/1183] via 20.0.0.1, 00:04:09, Serial0/0/2
o 10.0.21.0/24 [110/1182] via 20.0.0.1, 00:04:09, Serial0/0/2
o 192.168.50.0/24 [110/794] via 20.0.0.1, 00:04:09, Serial0/0/2
o 192.168.70.0/24 [110/1184] via 20.0.0.1, 00:04:09, Serial0/0/2
o 192.168.0.0/19 is a summary, 00:01:02, Null0
ABR1(config-if)#
ABR1(config-if)#

```

COM3 - PUTTY

```

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
is - IS-IS inter area, * - candidate default, U - per-user static route
o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

C 192.168.30.0/24 is directly connected, Vlan30
  30.0.0.0/24 is subnetted, 2 subnets
    0 20.0.0.0 [110/461] via 10.0.4.2, FastEthernet0/8
      [110/461] via 10.0.3.2, 00:48:15, FastEthernet0/7
    0 IA 20.0.0.4 [110/857] via 10.0.4.2, 00:48:15, FastEthernet0/8
      [110/857] via 10.0.3.2, 00:35:41, FastEthernet0/7
C 192.168.10.0/24 is directly connected, Vlan10
  10.0.0.0/24 is subnetted, 2 subnets
    0 192.168.16.40/24 [110/563] via 10.0.4.2, 00:35:15, FastEthernet0/8
      [110/563] via 10.0.3.2, 00:35:15, FastEthernet0/7
    C 192.168.20.0/24 is directly connected, Vlan20
      10.0.0.0/24 is subnetted, 2 subnets
        0 192.168.20.1/24 [110/627] via 10.0.4.2, 00:35:15, FastEthernet0/8
          [110/627] via 10.0.3.2, 00:35:15, FastEthernet0/7
    0 IA 10.0.11.0/24 [110/561] via 10.0.4.2, 00:35:40, FastEthernet0/8
      [110/561] via 10.0.3.2, 00:35:40, FastEthernet0/7
    0 IA 10.0.14.0/24 [110/562] via 10.0.4.2, 00:35:41, FastEthernet0/8
      [110/562] via 10.0.3.2, 00:35:41, FastEthernet0/7
    0 IA 10.0.15.0/24 [110/562] via 10.0.4.2, 00:35:41, FastEthernet0/8
      [110/562] via 10.0.3.2, 00:35:41, FastEthernet0/7
    0 IA 10.0.12.0/24 [110/564] via 10.0.4.2, 00:35:41, FastEthernet0/8
      [110/564] via 10.0.3.2, 00:35:41, FastEthernet0/7
    0 IA 10.0.19.0/24 [110/565] via 10.0.4.2, 00:35:41, FastEthernet0/8
      [110/565] via 10.0.3.2, 00:35:41, FastEthernet0/7
    0 10.0.2.0/24 [110/2] via 10.0.3.2, 00:48:45, FastEthernet0/7
  C 10.0.3/24 is directly connected, FastEthernet0/7
  0 10.0.4/24 [110/687] via 10.0.3.2, 00:48:45, FastEthernet0/7
  0 10.0.1/24 [110/563] via 10.0.3.2, 00:35:41, FastEthernet0/8
  C 10.0.4/24 is directly connected, FastEthernet0/8
  0 10.0.5/24 [110/2] via 10.0.4.2, 00:48:45, FastEthernet0/8
  0 IA 10.0.16.0/24 [110/957] via 10.0.4.2, 00:24:28, FastEthernet0/8
    [110/957] via 10.0.3.2, 00:34:28, FastEthernet0/7
  0 IA 192.168.50.0/24 [110/563] via 10.0.4.2, 00:35:41, FastEthernet0/8
    [110/563] via 10.0.3.2, 00:35:41, FastEthernet0/7
  0 IA 192.168.0.0/17 [110/959] via 10.0.4.2, 00:24:29, FastEthernet0/8
    [110/959] via 10.0.3.2, 00:24:29, FastEthernet0/7

MS2(config)#
MS2(config)#

```

COM3 - PuTTY

```

S2(config-if)#  

S2(config-if)#  

S2(config-if)#exit  

S2(config)#int Fa0/1  

S2(config-if)#ip ospf cost 10  

S2(config-if)#  

S2(config-if)#do show ip route  

Route(s) found...  

  0.0.0.0/0 [1/0] via 10.0.4.2, 0.0.0.0.0, S0, static, R = RIP, M = mobile, B = BGP  

    D = 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, si = 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 = OSPF, P = periodic downloaded static route

Gateway of last resort is not set

c 192.168.30.0/24 is directly connected, Vlan30  

  20.0.0.0/26 is subnetted, 1 subnets  

    192.168.30.128/26 is subnet of 192.168.30.0, 00:00:05, FastEthernet0/8  

  3 192.168.10.0/24 [110/0] via 10.0.4.2, 00:00:05, FastEthernet0/8  

  3 192.168.10.0/24 is directly connected, Vlan10  

  3 192.168.40.0/24 [110/563] via 10.0.4.2, 00:00:05, FastEthernet0/8  

  3 192.168.20.0/24 is directly connected, Vlan20  

  10.0.0.0/8 is variably subnetted, 13 subnets, 2 masks  

    10.0.0.0/24 [110/627] via 10.0.4.2, 00:00:05, FastEthernet0/8  

    3 19.1.0.0/24 [110/562] via 10.0.4.2, 00:00:05, FastEthernet0/8  

    3 19.0.0.14/24 [110/562] via 10.0.4.2, 00:00:06, FastEthernet0/8  

    3 19.0.0.15/24 [110/562] via 10.0.4.2, 00:00:06, FastEthernet0/8  

    3 19.0.0.12/24 [110/564] via 10.0.4.2, 00:00:06, FastEthernet0/8  

    3 19.0.0.13/24 [110/563] via 10.0.4.2, 00:00:06, FastEthernet0/8  

  3 19.0.0.2/24 [110/332] via 10.0.4.2, 00:00:06, FastEthernet0/7  

  3 10.0.0.0/24 [110/626] via 10.0.4.2, 00:00:07, FastEthernet0/7  

  3 10.0.0.20/24 [110/74] via 10.0.4.2, 00:00:07, FastEthernet0/7  

  3 10.0.1.0/24 [110/65] via 10.0.4.2, 00:00:07, FastEthernet0/8  

  3 10.0.4.0/24 is directly connected, FastEthernet0/8  

  3 10.0.5.0/24 [110/2] via 10.0.4.2, 00:00:07, FastEthernet0/8  

  3 10.0.16.0/24 [110/957] via 10.0.4.2, 00:00:07, FastEthernet0/8  

  3 192.168.10.0/24 [110/563] via 10.0.4.2, 00:00:07, FastEthernet0/8  

  3 192.168.0.0/17 [110/589] via 10.0.4.2, 00:00:07, FastEthernet0/8

S2(config-if)#
```

7.4.2 Block 2 Configuration:

Step 1: EtherChannel:

- We started with the Layer 3 switches we named them MS3 and MS4.

```

S1#COM1>#R1V7
S1(config-if-range)#exit
S1(config)#int port-channel 1
S1(config-if)#no mode trunk
S1(config-if)#exit
S1(config)#int range fa0/3-4
S1(config-if-range)#no shutdown
S1(config-if-range)#exit
S1(config-if-range)#
00:30:52: VLINE5-CHANGED: Interface FastEthernet0/3, changed state to administratively down
00:30:52: VLINE5-CHANGED: Interface FastEthernet0/4, changed state to administratively down
00:31:06: VLINE5-CHANGED: Line protocol on Interface FastEthernet0/3, changed state to down
00:31:06: VLINE5-CHANGED: Line protocol on Interface FastEthernet0/4, changed state to down
S1(config-if-range)#channel-group 2 mode active
Creating a port-channel interface Port-channel 2

S1(config-if-range)#no shut
S1(config-if-range)#
00:31:06: VLINE3-UPDOWN: Interface FastEthernet0/3, changed state to up
00:31:06: VLINE3-UPDOWN: Interface FastEthernet0/4, changed state to up
00:31:28: VLINEPROT0-5-UPDOWN: Line protocol on Interface FastEthernet0/4, changed state to up
00:31:28: VLINEPROT0-5-UPDOWN: Line protocol on Interface FastEthernet0/3, changed state to up
S1(config-if-range)#
S1(config)#int port-channel 2
S1(config-if)#no mode trunk
S1(config-if)#exit
S1(config)#int range fa0/5-6
S1(config-if-range)#no shutdown
S1(config-if-range)#exit
S1(config-if-range)#
00:32:41: VLINEPROT0-5-UPDOWN: Line protocol on Interface Vlan1, changed state to down
00:32:42: VLINE5-CHANGED: Interface FastEthernet0/5, changed state to administratively down
00:32:42: VLINE5-CHANGED: Interface FastEthernet0/6, changed state to administratively down
00:33:06: VLINE5-CHANGED: Line protocol on Interface FastEthernet0/5, changed state to down
00:33:06: VLINE5-CHANGED: Line protocol on Interface FastEthernet0/6, changed state to down
S1(config-if-range)#channel-group 3 mode active
Creating a port-channel interface Port-channel 3

S1(config-if-range)#
00:33:11: VLINEPROT0-5-UPDOWN: Line protocol on Interface Vlan1, changed state to up
S1(config-if-range)#no shut
S1(config-if-range)#
00:33:30: VLINE3-UPDOWN: Interface FastEthernet0/5, changed state to up
00:33:30: VLINE3-UPDOWN: Interface FastEthernet0/6, changed state to up
00:33:41: VLINEPROT0-5-UPDOWN: Line protocol on Interface FastEthernet0/6, changed state to up
00:33:41: VLINEPROT0-5-UPDOWN: Line protocol on Interface FastEthernet0/5, changed state to up
00:33:45: VLINEPROT0-5-UPDOWN: Line protocol on Interface Vlan1, changed state to down
S1(config-if-range)#exit
S1(config-if-range)#
S1(config)#int port-channel 3
S1(config-if)#no mode truc
S1(config-if)#exit
00:34:11: VLINEPROT0-5-UPDOWN: Line protocol on Interface Vlan1, changed state to up
S1(config-if)#no mode trunk
S1(config-if)#exit

```

```

COMS - PUTY
[0]#0:0:95: $LINEPROTO-5-UPDOWN: Line protocol on interface Port-channel, changed state to up
[0]#0:0:95: $LINEPROTO-5-UPDOWN: Line protocol on interface Port-channel, changed state to up
M3#(config)# int port-channel 1
M3#(config-if) ssw trunk encapsulation dot1q
M3#(config-if) ssw mode trunk
M3#(config-if) exit
M3#(config)# int range f0/3-4
M3#(config-if) shutdown
M3#(config-if) no shutdown
M3#(config-if-range) ca
[0]#4:15:2: $LINK-5-CHANGED: Interface FastEthernet0/3, changed state to administratively down
[0]#4:15:2: $LINK-5-CHANGED: Interface FastEthernet0/4, changed state to administratively down
[0]#4:15:3: $LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/3, changed state to down
[0]#4:15:3: $LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/4, changed state to do
M3#(config-if-range) channel-group 2 mode active
Creating a port-channel interface Port-channel 2

M3#(config-if-range) no shut
M3#(config-if-range)#
M3#(config-if-range)#
M3#(config-if-range) $LINEPROTO-5-UPDOWN: Interface FastEthernet0/3, changed state to up
[0]#4:2-3: $LINK-3-UPDOWN: Interface FastEthernet0/4, changed state to up
[0]#4:2-3: $LINK-5-CHANGED: Interface FastEthernet0/4, changed state to up
M3#(config-if-range) ssw encapsulation dot1q
M3#(config-if) ssw mode trunk
M3#(config-if) exit
M3#(config)# int range f0/5-6
M3#(config-if-range)#
M3#(config-if-range)#
M3#(config-if-range) $LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/5, changed state to up
[0]#4:4-5: $LINK-5-CHANGED: Interface FastEthernet0/6, changed state to administratively down
[0]#4:4-5: $LINK-5-CHANGED: Interface FastEthernet0/6, changed state to administratively down
[0]#4:4-6: $LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/5, changed state to down
[0]#4:4-6: $LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/6, changed state to down
M3#(config-if-range) channel-group 3 mode active
Creating a port-channel interface Port-channel 3

M3#(config-if-range) no shut
M3#(config-if-range)#
[0]#4:4-40: $LINK-3-UPDOWN: Interface FastEthernet0/5, changed state to up
[0]#4:4-40: $LINK-3-UPDOWN: Interface FastEthernet0/6, changed state to up
M3#(config-if-range)#
M3#(config-if-range)#
[0]#4:4-45: $LINKPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/5, changed state to up
[0]#4:4-45: $LINKPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/6, changed state to up
M3#(config-if-range) exit
M3#(config)# int port-channel 3
M3#(config-if) ssw trunk encapsulation dot1q
M3#(config-if) ssw mode trunk
M3#(config-if) exit
M3#(config)#

```

COM3 - PuTTY

```

Switch(config)#host MS4
MS4(config)int range F0/1-6
MS4(config-if-range)#sw trunk encapsulation dot1q
MS4(config-if-range)#sw mode trunk
MS4(config-if-range)#no shutdown
MS4(config-if-range)int range F0/1-2
MS4(config-if-range)#shut
MS4(config-if-range)#
MS4(config-if-range) 5LINK-5-CHANGED: Interface FastEthernet0/1, changed state to administratively down
00:51:15: *LINK-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to administratively up
00:51:17: *LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to down
00:51:17: *LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/2, changed state to down
% Ambiguous command: " "
MS4(config-if-range)channel-group 1 mode active
Creating a port-channel interface Port-channel 1

MS4(config-if-range)no shut
MS4(config-if-range)#
00:51:14: *LINK-3-UPDOWN: Interface FastEthernet0/1, changed state to up
00:51:20: *LINK-3-UPDOWN: Interface FastEthernet0/2, changed state to up
00:51:20: *LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/2, changed state to up
00:51:20: *LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to up
MS4(config-if-range)sw trunk encapsulation dot1q
MS4(config-if-range)int range F0/3-4
MS4(config-if-range)#shut
MS4(config-if-range)#
MS4(config-if-range) 5LINK-5-CHANGED: Interface FastEthernet0/3, changed state to administratively down
00:55:20: *LINK-5-CHANGED: Interface FastEthernet0/4, changed state to administratively down
00:55:20: *LINK-5-UPDOWN: Line protocol on Interface FastEthernet0/3, changed state to down
00:55:20: *LINK-5-UPDOWN: Line protocol on Interface FastEthernet0/4, changed state to down
% Incomplete command.

MS4(config-if-range)channel-group 2 mode active
Creating a port-channel interface Port-channel 2

MS4(config-if-range)no shut
MS4(config-if-range)exit
00:56:01: *LINK-3-UPDOWN: Interface FastEthernet0/3, changed state to up
00:56:01: *LINK-3-UPDOWN: Interface FastEthernet0/4, changed state to up
00:56:21: *LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/3, changed state to up
00:56:22: *LINK-3-UPDOWN: Interface Port-channel2, changed state to up
00:56:22: *LINEPROTO-5-UPDOWN: Line protocol on Interface Port-channel2, changed state to up
00:56:22: *LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/4, changed state to up
MS4(config-if-range)int port-channel 2
MS4(config-if)#sw trunk encapsulation dot1q

```

COM3 - PuTTY

```

00:55:25: *LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/4, changed state to down
% Incomplete command.

MS4(config-if-range)channel-group 2 mode active
Creating a port-channel interface Port-channel 2

MS4(config-if-range)no shut
MS4(config-if-range)exit
00:56:16: *LINK-3-UPDOWN: Interface FastEthernet0/3, changed state to up
00:56:16: *LINK-3-UPDOWN: Line protocol on Interface FastEthernet0/3, changed state to up
00:56:21: *LINK-3-UPDOWN: Line protocol on Interface FastEthernet0/3, changed state to up
00:56:22: *LINK-3-UPDOWN: Interface Port-channel2, changed state to up
00:56:22: *LINK-3-UPDOWN: Line protocol on Interface Port-channel2, changed state to up
00:56:22: *LINK-3-UPDOWN: Line protocol on Interface FastEthernet0/4, changed state to up
MS4(config-if-range)int port-channel 2
MS4(config-if)#sw trunk encapsulation dot1q
MS4(config-if-range)no shutdown
MS4(config-if-range)#
MS4(config-if-range)chan
00:57:32: *LINK-5-CHANGED: Interface FastEthernet0/5, changed state to administratively down
00:57:32: *LINK-5-CHANGED: Interface FastEthernet0/6, changed state to administratively down
00:57:33: *LINK-5-UPDOWN: Line protocol on Interface FastEthernet0/5, changed state to down
00:57:33: *LINK-5-UPDOWN: Line protocol on Interface FastEthernet0/6, changed state to down
% Incomplete command.

MS4(config-if-range)channel-group 3 mode active
Creating a port-channel interface Port-channel 3

MS4(config-if-range)no shut
MS4(config-if-range)#
00:58:20: *LINK-3-UPDOWN: Interface FastEthernet0/5, changed state to up
00:58:20: *LINK-3-UPDOWN: Interface FastEthernet0/6, changed state to up
00:58:20: *LINK-3-UPDOWN: Line protocol on Interface FastEthernet0/5, changed state to up
00:58:27: *LINK-3-UPDOWN: Interface Port-channel3, changed state to up
00:58:28: *LINK-3-UPDOWN: Line protocol on Interface FastEthernet0/6, changed state to up
00:58:28: *LINK-3-UPDOWN: Line protocol on Interface Port-channel3, changed state to up
MS4(config-if-range)exit
MS4(config-if-range)#
MS4(config-if)int port-channel 3
MS4(config-if)#sw trunk encapsulation dot1q
MS4(config-if)no mode trunk
MS4(config-if)#
Building configuration...
[OK]
MS4(config-if)end wr
Building configuration...
[OK]
MS4(config)#

```

COM3 - PuTTY

```

Switch# Configuration commands, one per line. End with CNTL/Z.
Switch(config)#host MS4
MS4(config)int range F0/1-6
% Invalid input detected at '^' marker.

MS4(config)int range F0/1 - 6
MS4(config-if-range)#sw mode trunk
MS4(config-if-range)#
MS4(config-if-range)int port-channel 1 - 2
MS4(config-if-range)exit
% Invalid input detected at '^' marker.

MS4(config-if-range)channel-group 1 mode active
% Invalid input detected at '^' marker.

MS4(config-if-range)channel-group 1 mode ?
  auto   Enable PAgP only if a PAgP device is detected
  desirable  Enable desirable mode
  enable   Enable Etherchannel only
MS4(config-if-range)channel-group 1 mode on
Creating a port-channel interface Port-channel1
MS4(config-if-range)no shut
MS4(config-if-range)#
01:14:45: *LINK-3-UPDOWN: Interface FastEthernet0/1, changed state to up
01:14:45: *LINK-3-UPDOWN: Interface FastEthernet0/2, changed state to up
01:14:45: *LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to up
01:14:45: *LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/2, changed state to up
01:14:45: *LINEPROTO-5-UPDOWN: Line protocol on Interface Port-channel1, changed state to up
01:14:45: *LINEPROTO-5-UPDOWN: Line protocol on Interface Port-channel1, changed state to up
MS4(config-if-range)exit
MS4(config-if-range)port-channel 1
MS4(config-if-range)no mode trunk
MS4(config-if-range)exit
MS4(config-if-range)int range F0/3-4
% Invalid input detected at '^' marker.

MS4(config-if-range)int range F0/3 - 4
MS4(config-if-range)#
MS4(config-if-range)#

```

COM3 - PuTTY

```

Presenting...  [ ] Give control  [ ] Stop presenting
Invalid input detected at '^' marker.

MS3(config)int range Fa0/9 - 10
MS3(config-if-range)#sw mode trun
Command rejected: An interface whose trunk encapsulation is "Auto" can not be configured to "trunk" mode.
Command rejected: An interface whose trunk encapsulation is "Auto" can not be configured to "trunk" mode.
MS3(config-if-range)no mode trunk
MS3(config-if-range)#
MS3(config-if-range)#
02:18:51: *LINK-5-CHANGED: Interface FastEthernet0/9, changed state to administratively down
02:18:51: *LINK-5-UPDOWN: Line protocol on Interface FastEthernet0/9, changed state to administratively down
02:18:52: *LINKPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/9, changed state to down
02:18:52: *LINKPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/10, changed state to down
MS3(config-if-range)channel-group 2 mode des
Creating a port-channel interface Port-channel 2

MS3(config-if-range)no shutdown
MS3(config-if-range)#
02:18:51: *LINK-5-CHANGED: Interface FastEthernet0/9, changed state to administratively down
02:18:51: *LINK-5-UPDOWN: Line protocol on Interface FastEthernet0/9, changed state to administratively down
02:18:52: *LINK-5-UPDOWN: Line protocol on Interface FastEthernet0/10, changed state to up
02:18:52: *LINKPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/9, changed state to up
02:18:52: *LINKPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/10, changed state to up
MS3(config-if-range)exit
MS3(config-if-range)port-channel 2
MS3(config-if-range)sw trunk encapsulation dot1q
MS3(config-if-range)no mode trunk
MS3(config-if-range)#
% Invalid input detected at '^' marker.

MS3(config-if-range)sw mode trun
MS3(config-if-range)exit
MS3(config-if-range)show ether summary
Flags: D - down F - in port-channel
I - stand-alone S - suspended
L - Layer1 M - Layer2
R - Layer3 S - Layer3
U - in use f - failed to allocate aggregator
u - unsuitable for bundling
v - waiting to be aggregated
d - default port

```

- To check the configuration, we used “show ether summary” command.

```

Switch(config-if)#exit
Switch(config)#int range Fa0/5 - 6
Switch(config-if-range)#shut
Switch(config-if-range)#no shutdown

30/40:0/5: WLINE-3-CHANGED: Interface FastEthernet0/5, changed state to administratively down
30/40:21: WLINE-3-CHANGED: Interface FastEthernet0/6, changed state to administratively down
30/40:0/22: WLINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/5, changed state to down
30/40:22: WLINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/6, changed state to down

Switch(config-if-range)#channel-group 3 mode des
Treating a port-channel interface Port-channel 3

Switch(config-if-range)#no shut
Switch(config-if-range)#shut
Switch(config-if-range)#no shutdown

30/40:45: WLINE-3-CHANGED: Interface FastEthernet0/5, changed state to up
30/40:45: WLINE-3-UPDOWN: Interface FastEthernet0/6, changed state to up
30/40:55: WLINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/6, changed state to up
30/40:55: WLINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/5, changed state to up

Switch(config-if-range)#exit
Switch(config)#int port-channel 3
Switch(config-if)#switchport trunk encapsulation dot1q
Switch(config-if)#sw mode trunk
Switch(config-if)#sw nonegotiate
Switch(config-if)#exit
Switch(config)#no show ether summary
[Aggr] D - known F - in port-channel
I - stand-alone S - suspended
H - Hot-standby (LACP only)
R - Layer3 S - Layer2
U - in use f - failed to allocate aggregator
u - unsuitable for bundling
w - waiting to be aggregated
d - default port

Number of channel-groups in use: 3
Number of aggregators: 3

Group Port-channel Protocol Ports
-----+
| Po1 (SD)      PAgP     Fa0/1 (I)   Fa0/2 (I)
| Po1 (SD)      PAgG    Fa0/3 (D)   Fa0/4 (D)
| Po1 (SD)      PAgP     Fa0/5 (I)   Fa0/6 (I)

Switch(config)#

```

```

Switch(config-if)#sw trunk encapsulation dot1q
Switch(config-if)#sw mode trunk
Switch(config-if)#sw n
00:37:22: NW MGMT-M-WCFLAP_NOTIF: Host 0011.931f.edcl in vlan 1 is flapping between port Fa0/8 and port Fa0/5
Switch(config-if)#sw negotiate
Switch(config-if)#sw fast
Switch(config-if)#do show ether suma
00:37:39: NW MGMT-M-WCFLAP_NOTIF: Host 0011.931f.edcl in vlan 1 is flapping between port Fa0/8 and port Fa0/5y
Flags: D - down P - is port-channel
I - stand-alone s - suspended
H - Hot-standby (LACP only)
R - Layer3 S - Layer2
U - in use f - failed to allocate aggregator
u - unavailable for bundling
w - waiting to be aggregated
d - default port

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

Group Port-channel Protocol Ports
-----
1 Po1 (S0) RRoP Fa0/1(I) Fa0/2(I)

Switch(config)# 
Switch(config)#int range Fa0/3 - 4
Switch(config-if-range)# 
00:37:55: NW MGMT-M-WCFLAP_NOTIF: Host 0011.931f.edcl in vlan 1 is flapping between port Fa0/8 and port Fa0/5
Switch(config-if-range)#shut
Switch(config-if-range)#
00:38:00: NW MGMT-M-CHANGETIMEOUT: Interface FastEthernet0/3, changed state to administratively down
00:38:00: NW MGMT-M-CHANGETIMEOUT: Interface FastEthernet0/4, changed state to administratively down
Switch(config-if-range)#
00:38:09: NW MGMT-M-WCFLAP_NOTIF: Host 0011.931f.edcl in vlan 1 is flapping between port Fa0/8 and port Fa0/5
Switch(config-if-range)#channel-group 2 on
00:38:21: NW MGMT-M-WCFLAP_NOTIF: Host 0011.931f.edcl in vlan 1 is flapping between port Fa0/8 and port Fa0
% incomplete command.

Switch(config-if-range)#channel-group 2 mode trunk
%
% Invalid input detected at `*' marker.

Switch(config-if-range)#channel-group 2 mode desi

```

Step 2: VTP Configuration:

- We configured MS3 and MS4 in the server mode. For VTP setting for this block (VTP domain: entb2, VTP password 2022).
 - Then we added and named the VLANs of this block just once on the MS3 and VLANs information propagated to all other switches, we used “show vtp status” command to check. Note that the ***Number of existing VLANs*** and the ***Configuration Revision*** number are increased.

```
3>
3$en
3$conf t
Enter configuration commands, one per line. End with CNTL/Z.
3$[config]#vtp mode client
Setting device to VTP CLIENT mode.
3$[config]#vtp domain ent2
Changing VTP domain name from NULL to ent2
3$[config]#vtp password 2022
Setting device VLAN database password to 2022
3$[config]#vtp version 2
3$[config]#do show vtp status
VTP Version : 2
Configuration Revision : 0
Maximum VLANs supported locally : 255
Number of existing VLANs : 5
VTP Operating Mode : Client
VTP Domain Name : ent2
VTP Pruning Mode : Disabled
VTP V2 Mode : Disabled
VTP Trap Generation : Disabled
MDS digest : 0x86 0xC4 0x21 0x70 0x1D 0x86 0xB8 0xF
configuration last modified by 0.0.0.0 at 0-0-00 00:00:00
3$[config]#
3$[config]#
3$[config]#
3$[config]#
3$[config]#do show vtp status
VTP Version : 2
Configuration Revision : 0
Maximum VLANs supported locally : 255
Number of existing VLANs : 5
VTP Operating Mode : Client
VTP Domain Name : ent2
VTP Pruning Mode : Disabled
VTP V2 Mode : Disabled
VTP Trap Generation : Disabled
MDS digest : 0x86 0xC4 0x21 0x70 0x1D 0x86 0xB8 0xF
Configuration last modified by 0.0.0.0 at 0-0-00 00:00:00
3$[config]#
HS#1
HS#2
HS#3
```

Presenting...

```

MS4>
MS4>
MS4>en
MS4#conf t
Enter configuration commands, one per line. End with CNTL/Z.
MS4(config)#vtp domain ent2
MS4(config)#vtp mode server
MS4(config)#vtp password 2022
Setting device VLAN database password to 2022
MS4(config)#do show vtp status
MS4#VTP Version : 2
Last Configuration Revision : 0
Maximum VLANs supported locally : 1005
Number of existing VLANs : 5
VTP Operating Mode : Server
VTP Domain Name : ent2
VTP Pruning Mode : Disabled
VTP Version : 2
VTP Traps Generation : Disabled
MD5 digest : 0x86 0xC4 0x21 0x70 0x1D 0x36 0xBB 0xFE
Configuration last modified by 0.0.0.0 at 0-0-00 00:00:00
Local updater ID is 0.0.0.0 (no valid interface found)
MS4(config)#
MS4(config)#do show vlan
VLAN Name Status Ports
-----  

1 default active Fa0/7, Fa0/9, Fa0/10, Fa0/11  

Fa0/12, Fa0/13, Fa0/14, Fa0/15  

Fa0/16, Fa0/17, Fa0/18, Fa0/19  

Fa0/20, Fa0/21, Fa0/22, Fa0/23  

Fa0/24, Gi0/1, Gi0/2
-----  

1002 fddi-default act/unsup
1003 token-ring-default act/unsup
1004 fdinnet-default act/unsup
1005 timer-default act/unsup

VLAN Type SAD MVU Parent RingNo BrdgNo Stp BrdgMode Transl Trans2
-----  

1 enet 100001 1500 - - - - 0 0
1002 fddi 101002 1500 - - - - 0 0
1003 token-ring 100003 1500 - - - - 0 0
1004 fdin 101004 1500 - - - - ieee 0 0

```

```

MS3(config-if-range)#do show ether summar
Presenting... [ ] Give control [ ] Stop presenti
Flags: D - down P - in port-channel
I - stand-alone S - suspended
H - Hot-standby (LACP only)
R - Layer3 S - Layer2
U - in use f - failed to allocate aggregator
u - unsuitable for bundling
w - waiting to be aggregated
d - default port

Number of channel-groups in use: 3
Number of aggregators: 3

Group Port-channel Protocol Ports
-----+
1 Po1(SU)     PAgP   Fa0/1(P)   Fa0/2(P)
2 Po2(SD)     -       -
3 Po3(SU)     PAgP   Fa0/5(P)   Fa0/6(P)

MS3(config-if-range)#exit
^
* Invalid input detected at `''' marker.

MS3(config-if-range)#exit
^
* Invalid input detected at `''' marker.

MS3(config-if-range)#do int port-channel 2
MS3(config)#do show ether summary
Presenting... [ ] Give control [ ] Stop presenti
Flags: D - down P - in port-channel
I - stand-alone S - suspended
H - Hot-standby (LACP only)
R - Layer3 S - Layer2
U - in use f - failed to allocate aggregator
u - unsuitable for bundling
w - waiting to be aggregated
d - default port

Number of channel-groups in use: 2
Number of aggregators: 2

Group Port-channel Protocol Ports
-----+
1 Po1(SU)     PAgP   Fa0/1(P)   Fa0/2(P)
2 Po3(SU)     PAgP   Fa0/5(P)   Fa0/6(P)

```

```

Presenting... [ ] Give control [ ] Stop presenti
^
* Invalid input detected at `''' marker.

MS3(config)#int range Fa0/9 - 10
MS3(config-if-range)#sw mode trunk
Command rejected: An interface whose trunk encapsulation is "Auto" can not be configured to "trunk" mode.
Command rejected: An interface whose trunk encapsulation is "Auto" can not be configured to "trunk" mode.
MS3(config-if-range)#trunk encapsulation dot1q
MS3(config-if-range)#sw mode trunk
MS3(config-if-range)#shut
MS3(config-if-range)#
02:18:51: WLNWK-5-CHANGED: Interface FastEthernet0/9, changed state to administratively down
02:18:51: WLNWK-5-CHANGED: Interface FastEthernet0/10, changed state to administratively down
02:18:52: WLNWK-5-UPDOWN: Line protocol on Interface FastEthernet0/9, changed state to down
02:18:52: WLNWK-5-UPDOWN: Line protocol on Interface FastEthernet0/10, changed state to down
MS3(config-if-range)#channel-group 2 mode des
Creating a port-channel interface Port-channel 2
MS3(config-if-range)#
MS3(config-if-range)#no shut
MS3(config-if-range)#
02:18:51: WLNWK-3-UPDOWN: Interface FastEthernet0/9, changed state to up
02:18:51: WLNWK-3-UPDOWN: Interface FastEthernet0/10, changed state to up
02:18:52: WLNWK-5-UPDOWN: Line protocol on Interface FastEthernet0/9, changed state to up
02:18:52: WLNWK-5-UPDOWN: Line protocol on Interface FastEthernet0/10, changed state to up
02:18:52: WLNWK-5-UPDOWN: Line protocol on Interface Port-channel, changed state to up
02:18:52: WLNWK-5-UPDOWN: Line protocol on Interface Port-channel, changed state to up
MS3(config-if-range)#exit
MS3(config)#
MS3(config)#port-channel 2
MS3(config-if)#sv mode trunk
MS3(config-if)#
^
* Invalid input detected at `''' marker.

MS3(config-if)#sw mode trunk
MS3(config-if)#
MS3(config-if)#exit
MS3(config)#
MS3(config)#do show ether summary
Presenting... [ ] Give control [ ] Stop presenti
Flags: D - down P - in port-channel
I - stand-alone S - suspended
H - Hot-standby (LACP only)
R - Layer3 S - Layer2
U - in use f - failed to allocate aggregator
u - unsuitable for bundling
w - waiting to be aggregated
d - default port

MS3(config-if)#

```

```

Presenting... [ ] Give control [ ] Stop presenti
MS3(config)#vlan 40
MS3(config-vlan)#name Finance
MS3(config-vlan)#vlan 50
MS3(config-vlan)#name Marketing
MS3(config-vlan)#do show vlan
show vlan
^
* Invalid input detected at `''' marker.

MS3(config-vlan)#do show vl
VLAN Name          Status    Ports
-----+
1  default         active    Fa0/3, Fa0/4, Fa0/7, Fa0/11
                           Fa0/12, Fa0/13, Fa0/14, Fa0/15
                           Fa0/16, Fa0/17, Fa0/18, Fa0/19
                           Fa0/20, Fa0/21, Fa0/22, Fa0/23
                           Fa0/24, Gi0/1, Gi0/2
40  Finance        active
1002 rddi-default  act/unsup
1003 token-ring-default  act/unsup
1005 rrdnnt-default  act/unsup
1005 tnet-default   act/unsup

VLAN Type      SAID      MTU      Parent RingNo BridgeNo Stp  BridgMode Transl Trans2
-----+
1  enet  100001  1500      -      -      -      -      0      0
40  enet  100040  1500      -      -      -      -      0      0
1002 enet  101003  1500      -      -      -      -      0      0
1003 tr   101003  1500      -      -      -      -      0      0
1004 xdnec 101004  1500      -      -      -      ieee -      0      0
1005 trnet 101005  1500      -      -      -      ilm -      0      0

Primary Secondary Type          Ports
-----+
MS3(config-vlan)#
MS3(config-vlan)#do show vlan
VLAN Name          Status    Ports
-----+

```

Step 3: Spanning Tree Protocol (STP):

- We configured Per VLAN Spanning Tree (PVST), we chose MS3 as the primary Root Bridge for all the four VLANs and MS4 as the secondary Root Bridge for the four VLANs.

Command we used:

- In MS3: spanning-tree vlan 40,45,50,60 root primary.
 - In MS4: spanning-tree vlan 40,45,50,60 root secondary.

Presenting...						
MS4#(config)#						
MS4#(config)#span vlan 40,50 root secondary						
MS4#(config)#do show span						
VLAN0001						
Spanning tree enabled protocol ieee						
Root ID	Priority	32769				
	Address	000a.b7fd.5a40				
	Cost	12				
	Port	56 (Port-channel)				
	Hello Time	2 sec	Max Age	20 sec	Forward Delay	15 sec
Bridge ID	Priority	32769 (priority 32768 sys-id-ext 1)				
	Address	0024.e93e.7200				
	Hello Time	2 sec	Max Age	20 sec	Forward Delay	15 sec
	Aging Time	300				
Interface	Role	Sts	Cost	Fric.Nbr	Type	
Fast0/7	Desg	FWD	19	128.9	P2p	
Pos1	Root	FWD	12	128.56	P2p	
Pos2	Desg	FWD	12	128.64	P2p	
Pos3	Altng	BLK	12	128.72	P2p	
VLAN0040						
Spanning tree enabled protocol ieee						
Root ID	Priority	24616				
	Address	0024.e93e.4e80				
	Cost	12				
	Port	72 (Port-channel3)				
	Hello Time	2 sec	Max Age	20 sec	Forward Delay	15 sec
Bridge ID	Priority	28712 (priority 28672 sys-id-ext 40)				
	Address	0024.e93e.7200				
	Hello Time	2 sec	Max Age	20 sec	Forward Delay	15 sec
	Aging Time	300				
Interface	Role	Sts	Cost	Fric.Nbr	Type	
Pos1	Desg	FWD	12	128.56	P2p	
Pos2	Desg	FWD	12	128.64	P2p	
Pos3	Root	FWD	12	128.72	P2p	

```

Presenting... Give control
Configuration last modified by 0.0.0.0 at
Local Updater ID is 0.0.0.0 (no valid intfs)
MS3(config)#span vlan 40,50 root primary
MS3(config)#do show span

VLAN0001
Spanning tree enabled protocol ieee
  Root ID    Priority  32769
              Address   000a.b7c1.8a40
              Cost        12
              Port       64 (Port-channel12)
              Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec

  Bridges ID Priority  32769 (priority 32768 sys-id-ext 1)
              Address   0024.4c2.0c80
              Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
              Aging Time 300

Interface      Role Sts Cost      Prio.Nbr Type
-----
Fa0/7          Desg FWD 19      128.9   P2p
Fa0/8          Desg FWD 19      128.56  P2p
Po2            Root FWD 1      128.64  P2p
Po3            Desg FWD 12     128.72  P2p

VLAN0040
Spanning tree enabled protocol ieee
  Root ID    Priority  24616
              Address   0024.4c2.0c80
              This bridge is the root
              Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec

  Bridges ID Priority  24616 (priority 24576 sys-id-ext 40)
              Address   0024.4c2.0c80
              Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
              Aging Time 300

Interface      Role Sts Cost      Prio.Nbr Type
-----
Po1            Desg FWD 12     128.56  P2p
Po2            Desg FWD 12     128.64  P2p
Po3            Desg FWD 12     128.72  P2p

```

```

Presenting...

Spanning tree enabled protocol ieee
Root ID Priority 24626
Address 0024.14e2.0c80
Cost 12
Port 72 (Port-channel3)
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec

Bridge ID Priority 28712 (priority 28672 sys-id-ext 40)
Address 0024.f93e.7f00
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
Aging Time 300

Interface Role Sts Cost Prio.Nbr Type
-----  

Po1 Desg FWD 12 128.56 P2p
Po2 Desg FWD 12 128.64 P2p
Po3 Root FWD 12 128.72 P2p

VLAN0050
Spanning tree enabled protocol ieee
Root ID Priority 24626
Address 0024.14e2.0c80
Cost 12
Port 72 (Port-channel3)
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec

Bridge ID Priority 28720 (priority 28672 sys-id-ext 50)
Address 0024.f93e.7f00
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
Aging Time 300

Interface Role Sts Cost Prio.Nbr Type
-----  

Po1 Desg FWD 12 128.56 P2p
Po2 Desg FWD 12 128.64 P2p
Po3 Root FWD 12 128.72 P2p

MS4(config)#  

MS4(config)#  

MS4(config)#  

MS4(config)#  

MS4(config)#

```

- Then we configured the ports of the access layer switches, each port with the appropriate VLAN access, and for those ports (which are not participate on SPT operations) we enabled the BPDU guard.

Command we used:

- int range <range of interfaces>
- switchport access vlan <VLAN ID>
- spanning-tree bpduguard enable

```

Remote SPAN VLANs
Presenting... Give control
[...]
Primary Secondary Type Ports
[...]
VLAN Name Status Ports
1 default active Fa0/8, Fa0/9, Fa0/10, Fa0/11
[...]
40 Finance active Fa0/7
50 Marketing active act/unsup
1002 fddi-default act/unsup
1003 fddinet-default act/unsup
1004 fddinnet-default act/unsup
1005 tnet-default act/unsup
[...]
VLAN Type SAID MTU Parent RingNo BridgeNo Stp BrdgMode Transl Trans2
[...]
enet 100001 1500 - - - - - - 0 0
40 enet 100040 1500 - - - - - - 0 0
50 enet 100050 1500 - - - - - - 0 0
1002 fddi 101000 1500 - - - - - - 0 0
1003 fddinet 101003 1500 - - - - - - 0 0
1004 fddinnet 101004 1500 - - - - - - 0 0
1005 tnet 101005 1500 - - - - - - 0 0
[...]
Remote SPAN VLANs
Presenting... Give control
[...]
1005 tnet 101005 1500 - -
S4#
S4#
S4#
S4#config t
Enter configuration commands, one per line. End with CNTL/Z.
S4(config)#int Fa0/8
S4(config-if)#switchport
S4(config-if)#switchport access
S4(config-if)#switchport access vlan 50
S4(config-if)#spanning-tree
S4(config-if)#spanning-tree bpduguard enable
S4(config-if)#exit
S4#
S4#3102: %SYS-5-CONFIG_I: Configured from console by console
Translating "showw"...domain server (255.255.255.255)
% Unknown command or computer name, or unable to find computer address
% Error: "show"
S4#
VLAN Name Status Ports
1 default active Fa0/7, Fa0/9, Fa0/10, Fa0/11
Fa0/12
40 Finance active Fa0/8
50 Marketing active
1002 fddi-default active
1003 fddinet-default active
1004 fddinnet-default active
1005 tnet-default active
[...]
VLAN Type SAID MTU Parent RingNo BridgeNo Stp BrdgMode Transl Trans2
[...]
enet 100001 1500 - - - - - - 0 0
40 enet 100040 1500 - - - - - - 0 0
50 enet 100050 1500 - - - - - - 0 0
1002 fddi 101000 1500 - - - - - - 0 0
1003 fddinet 101003 1500 - - - - - - 0 0
1004 fddinnet 101004 1500 - - - - - - 0 0
1005 tnet 101005 1500 - - - - - - 0 0
[...]
S4#
S4#wr
Writing configuration...
[OK]
S4#

```

Step 4: Hot Standby Router Protocol (HSRP):

- First, we enabled routing functionality on the Layer 3 switch using “ip routing” command inside the configuration mode of the MS.
- We created an interface for each VLAN and assigned to it IP address from the local subnet of the VLAN.
- Under the VLAN interface configuration we implemented the HSRP configuration
For the MS3 we gave it higher priority 150 and we left the MS4 with the default priority

```
MS3(config)#int vlan 40
MS3(config-if)# 
03:02:34: %LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan40, changed state to up
MS3(config-if)#ip add 192.168.40.2 255.255.255.0
MS3(config-if)#standby 40 ip 192.168.40.1
MS3(config-if)#standby 40 preempt
MS3(config-if)#standby 40 priority 150
MS3(config-if)#exit
MS3(config)#
03:04:10: %HSRP-6-STATECHANGE: Vlan40 Grp 40 state Speak -> Standby
03:04:11: %HSRP-6-STATECHANGE: Vlan40 Grp 40 state Standby -> Active
MS3(config)#int vlan 50
MS3(config-if)#
03:04:20: %LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan50, changed state to up
MS3(config-if)#ip add 192.168.50.2 255.255.255.0
MS3(config-if)#standby 50 ip 192.168.50.1
^
% Invalid input detected at `'' marker.

MS3(config-if)#standby 50 ip 192.168.50.1
MS3(config-if)#standby 40 priority 150
MS3(config-if)#standby 50 priority 150
MS3(config-if)#
03:05:26: %HSRP-6-STATECHANGE: Vlan50 Grp 50 state Speak -> Standby
03:05:27: %HSRP-6-STATECHANGE: Vlan50 Grp 50 state Standby -> Active
MS3(config-if)#standby 50 preempt
MS3(config-if)#exit
MS3(adv wr
MS3#do wr
MS3#show stand bri
          F indicates configured to preempt.
          |
Interface  Grp Prio F State   Active      Standby      Virtual IP
V140       40  150  P Active   local       unknown     192.168.40.1
V150       50  150  P Active   local       unknown     192.168.50.1
MS3#
```

```
Presenting...  Give control

Press RETURN to get started.

03:07:09: %SYS-5-CONFIG_I: Configured from console by console
MS4>
MS4>
MS4>en
MS4#conf t
Enter configuration commands, one per line. End with CNTL/Z.
MS4(config)#int vlan 40
MS4(config-if)#ip ad
03:07:40: %LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan40, changed state
MS4(config-if)#ip add 192.168.40.3 255.255.255.0
MS4(config-if)#standby 40 ip 192.168.40.1
MS4(config-if)#exit
MS4(config)#
03:08:40: %SERP-6-STATECHANGE: Vlan40 Grp 40 state Speak -> Standby
MS4(config)#
MS4(config)#int vlan 50
MS4(config-if)#
03:09:38: %LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan50, changed state to up
MS4(config-if)#ip add 192.168.50.3 255.255.255.0
MS4(config-if)#standby 50 ip 192.168.50.1
MS4(config-if)#exit
MS4(config)#
03:09:38: %SERP-6-STATECHANGE: Vlan50 Grp 50 state Speak -> Standby
MS4(config)#+d# show stand bri
          + indicates configured to preempt.
+
Interface  Grp  Prio  P State      Active      Standby      Virtual IP
V140       40  100   Standby  192.168.40.2  local        192.168.40.1
V150       50  100   Standby  192.168.50.2  local        192.168.50.1
MS4(config)#+d# wr
Building configuration...
[OK]
MS4(config)#[
```

```
MS5>
MS5>
MS5>
MS5>en
MS5#conf t
Enter configuration commands, one per line. End with CNTL/Z.
MS5(config)#do show ether summary
Flags: D - down P - in port-channel
I - stand-alone s - suspended
H - Hot-standby (LACP only)
R - Layer3 S - Layer2
U - unsuitable for bundling
U - in use f - failed to allocate aggregator
d - default port

Number of channel-groups in use: 3
Number of aggregators: 3

Group Port-channel Protocol Ports
-----+-----+-----+
1 Po1(SU) LACP Fa0/1(P) Fa0/2(P)
2 Po2(SU) LACP Fa0/3(P) Fa0/4(P)
3 Po3(SU) LACP Fa0/5(P) Fa0/6(P)

MS5(config)#
```

Step 5: Dynamic Host Configuration Protocol (DHCP):

- In the MS3 we created a DHCP pool for each VLAN.

Note: use the appropriate VIP for the default-router in each pool

- ❖ Assign IP addresses for router interfaces

MS3&MS4

```

MS>en
MS>conf t
Enter configuration commands, one per line. End with CNTL/Z.
MS>int fa0/0
MS>ip routing
MS>(config)int range Fa0/7 - 8
MS>(config-if-range)no sv
MS>(config-if-range)#
MS>32<43> %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/7, changed state to down
MS>32<46> %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/7, changed state to up
MS>(config-if-range)#
MS>(config-if-range)no shutdown
MS>(config-if-range)exit
MS>(config)int Fa0/7
MS>(config-if)no shutdown
MS>(config-if)ip add 10.0.12.1 255.255.255.0
MS>(config-if)no shutdown
MS>(config-if)ip add 10.0.12.2 255.255.255.0
MS>(config-if)no shutdown
MS>(config-if)ip add 10.0.15.1 255.255.255.0
MS>(config-if)no shutdown
MS>(config)#
MS>show ip int bri
Interface          IP-Address      OK? Method Status           Protocol
Vlan1              unassigned     YES NVRAM up
Vlan2              unassigned     YES NVRAM up
Vlan3              192.168.40.1  YES NVRAM up
Vlan50             192.168.50.2  YES NVRAM up
FastEthernet0/1    unassigned     YES unset up
FastEthernet0/2    unassigned     YES unset up
FastEthernet0/3    unassigned     YES unset down
FastEthernet0/4    unassigned     YES unset down
FastEthernet0/5    unassigned     YES unset up
FastEthernet0/6    unassigned     YES unset up
FastEthernet0/7    10.0.12.1   YES manual up
FastEthernet0/8    10.0.15.1   YES manual up
FastEthernet0/9    unassigned     YES unset up
FastEthernet0/10   unassigned     YES unset up
FastEthernet0/11   unassigned     YES unset down
FastEthernet0/12   unassigned     YES unset down
FastEthernet0/13   unassigned     YES unset down
FastEthernet0/14   unassigned     YES unset down
FastEthernet0/15   unassigned     YES unset down
FastEthernet0/16   unassigned     YES unset down
FastEthernet0/17   unassigned     YES unset down
FastEthernet0/18   unassigned     YES unset down

```

R3&R4

```

33
33[config]#
33[config]# Inter configuration commands, one per line. End with CNTL/Z.
33[config]#int Fa0/0
33[config-if]#no shu
33[config-if]# Invalid input detected at `''' marker.

33[config-if]#no shut
33[config-if]#duplex full
33[config-if]#speed 100
33[config-if]#link-mode auto
33[config-if]#lnk-detect off
33[config-if]#lnk-detect-timeout 10.0.12.2 255.255.255.0
33[config-if]#exit
33[config]#int Fa0/1
33[config-if]#no shut
33[config-if]#duplex full
33[config-if]#speed 100
33[config-if]#link-mode auto
33[config-if]#lnk-detect off
33[config-if]#lnk-detect-timeout 10.0.13.2 255.255.255.0
33[config-if]#exit
33[config]#exit
33[config]#show j

33[14141481]#SYS-5-CONFIG_I: Configured from console by console
33[config]# Allowing command "show i"
33[config]#sh ip int brx
Interface          IP-Address      OK? Method Status      Protocol
FastEthernet0/0    10.0.12.2       YES manual up        up
Serial0/0          unassigned     YES unset administratively down
FastEthernet0/1    10.0.13.2       YES manual up        up
33[config]#t
Inter configuration commands, one per line. End with CNTL/Z.
33[config]#int Se0/0
33[config]#no ip address
33[config]#no shut
33[config-if]#lnk-detect off
33[config-if]#lnk-detect-timeout 10.0.10.2 255.255.255.0
33[config-if]#exit
33[config]#end
33[config]#wr
33[config]# Invalid input detected at `''' marker.

33[config]#exit

```

Step 6: Open Shortest Path First (OSPF) Protocol.

❖ **Connectivity Between the Blocks**

- We connected the routers of the three blocks using the OSPF protocol, our network is divided into three area, area 0 (block 2), area 1 (block 1) and area 3 (block 3).

```
ASBR>en
ASBR#conf t
Enter configuration commands, one per line. End with CNTL/Z.
ASBR(config)#do show ip protocol

ASBR(config)#router ospf 1
ASBR(config-router)#do show ip route conn
  20.0.0.0/26 is subnetted, 2 subnets
    C        20.0.0.0 is directly connected, Serial0/0/2
    C        20.0.0.64 is directly connected, Serial0/0/3
  10.0.0.0/24 is subnetted, 2 subnets
    C        10.0.10.0 is directly connected, Serial0/0/0
    C        10.0.11.0 is directly connected, Serial0/0/1
ASBR(config-router)#network 20.0.0.0 0.0.0.63 area 0
ASBR(config-router)#ne
Jan 1 01:28:52.327: %OSPF-5-ADCHG: Process 1, Nbr 20.0.0.2 on Serial0/0/2 from LOADING to FULL, Loading Done!
% Incomplete command.

ASBR(config-router)#network 20.0.0.64 0.0.0.63 area 0
ASBR(config-router)#network 10.0.10.0 0.0.0.255 area 0
ASBR(config-router)#network 10.0.11.0 0.0.0.255 area 0
ASBR(config-router)#ex
```

```

LSBR(config)#do show ip route
Codes: 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

Gateway of last resort is not set

> IA 192.168.30.0/24 [110/794] via 20.0.0.2, 00:01:28, Serial0/0/2
  20.0.0.0/26 is subnetted, 2 subnets
    > 20.0.0.0 is directly connected, Serial0/0/2
    > 20.0.0.64/24 is directly connected, Serial0/0/3
> IA 192.168.10.0/24 [110/794] via 20.0.0.2, 00:01:28, Serial0/0/2
> IA 192.168.20.0/24 [110/794] via 20.0.0.2, 00:01:28, Serial0/0/2
  10.0.0.0/24 is subnetted, 8 subnets
    > 10.0.10.0 is directly connected, Serial0/0/0
    > 10.0.11.0 is directly connected, Serial0/0/1
> IA 10.0.2.0 [110/793] via 20.0.0.2, 00:01:29, Serial0/0/2
> IA 10.0.3.0 [110/793] via 20.0.0.2, 00:01:29, Serial0/0/2
> IA 10.0.0.0 [110/792] via 20.0.0.2, 00:01:29, Serial0/0/2
> IA 10.0.1.0 [110/792] via 20.0.0.2, 00:01:29, Serial0/0/2
> IA 10.0.4.0 [110/793] via 20.0.0.2, 00:01:48, Serial0/0/2
> IA 10.0.5.0 [110/793] via 20.0.0.2, 00:01:48, Serial0/0/2
192R#lnconfig#

```

COM3 - PUTTY

```

MS4(config)#do sh ip protocol
*** IP Routing is NSF aware ***

MS4(config)#router ospf 1
MS4(config-router)#do sho ip route conn
C 192.168.40.0/24 is directly connected, Vlan40
 10.0.0.0/24 is subnetted, 2 subnets
    C 10.0.14.0 is directly connected, FastEthernet0/8
    C 10.0.13.0 is directly connected, FastEthernet0/7
C 192.168.50.0/24 is directly connected, Vlan50
MS4(config-router)#
MS4(config-router)#network 192.168.40.0 0.0.0.255 area 0
MS4(config-router)#network 192.168.50.0 0.0.0.255 area 0
MS4(config-router)#network 10.0.14.0 0.0.0.255 area 0
MS4(config-router)#
01:46:34: %OSPF-5-ADVCHG: Process 1, Nbr 10.0.15.2 on FastEthernet0/8 from LOADING to FULL, Loading Done
MS4(config-router)#network 10.0.13.0 0.0.0.255 area 0
MS4(config-router)#
01:47:04: %OSPF-5-ADVCHG: Process 1, Nbr 10.0.13.2 on FastEthernet0/7 from LOADING to FULL, Loading Done
MS4(config-router)#

```

```

0 IA 192.168.30.0/24 [110/858] via 10.0.11.1, 00:00:05, Serial0/0
  20.0.0.0/26 is subnetted, 2 subnets
    0 20.0.0.0 [110/460] via 10.0.11.1, 00:00:05, Serial0/0
    0 20.0.0.64 [110/460] via 10.0.11.1, 00:00:05, Serial0/0
0 IA 192.168.10.0/24 [110/858] via 10.0.11.1, 00:00:05, Serial0/0
0 IA 192.168.20.0/24 [110/858] via 10.0.11.1, 00:00:05, Serial0/0
  10.0.0.0/24 is subnetted, 12 subnets
    0 10.0.10.0 [110/460] via 10.0.11.1, 00:00:05, Serial0/0
    0 10.0.11.0 is directly connected, Serial0/0
    0 10.0.14.0 is directly connected, FastEthernet0/0
    0 10.0.15.0 is directly connected, FastEthernet0/1
    0 10.0.12.0 [110/461] via 10.0.11.1, 00:00:07, Serial0/0
    0 10.0.13.0 [110/461] via 10.0.11.1, 00:00:07, Serial0/0
0 IA 10.0.2.0 [110/857] via 10.0.11.1, 00:00:07, Serial0/0
0 IA 10.0.3.0 [110/857] via 10.0.11.1, 00:00:07, Serial0/0
0 IA 10.0.0.0 [110/856] via 10.0.11.1, 00:00:08, Serial0/0
0 IA 10.0.1.0 [110/856] via 10.0.11.1, 00:00:08, Serial0/0
0 IA 10.0.4.0 [110/857] via 10.0.11.1, 00:00:08, Serial0/0
0 IA 10.0.5.0 [110/857] via 10.0.11.1, 00:00:08, Serial0/0
R4(config-router)#

```

```

0 IA 192.168.30.0/24 [110/858] via 10.0.11.1, 00:00:05, Serial0/0
  20.0.0.0/26 is subnetted, 2 subnets
    0 20.0.0.0 [110/460] via 10.0.11.1, 00:00:05, Serial0/0
    0 20.0.0.64 [110/460] via 10.0.11.1, 00:00:05, Serial0/0
0 IA 192.168.10.0/24 [110/858] via 10.0.11.1, 00:00:05, Serial0/0
0 IA 192.168.20.0/24 [110/858] via 10.0.11.1, 00:00:05, Serial0/0
  10.0.0.0/24 is subnetted, 12 subnets
    0 10.0.10.0 [110/460] via 10.0.11.1, 00:00:05, Serial0/0
    0 10.0.11.0 is directly connected, Serial0/0
    0 10.0.14.0 is directly connected, FastEthernet0/0
    0 10.0.15.0 is directly connected, FastEthernet0/1
    0 10.0.12.0 [110/461] via 10.0.11.1, 00:00:07, Serial0/0
    0 10.0.13.0 [110/461] via 10.0.11.1, 00:00:07, Serial0/0
0 IA 10.0.2.0 [110/857] via 10.0.11.1, 00:00:07, Serial0/0
0 IA 10.0.3.0 [110/857] via 10.0.11.1, 00:00:07, Serial0/0
0 IA 10.0.0.0 [110/856] via 10.0.11.1, 00:00:08, Serial0/0
0 IA 10.0.1.0 [110/856] via 10.0.11.1, 00:00:08, Serial0/0
0 IA 10.0.4.0 [110/857] via 10.0.11.1, 00:00:08, Serial0/0
0 IA 10.0.5.0 [110/857] via 10.0.11.1, 00:00:08, Serial0/0
R4(config-router)#

```

Step 7: Load Balancing in OSPF and Area Summarization.

```

COM3 <

ASBR#en
ASBR# conf t
Enter configuration commands, one per line. End with CNTL/Z.
ASBR(config)#int S0/0/1
ASBR(config-if)#ip ospf 100
  % incomplete command.

ASBR#conf t(4)#
ASBR#show ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
      D - dynamic, * - EIGRP external, E - OSPF external type 1
      * - OSPF external type 2, 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

Gateway of last resort is not set

O IA 192.168.60.0/24 [110/788] via 20.0.0.66, 02:38:34, Serial0/0
  20.0.0.66 is subnetted, 2 subnets
    C 192.168.60.1 is directly connected, Serial0/0/2
    C 20.0.0.64 is directly connected, Serial0/0/3
O 192.168.40.0/24 [110/102] via 10.0.11.2, 0:00:03, Serial0/0/1
  10.0.0.0/8 is variably subnetted, 13 subnets, 2 masks
    O 10.0.10.0/24 is directly connected, Serial0/0/0
    I 10.0.10.1 is directly connected, Serial0/0/0
    O 10.0.14.0/24 [110/101] via 10.0.11.2, 00:00:05, Serial0/0/1
    O 10.0.15.0/24 [110/101] via 10.0.11.2, 00:00:05, Serial0/0/1
    O 10.0.12.0/24 [110/101] via 10.0.11.2, 00:00:05, Serial0/0/1
    O 10.0.13.0/24 [110/101] via 10.0.11.2, 00:00:05, Serial0/0/1
    O 10.0.14.1/24 [110/787] via 20.0.0.66, 02:44:26, Serial0/0/3
    O 10.0.25.0/24 [110/787] via 20.0.0.66, 02:44:26, Serial0/0/3
    O 10.0.22.0/24 [110/787] via 20.0.0.66, 02:49:45, Serial0/0/3
    O 10.0.23.0/24 [110/787] via 20.0.0.66, 02:49:45, Serial0/0/3
    O 10.0.24.0/24 [110/787] via 20.0.0.66, 02:49:45, Serial0/0/3
    O 10.0.21.0/24 [110/786] via 20.0.0.66, 02:55:13, Serial0/0/3
O 192.168.50.0/24 [110/102] via 10.0.11.2, 0:00:06, Serial0/0/1
O 192.168.70.0/24 [110/788] via 20.0.0.66, 02:38:37, Serial0/0/3
O 192.168.0.0/1 [110/998] via 20.0.0.2, 00:13:10, Serial0/0/2

```

```

COM3-F011

20.0.0.0/26 is subnetted, 2 subnets
O 20.0.0.0 [110/461] via 10.0.14.2, 00:00:14, FastEthernet0/8
    [110/461] via 10.0.13.2, 00:00:14, FastEthernet0/7
O 20.0.0.64 [110/461] via 10.0.14.2, 00:00:14, FastEthernet0/8
    [110/461] via 10.0.13.2, 00:00:14, FastEthernet0/7
C 192.168.40.0/24 is directly connected, Vlan40
0 10.0.0.0/8 is variably subnetted, 9 subnets, 3 masks
O 10.10.0.0/24 [110/653] via 10.0.13.2, 00:00:14, FastEthernet0/7
    [110/653] via 10.0.13.2, 00:00:14, FastEthernet0/8
O 10.10.0.64 [110/653] via 10.0.13.2, 00:00:14, FastEthernet0/8
O 10.0.14.0/24 [110/653] via 10.0.13.2, 00:00:14, FastEthernet0/7
O 10.0.15.0/24 [110/21] via 10.0.14.2, 00:00:14, FastEthernet0/8
O 10.0.12.0/24 [110/2] via 192.168.50.2, 00:00:14, Vlan50
    [110/2] via 192.168.40.2, 00:00:14, Vlan40
    [110/2] via 10.0.14.2, 00:00:14, FastEthernet0/7
C 10.0.13.0/24 is directly connected, FastEthernet0/7
O IA 10.0.0.0/21 [110/561] via 10.0.14.2, 00:00:15, FastEthernet0/8
    [110/561] via 10.0.13.2, 00:00:15, FastEthernet0/7
O IA 10.0.16.0/20 [110/561] via 10.0.14.2, 00:00:15, FastEthernet0/8
    [110/561] via 10.0.13.2, 00:00:15, FastEthernet0/7
C 192.168.50.0/24 is directly connected, Vlan50
O IA 192.168.0.0/19 [110/563] via 10.0.14.0, 00:00:16, FastEthernet0/8
    [110/563] via 10.0.13.2, 00:00:16, FastEthernet0/7
O IA 192.168.0.0/17 [110/563] via 10.0.14.2, 00:00:16, FastEthernet0/8
    [110/563] via 10.0.13.2, 00:00:16, FastEthernet0/7

MS4#config-router#
MS4(config-router)#exit
MS4#config#Fin
MS4#config#Fin
MS4#conf t
MS4#conf t 10
MS4#conf t 15
MS4#conf t 15 ip ospf cost 10
MS4#conf t 15 ip ospf 1
MS4#conf t 15 show ip route cs
0 20.0.0.0/26 is subnetted, 2 subnets
O 20.0.0.0 [110/461] via 10.0.14.2, 00:00:08, FastEthernet0/8
    [110/461] via 10.0.13.2, 00:00:08, FastEthernet0/7
O 10.0.0.0/8 is variably subnetted, 3 masks, 2 routes
O 10.0.10.0/24 [110/66] via 192.168.50.2, 00:00:03, Vlan50
    [110/66] via 192.168.40.2, 00:00:03, Vlan40
O 10.0.0.0/24 [110/653] via 10.0.14.2, 00:00:04, FastEthernet0/8
    [110/653] via 10.0.13.2, 00:00:04, FastEthernet0/7
O 10.0.15.0/24 [110/21] via 10.0.14.2, 00:00:04, FastEthernet0/8
    [110/21] via 192.168.50.2, 00:00:04, Vlan50
    [110/2] via 192.168.40.2, 00:00:04, Vlan40
D IA 10.0.0.0/21 [110/561] via 10.0.14.2, 00:00:04, FastEthernet0/8
    [110/561] via 10.0.13.2, 00:00:04, FastEthernet0/7
O IA 192.168.0.0/19 [110/563] via 10.0.14.0, 00:00:04, FastEthernet0/8
    [110/563] via 10.0.13.2, 00:00:04, FastEthernet0/7
O IA 192.168.0.0/17 [110/563] via 10.0.14.2, 00:00:04, FastEthernet0/8
    [110/563] via 10.0.13.2, 00:00:04, FastEthernet0/7

MS4#conf t f1

```

```

CSR#config-if#do show ip route cs
D 192.168.46.0/24 [110/399] via 10.0.11.2, 00:00:03, Serial1/0/1
  10.0.0.0/8 is variably subnetted, 8 subnets, 3 masks
D 10.0.14.0/24 [110/397] via 10.0.11.2, 00:00:03, Serial1/0/0
D 10.0.15.0/24 [110/398] via 10.0.11.2, 00:00:03, Serial1/0/0
D 10.0.12.0/24 [110/397] via 10.0.10.2, 00:00:03, Serial1/0/0
D 10.0.13.0/24 [110/397] via 10.0.10.2, 00:00:03, Serial1/0/0
D 1A 10.0.0.2/21 [110/996] via 20.0.0.2, 01:35:09, Serial1/0/0
D 10.0.14.0/20 [110/398] via 10.0.11.1, 00:00:03, Serial1/0/0
D 192.166.16.0/24 [110/399] via 10.0.10.2, 00:00:03, Serial1/0/0
D 1A 192.166.16.0/19 [110/598] via 20.0.0.2, 01:35:09, Serial1/0/2
D 192.166.16.0/17 [110/498] via 20.0.0.66, 02:14:47, Serial1/0/3

CSR#config-if#exit
CSR#config>#Se0/0/0
CSR#config>#ospf cost 100
CSR#config>#show ip route conn
20.0.0.26 is subnetted, 2 subnets
C 20.0.0.0 is directly connected, Serial1/0/2
C 20.0.0.64 is directly connected, Serial1/0/3
CSR#config>#show ip route ospf
10.0.0.0/8 is variably subnetted, 8 subnets, 3 masks
C 10.0.10.0/24 is directly connected, Serial1/0/0
C 10.0.11.0/24 is directly connected, Serial1/0/1
CSR#config-if#show ip route ospf
C 15.0.0.0/24 [110/103] via 10.0.10.2, 00:00:30, Serial1/0/0
  10.0.0.0/8 is variably subnetted, 8 subnets, 3 masks
D 10.0.14.0/24 [110/102] via 10.0.10.2, 00:00:30, Serial1/0/0
D 10.0.15.0/24 [110/103] via 10.0.10.2, 00:00:30, Serial1/0/0
D 10.0.12.0/24 [110/104] via 10.0.10.2, 00:00:30, Serial1/0/0
D 10.0.13.0/24 [110/105] via 10.0.10.2, 00:00:30, Serial1/0/0
D 1A 10.0.0.2/21 [110/996] via 20.0.0.2, 01:36:21, Serial1/0/0
D 1A 10.0.16.0/20 [110/498] via 20.0.0.66, 02:16:16, Serial1/0/3
D 192.166.16.0/24 [110/106] via 10.0.10.2, 01:36:21, Serial1/0/3
D 1A 192.166.16.0/17 [110/498] via 20.0.0.66, 02:15:59, Serial1/0/3

CSR#config-if#do wr
Building configuration...

[OK]

```

```

COM3 - P

R3>
R3>
R3>
R3>
R3>en
R3(config)#
R3(config)# show ip route ospf
 20.0.0.0/6 is subnetted, 2 subnets
 0 20.0.0.0 [110/460] via 10.0.10.1, 01:22:38, Serial0/0/0
 0 20.0.0.64 [110/460] via 10.0.10.1, 01:22:38, Serial0/0/0
 0 192.168.40.0/24 [110/560] via 10.0.12.1, 00:13:33, FastEthernet0/0
 0 192.168.40.0/24 [110/21] via 10.0.12.1, 00:13:33, FastEthernet0/0
 10.0.0.0/8 is variably subnetted, 8 subnets, 3 masks
 0 10.0.11.0/24 [110/66] via 10.0.13.1, 01:22:38, FastEthernet0/1
 0 10.0.14.0/24 [110/2] via 10.0.13.1, 01:22:38, FastEthernet0/1
 0 10.0.15.0/24 [110/8] via 10.0.13.1, 00:11:21, FastEthernet0/1
 0 IA 50.0.0.0/16 [110/560] via 10.0.10.1, 00:07:00, Serial0/0/0
 0 IA 10.0.16.0/24 [110/560] via 10.0.10.1, 01:22:38, Serial0/0/0
 0 192.168.50.0/24 [110/21] via 10.0.13.1, 00:07:00, FastEthernet0/1
 0 192.168.50.0/24 [110/2] via 10.0.12.1, 00:13:33, FastEthernet0/0
 0 IA 192.168.0.0/16 [110/562] via 10.0.10.1, 01:22:38, Serial0/0/0
 0 192.168.0.0/16 [110/562] via 10.0.10.1, 01:22:38, Serial0/0/0
R3(config)#int Fast0/0
R3(config-if)#ip cost 10
R3(config-if)#show ip route ospf
 20.0.0.0/6 is subnetted, 2 subnets
 0 20.0.0.0 [110/460] via 10.0.10.1, 01:22:38, Serial0/0/0
 0 20.0.0.64 [110/460] via 10.0.10.1, 01:22:38, Serial0/0/0
 0 192.168.40.0/24 [110/2] via 10.0.12.1, 00:13:12, FastEthernet0/0
 10.0.0.0/8 is variably subnetted, 8 subnets, 3 masks
 0 10.0.11.0/24 [110/67] via 10.0.12.1, 00:00:04, FastEthernet0/0
 0 10.0.14.0/24 [110/3] via 10.0.12.1, 00:00:04, FastEthernet0/0
 0 10.0.15.0/24 [110/9] via 10.0.12.1, 00:00:04, FastEthernet0/0
 0 IA 50.0.0.0/16 [110/560] via 10.0.10.1, 01:23:16, Serial0/0/0
 0 IA 10.0.16.0/24 [110/560] via 10.0.10.1, 01:23:16, Serial0/0/0
 0 192.168.50.0/24 [110/2] via 10.0.12.1, 00:14:12, FastEthernet0/0
 0 IA 192.168.0.0/19 [110/562] via 10.0.10.1, 01:23:16, Serial0/0/0
 0 IA 192.168.0.0/17 [110/562] via 10.0.10.1, 01:23:16, Serial0/0/0
R3(config-if)#
R3(config-if)#
R3(config-if)#
R3(config-if)#
R3(config-if)#

```

7.4.3 Block 3 Configuration:

Step 1: EtherChannel:

- We started with the Layer 3 switches we named them MS5 and MS6.

2) COM3 - PUTTY

```
MS5(config-if-range)#channel-group 1 mode active
Creating a port-channel interface Port-channel 1

MS5(config-if-range)#no shut
MS5(config-if-range)#exit
00:00:55:1LINK-3-FDDOWN: Interface FastEthernet0/1, changed state to down
00:00:55:1LINK-3-FDUPDOWN: Interface FastEthernet0/2, changed state to down
MS5(config-if-range)#exit
MS5(config-if-range)#port-channel 1
MS5(config-if)##trunk encapsulation dot1q
MS5(config-if)#new mode trunk
^
` Invalid input detected at `'' marker.

MS5(config-if)#mode trun
MS5(config-if)#exit
MS5(config)#fd show int Fe0/1
FastEthernet0/1 is down, line protocol is down (notconnect)
Hardware is Fast Ethernet, address is 0012.4317.e181 (Rte 0012.4317.e181)
MTU 1500 bytes, 10000 Kbit, DLY 1000 usec,
    reliability 255/255, txload 1/255, rxload 1/255
Encapsulation ARPA, loopback not set
Broadcasting (infcnt 10 sec)

Auto-duplex, Auto-speed, media type is 100BaseTX
input flow-control is off, output flow-control is unsupported
Auto type: dynamic, Auto speed: 100
Last clearing of "show interface" counters never
Last clearing of "show interface" counters never
Input queue: 0/5/0/0 (size/max/drops/flushes); Total output drops: 0
Waiting stratus filter
Output queue: 0/40 (size/max)
5 minute input rate 0 bits/sec, 0 packets/sec
5 minute output rate 0 bits/sec, 0 packets/sec
0 packets input, 0 bytes, 0 no buffer
Received 0 broadcasts (0 multicast)
0 runts, 0 giants, 0 throttles
0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored
0 watchdog, 0 multicast, 0 pause input
0 input errors with discard, 0 discarded
0 packets output, 0 bytes, 0 underruns

MS5(config)#no shut
` Incomplete command.
```

```

[D] MS6(config)#f-range#
[D] MS6(00:004): #LINE3-0-DOWN: Interface FastEthernet0/5, changed state to up
[D] MS6(00:004): #LINE3-0-UPDOWN: Interface FastEthernet0/6, changed state to up
[D] MS6(00:004): #LINE3-0-DOWN: Line protocol on interface FastEthernet0/6, changed state to up
[D] MS6(00:004): #LINE3-0-UPDOWN: Line protocol on interface FastEthernet0/5, changed state to up
[D] MS6(00:11): #LINE3-0-DOWN: Interface Port-channel1, changed state to up
[D] MS6(00:12): #LINEPCP0-0-UPDOWN: Line protocol on interface Port-channel1, changed state to up
[D] MS6(config)f-range#exit
MS6(config)f#exit
MS6(config)int port-channel 3
MS6(config)#trunk encapsulation dot1q
MS6(config-if)#mode trunk

% Invalid input detected at `''' marker.

MS6(config-if)#mode trunk
MS6(config-if)#exit
MS6(config)#do show ether summary
Flags: I - Interface, S - Status in port-channel
      L - Stand-alone, s - suspended
      H - Hot-standby (LACP only)
      R - Layer3
      U - User-defined
      F - Failed to allocate aggregator
      u - unsuitable for bundling
      w - waiting to be aggregated
      d - default port

Number of channel-groups in use: 3
Number of aggregators: 3

Group Port-channel Protocol Ports
-----+
1 Po1(SD) LACP Fa0/1(I) Fa0/2(I)
2 Po2(SD) LACP Fa0/3(I) Fa0/4(I)
3 Po3(SU) LACP Fa0/5(P) Fa0/6(F)

MS6(config)#do wr
Building configuration...
[OK]
MS6(config)#do wr
Building configuration...
[OK]
MS6(config)#

```

Step 2: VTP Configuration:

- We configured MS3 and MS4 in the server mode. For VTP setting for this block (VTP domain: entb3, VTP password 2022).

Step 3: Spanning Tree Protocol (STP):

- We configured Per VLAN Spanning Tree (PVST), we chose MS5 as the primary Root Bridge for all the four VLANs and MS6 as the secondary Root Bridge for the four VLANs.

Command we used:

- In MS5: spanning-tree vlan 70,75,80 root primary.
- In MS6: spanning-tree vlan 70,75,80 root secondary.

```

MS5#conf t
Enter configuration commands, one per line. End with CNTL/Z.
MS5(config)#do show ether summary
Flags: D - down P - in port-channel
I - stand-alone S - suspended
H - Hot-standby (LACP only)
R - Layer3 S - Layer2
u - unsuitable for bundling
U - in use f - failed to allocate aggregator
d - default port

Number of channel-groups in use: 3
Number of aggregators: 3

Group Port-channel Protocol Ports
1 Po1 (SD) LACP Fa0/1(D) Fa0/2(D)
2 Po2 (SD) LACP Fa0/3(P) Fa0/4(F)
3 Po3 (SD) LACP Fa0/5(F) Fa0/6(F)

MS5(config)#vtp domain ent3
Changing VTP domain name from NULL to ent3
MS5(config)#vtp password 2022
Setting device VLAN database password to 2022
MS5(config)#do show vtp status
show vtp status ?
* Invalid input detected at `''' marker.

MS5(config)#do show vtp status
VTP Version : 2
Configuration Revision : 2
Maximum VLANs supported locally : 1005
Number of existing VLANs : 7
VTP Operating Mode : Server
VTP Domain Name : ent3
VTP Forwarding Mode : Enabled
VTP V2 Mode : Disabled
VTP Trap Generation : Disabled
MS5 digest : 0x00 0x6A 0x51 0x99 0xC8 0x48 0x55 0x87
Configuration last modified by 0.0.0.0 at 3-1-93 00:14:56
Local update ID is 0.0.0.0 (no valid interface found)
MS5(config)#do show vtp
MS5(config)#spanning-tree enable
MS5(config)#spanning-tree vlan 70 root primary
MS5(config)#spanning-tree vlan 75 root secondary
MS5(config)#spanning-tree vlan 80 root secondary
MS5(config)#do show spanning-tree
VLAN0001
Spanning tree enabled protocol ieee
Root ID Priority 32769
Address 0012.4317.e180
This bridge is the root
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
Bridge ID Priority 32769 (priority 32768 sys-id-ext 1)
Address 0012.4317.e180
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
Aging Time 300
Interface Role Sts Cost Prio.Nbr Type
Fa0/8 Designated 19 128.8 P2p
Po2 Designated 12 128.66 P2p
Po3 Designated 12 128.67 P2p

VLAN0060
Spanning tree enabled protocol ieee
Root ID Priority 24636
Address 0012.4317.e180
This bridge is the root
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
Bridge ID Priority 24636 (priority 24576 sys-id-ext 60)
Address 0012.4317.e180
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
Aging Time 300
Interface Role Sts Cost Prio.Nbr Type
Po2 Designated 12 128.66 P2p
Po3 Designated 12 128.67 P2p

VLAN0070
Spanning tree enabled protocol ieee

```

```

MS5#conf t
Enter configuration commands, one per line. End with CNTL/Z.
MS5(config)#do show ether summary
Flags: D - down P - in port-channel
I - stand-alone S - suspended
H - Hot-standby (LACP only)
R - Layer3 S - Layer2
u - unsuitable for bundling
U - in use f - failed to allocate aggregator
d - default port

Number of channel-groups in use: 3
Number of aggregators: 3

Group Port-channel Protocol Ports
1 Po1 (SD) LACP Fa0/1(D) Fa0/2(D)
2 Po2 (SD) LACP Fa0/3(P) Fa0/4(F)
3 Po3 (SD) LACP Fa0/5(F) Fa0/6(F)

MS5(config)#vtp domain ent3
Changing VTP domain name from NULL to ent3
MS5(config)#vtp password 2022
Setting device VLAN database password to 2022
MS5(config)#do show vtp status
show vtp status ?
* Invalid input detected at `''' marker.

MS5(config)#do show vtp status
VTP Version : 2
Configuration Revision : 2
Maximum VLANs supported locally : 1005
Number of existing VLANs : 7
VTP Operating Mode : Server
VTP Domain Name : ent3
VTP Forwarding Mode : Enabled
VTP V2 Mode : Disabled
VTP Trap Generation : Disabled
MS5 digest : 0x00 0x6A 0x51 0x99 0xC8 0x48 0x55 0x87
Configuration last modified by 0.0.0.0 at 3-1-93 00:14:56
Local update ID is 0.0.0.0 (no valid interface found)
MS5(config)#do show vtp
MS5(config)#spanning-tree enable
MS5(config)#spanning-tree vlan 70 root primary
MS5(config)#spanning-tree vlan 75 root secondary
MS5(config)#spanning-tree vlan 80 root secondary
MS5(config)#do show spanning-tree
VLAN0001
Spanning tree enabled protocol ieee
Root ID Priority 32769
Address 0012.4317.e180
This bridge is the root
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
Bridge ID Priority 32769 (priority 32768 sys-id-ext 1)
Address 0012.4317.e180
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
Aging Time 300
Interface Role Sts Cost Prio.Nbr Type
Fa0/8 Designated 19 128.8 P2p
Po2 Designated 12 128.66 P2p
Po3 Designated 12 128.67 P2p

VLAN0060
Spanning tree enabled protocol ieee
Root ID Priority 24636
Address 0012.4317.e180
This bridge is the root
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
Bridge ID Priority 24636 (priority 24576 sys-id-ext 60)
Address 0012.4317.e180
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
Aging Time 300
Interface Role Sts Cost Prio.Nbr Type
Po2 Designated 12 128.66 P2p
Po3 Designated 12 128.67 P2p

VLAN0070
Spanning tree enabled protocol ieee

```

```

C:\> S6(config-if)#do show vtp status
VTP Version : 2
Configuration Revision : 6
Maximum VLANs supported locally : 1005
Number of existing VLANs : 7
VTP Operating Mode : Client
VTP Domain Name : ent3
VTP Pruning Mode : Disabled
VTP V2 Mode : Disabled
VTP Trap Generation : Disabled
MDS digest : 0x67 0xb3 0x7e 0xb0 0x9b 0x2b 0x58 0x37
Configuration last modified by 0.0.0.0 at 3-1-93 06:04:20
S6(config-if)#
S6(config-if)#do show vlan
VLAN Name Status Ports
-----+
1 default active Fa0/1, Fa0/2, Fa0/7, Fa0/9
                                Fa0/10, Fa0/11, Fa0/12
                                Fa0/13, Fa0/14, Fa0/15
                                Fa0/17, Fa0/18, Fa0/19, Fa0/20
                                Fa0/21, Fa0/22, Fa0/23, Fa0/24
                                Gi0/1, Gi0/2
60 Support active
6000 search active
1003 fddi-default act/unsup
1003 token-ring-default act/unsup
1004 fddinet-default act/unsup
1005 trnet-default act/unsup
VLAN Type SAID MTU Parent RingNo BridgeNo Stp BridgMode Transl Trans2
-----+
1 enet 100001 1500 - - - - 0 0
60 enet 100000 1500 - - - - 0 0
70 enet 100070 1500 - - - - 0 0
6002 fddi 101000 1500 - - - - 0 0
6003 token 101000 1500 - - - - srdb 0 0
1004 fddinet 101004 1500 - - - - ieee 0 0
1005 trnet 101005 1500 - - - - ihm 0 0
Remote SPAN VLANs

```

```

COM3 - Putty
S6(config)#do show vtp status
VTP Version : 2
Configuration Revision : 6
Maximum VLANs supported locally : 1005
Number of existing VLANs : 7
VTP Operating Mode : Server
VTP Domain Name : ent3
VTP Pruning Mode : Disabled
VTP V2 Mode : Disabled
VTP Trap Generation : Disabled
MDS digest : 0x67 0xb3 0x7e 0xb0 0x9b 0x2b 0x58 0x37
Configuration last modified by 0.0.0.0 at 3-1-93 06:04:28
Local VTP ID is 0.0.0.0 (no valid interface found)
S6(config)#
S6(config)#
S6(config)#span vlan 60,70 root secondary
S6(config)#
S6(config)#
S6(config)#
VLAN0001
Spanning tree enabled protocol ieee
Root ID Priority 32769
    Address 0012.4317.e100
    Cost 12
    Port 72 (Port-channel13)
    Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
Bridge ID Priority 32769 (Priority 32768 sys-id-ext 1)
    Address 0024.e99e.7d80
    Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
    Aging Time 300
Interface Role Sts Cost Prio.Hdr Type
-----+
Fa0/7  Designated FWD 19 128.9 P2p
Fa0/8  Designated FWD 19 128.10 P2p
Po1   Designated FWD 12 128.56 P2p
Po2   Designated FWD 12 128.57 P2p
Po3   Root FWD 12 128.72 P2p
VLAN0060
Spanning tree enabled protocol ieee
Root ID Priority 24668

```

- Then we configured the ports of the access layer switches, each port with the appropriate VLAN access, and for those ports (which are not participate on SPT operations) we enabled the BPDU guard.

Command we used:

- int range <range of interfaces>
- switchport access vlan <VLAN ID>
- switchport voice vlan <VLAN ID>
- spanning-tree bpduguard enable

```

COM3 - PuTTY
-----[Switch 1 Configuration]-----
S5(config-if)# int range Fa0/7-24
S5(config-if)# exit
S5(config)# int Fa0/7
S5(config-if)# switchport mode access
S5(config-if)# switchport access vlan 60
S5(config-if)# spanning-tree bpduguard enable
S5(config-if)# exit
S5(config)# do show vlan
VLAN Name          Status    Ports
1  default         active    Fa0/1, Fa0/2, Fa0/8, Fa0/9
                   active    Fa0/10, Fa0/11, Fa0/12, Fa0/13
                   active    Fa0/14, Fa0/15, Fa0/16, Fa0/17
                   active    Fa0/18, Fa0/19, Fa0/20, Fa0/21
                   active    Fa0/22, Fa0/23, Fa0/24, Gi0/1
                   active    Gi0/2
60  Support        active    Fa0/7
70  Research       active
1002 fddi-default  act/unsup
1003 token-ring-default  act/unsup
1004 fddinet-default  act/unsup
1005 trnet-default  act/unsup
VLAN Type SAID      MTU Parent RingNo BridgeNo Stp BrdgMode Transl Trans2
1  enet 100001 1500  -   -   -   -   0   0
60  enet 100060 1500  -   -   -   -   0   0
70  enet 100070 1500  -   -   -   -   0   0
1002 fddi 101002 1500  -   -   -   -   0   0
1003 tr 101003 1500  -   -   -   srb  0   0
1004 fddnet 101004 1500  -   -   -   ieee -   0   0
S5(config)#do wr
Building configuration...
[OK]
S5(config)#
-----[Switch 2 Configuration]-----
S6(config-if)# int range Fa0/3-9
S6(config-if)# exit
S6(config)# int Fa0/3
S6(config-if)# switchport mode access
S6(config-if)# switchport access vlan 70
S6(config-if)# spanning-tree bpduguard enable
S6(config-if)# exit
S6(config)# do show vlan
VLAN Name          Status    Ports
1  default         active    Fa0/7, Fa0/8, Fa0/10, Fa0/11
                   active    Fa0/12, Fa0/13, Fa0/14, Fa0/15
                   active    Fa0/16, Fa0/17, Fa0/18, Fa0/19
                   active    Fa0/20, Fa0/21, Fa0/22, Fa0/23
                   active    Fa0/24, Gi0/1, Gi0/2
40  Support        active
70  Research       active    Fa0/8
1002 fddi-default  act/unsup
1003 token-ring-default  act/unsup
1004 fddinet-default  act/unsup
1005 trnet-default  act/unsup
VLAN Type SAID      MTU Parent RingNo BridgeNo Stp BrdgMode Transl Trans2
1  enet 100001 1500  -   -   -   -   0   0
60  enet 100060 1500  -   -   -   -   0   0
70  enet 100070 1500  -   -   -   -   0   0
1002 fddi 101002 1500  -   -   -   -   0   0
1003 tr 101003 1500  -   -   -   srb  0   0
1004 fddnet 101004 1500  -   -   -   ieee -   0   0
S6(config)#do wr
Building configuration...
[OK]
S6(config)#

```

Step 4: Hot Standby Router Protocol (HSRP):

- First, we enabled routing functionality on the Layer 3 switch using “ip routing” command inside the configuration mode of the MS.
- We created an interface for each VLAN and assigned to it IP address from the local subnet of the VLAN.
- Under the VLAN interface configuration we implemented the HSRP configuration
For the MS5 we gave it higher priority 150 and we left the MS6 with the default priority.

```

MS6(config)#
MS6>
MS6>
MS6>
MS6<conf t
Enter configuration commands, one per line. End with CNTL/Z.
MS6(config)#
MS6(config)#int vlan 60
MS6(config-if)#
06:51:21: %LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan60, changed state to up
MS6(config-if)#ip add 192.168.60.3 255.255.255.0
MS6(config-if)##standby 60 ip 192.168.60.1
MS6(config-if)##exit
MS6(config)#
06:52:11: %HSRP-6-STATECHANGE: Vlan60 Grp 60 state Speak -> Standby
MS6(config)##int vlan 70
MS6(config-if)#
06:52:40: %LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan70, changed state to up
MS6(config-if)##ip add 192.168.70.3 255.255.255.0
MS6(config-if)##standby 70 ip 192.168.70.1
MS6(config-if)##exit
MS6(config)#
06:53:34: %HSRP-6-STATECHANGE: Vlan70 Grp 70 state Speak -> Standby
MS6(config)##do wr
Building configuration...
[OK]
MS6(config)##do show stand bri
      F indicates configured to preempt.
      !
Interface  Grp  Prio  P State    Active      Standby      Virtual IP
V160       60   100   Standby  192.168.60.2  local        192.168.60.1
V170       70   100   Standby  192.168.70.1  local        192.168.70.1
MS6(config)#

```

Step 5: Dynamic Host Configuration Protocol (DHCP):

- In the MS5 we created and DHCP pool for each VLAN.

Note: use the appropriate VIP for the default-router in each pool

```

MS5(config)#
MS5(config)#ip dhcp pool VLAN60
MS5(dhcp-config)#network 192.168.60.0 255.255.255.0
MS5(dhcp-config)#default-router 192.168.60.1
MS5(dhcp-config)#dns-server 172.16.0.10
MS5(dhcp-config)##exit
MS5(config)#ip dhcp pool VLAN70
MS5(dhcp-config)#network 192.168.70.0 255.255.255.0
MS5(dhcp-config)#default-router 192.168.70.1
MS5(dhcp-config)#dns-server 172.16.0.10
MS5(dhcp-config)##exit
MS5(config)##do wr
Building configuration...
[OK]
MS5(config)#

```

Step 6: Open Shortest Path First (**OSPF**) Protocol:

❖ Connectivity Between the Blocks

- We connected the routers of the three blocks using the OSPF protocol, our network is divided into three area, area 0 (block 2), area 1 (block 1) and area 3 (block 3).

```
Gateway of last resort is not set

O IA 192.168.30.0/24 [110/1184] via 20.0.0.65, 00:00:17, Serial0/0/2
  20.0.0.0/26 is subnetted, 2 subnets
    O 20.0.0.0 [110/786] via 20.0.0.65, 00:00:17, Serial0/0/2
    C 20.0.0.64 is directly connected, Serial0/0/2
O IA 192.168.10.0/24 [110/1184] via 20.0.0.65, 00:00:17, Serial0/0/2
  192.168.40.0/24 [110/788] via 20.0.0.65, 00:00:17, Serial0/0/2
O IA 192.168.20.0/24 [110/1184] via 20.0.0.65, 00:00:17, Serial0/0/2
  10.0.0.0/24 is subnetted, 14 subnets
    O 10.0.10.0 [110/786] via 20.0.0.65, 00:00:19, Serial0/0/2
    O 10.0.11.0 [110/786] via 20.0.0.65, 00:00:19, Serial0/0/2
    O 10.0.14.0 [110/787] via 20.0.0.65, 00:00:19, Serial0/0/2
    O 10.0.15.0 [110/787] via 20.0.0.65, 00:00:19, Serial0/0/2
    O 10.0.12.0 [110/787] via 20.0.0.65, 00:00:19, Serial0/0/2
    O 10.0.13.0 [110/787] via 20.0.0.65, 00:00:20, Serial0/0/2
    O IA 10.0.2.0 [110/1183] via 20.0.0.65, 00:00:21, Serial0/0/2
    O IA 10.0.3.0 [110/1183] via 20.0.0.65, 00:00:21, Serial0/0/2
    O IA 10.0.0.0 [110/1182] via 20.0.0.65, 00:00:21, Serial0/0/2
    O IA 10.0.1.0 [110/1182] via 20.0.0.65, 00:00:21, Serial0/0/2
    O IA 10.0.4.0 [110/1183] via 20.0.0.65, 00:00:21, Serial0/0/2
    O IA 10.0.5.0 [110/1183] via 20.0.0.65, 00:00:21, Serial0/0/2
    C 10.0.20.0 is directly connected, Serial0/0/0
    C 10.0.21.0 is directly connected, Serial0/0/1
RBR2(config-router)#
```

```
Gateway of last resort is not set

O IA 192.168.30.0/24 [110/1248] via 10.0.20.1, 00:00:14, Serial0/0/1
  20.0.0.0/26 is subnetted, 2 subnets
    O IA 20.0.0.0 [110/850] via 10.0.20.1, 00:00:14, Serial0/0/1
    O IA 20.0.0.64 [110/454] via 10.0.20.1, 00:00:14, Serial0/0/1
O IA 192.168.10.0/24 [110/1248] via 10.0.20.1, 00:00:14, Serial0/0/1
O IA 192.168.40.0/24 [110/852] via 10.0.20.1, 00:00:14, Serial0/0/1
O IA 192.168.20.0/24 [110/1248] via 10.0.20.1, 00:00:14, Serial0/0/1
  10.0.0.0/24 is subnetted, 16 subnets
    O IA 10.0.10.0 [110/850] via 10.0.20.1, 00:00:14, Serial0/0/1
    O IA 10.0.11.0 [110/850] via 10.0.20.1, 00:00:14, Serial0/0/1
    O IA 10.0.14.0 [110/851] via 10.0.20.1, 00:00:14, Serial0/0/1
    O IA 10.0.15.0 [110/851] via 10.0.20.1, 00:00:14, Serial0/0/1
    O IA 10.0.12.0 [110/851] via 10.0.20.1, 00:00:14, Serial0/0/1
    O IA 10.0.13.0 [110/851] via 10.0.20.1, 00:00:16, Serial0/0/1
    O IA 10.0.2.0 [110/1247] via 10.0.20.1, 00:00:17, Serial0/0/1
    O IA 10.0.3.0 [110/1247] via 10.0.20.1, 00:00:17, Serial0/0/1
    O IA 10.0.0.0 [110/1246] via 10.0.20.1, 00:00:17, Serial0/0/1
    O IA 10.0.1.0 [110/1246] via 10.0.20.1, 00:00:17, Serial0/0/1
    O IA 10.0.4.0 [110/1247] via 10.0.20.1, 00:00:17, Serial0/0/1
    O IA 10.0.5.0 [110/1247] via 10.0.20.1, 00:00:17, Serial0/0/1
    C 10.0.22.0 is directly connected, FastEthernet0/0
    C 10.0.23.0 is directly connected, FastEthernet0/1
    C 10.0.20.0 is directly connected, Serial0/0/1
    O 10.0.21.0 [110/454] via 10.0.20.1, 00:00:18, Serial0/0/1
R5(config-router)#

```

```
COM3 - PUTTY

S(config)#router os 1
S(config-router)#do show ip conn
how ip conn
^
Invalid input detected at '''' marker.

S(config-router)#do show ip route conn
10.0.0.0/24 is subnetted, 3 subnets
  10.0.22.0 is directly connected, FastEthernet0/0
  10.0.23.0 is directly connected, FastEthernet0/1
  10.0.20.0 is directly connected, Serial0/0/1
S(config-router)#
S(config-router)#
S(config-router)#
S(config-router)#
S(config-router)#
S(config-router)#
Jan 1 02:33:58.767: %OSPF-5-ADUNCH3: Process 1, Nbr 20.0.0.66 on Serial0/0/1 from LOADING to FULL, Loading Done
S(config-router)#
S(config-router)#
S(config-router)#

```

```
Gateway of last resort is not set

O IA 192.168.30.0/24 [110/1184] via 20.0.0.65, 00:00:17, Serial0/0/2
  20.0.0.0/26 is subnetted, 2 subnets
    O 20.0.0.0 [110/786] via 20.0.0.65, 00:00:17, Serial0/0/2
    C 20.0.0.64 is directly connected, Serial0/0/2
O IA 192.168.10.0/24 [110/1184] via 20.0.0.65, 00:00:17, Serial0/0/2
  192.168.40.0/24 [110/788] via 20.0.0.65, 00:00:17, Serial0/0/2
O IA 192.168.20.0/24 [110/1184] via 20.0.0.65, 00:00:17, Serial0/0/2
  10.0.0.0/24 is subnetted, 14 subnets
    O 10.0.10.0 [110/786] via 20.0.0.65, 00:00:19, Serial0/0/2
    O 10.0.11.0 [110/786] via 20.0.0.65, 00:00:19, Serial0/0/2
    O 10.0.14.0 [110/787] via 20.0.0.65, 00:00:19, Serial0/0/2
    O 10.0.15.0 [110/787] via 20.0.0.65, 00:00:19, Serial0/0/2
    O 10.0.12.0 [110/787] via 20.0.0.65, 00:00:19, Serial0/0/2
    O 10.0.13.0 [110/787] via 20.0.0.65, 00:00:20, Serial0/0/2
    O IA 10.0.2.0 [110/1183] via 20.0.0.65, 00:00:21, Serial0/0/2
    O IA 10.0.3.0 [110/1183] via 20.0.0.65, 00:00:21, Serial0/0/2
    O IA 10.0.0.0 [110/1182] via 20.0.0.65, 00:00:21, Serial0/0/2
    O IA 10.0.1.0 [110/1182] via 20.0.0.65, 00:00:21, Serial0/0/2
    O IA 10.0.4.0 [110/1183] via 20.0.0.65, 00:00:21, Serial0/0/2
    O IA 10.0.5.0 [110/1183] via 20.0.0.65, 00:00:21, Serial0/0/2
    C 10.0.20.0 is directly connected, Serial0/0/0
    C 10.0.21.0 is directly connected, Serial0/0/1
RBR2(config-router)#

```

```
Gateway of last resort is not set

O IA 192.168.30.0/24 [110/1248] via 10.0.21.1, 00:00:19, Serial10/0
  20.0.0.0/26 is subnetted, 2 subnets
    O IA 20.0.0.0/24 [110/850] via 10.0.21.1, 00:00:19, Serial10/0
      O IA 20.0.0.64 [110/454] via 10.0.21.1, 00:00:19, Serial10/0
        O IA 192.168.10.0/24 [110/1248] via 10.0.21.1, 00:00:19, Serial10/0
          O IA 192.168.40.0/24 [110/852] via 10.0.21.1, 00:00:19, Serial10/0
            O IA 192.168.20.0/24 [110/1248] via 10.0.21.1, 00:00:19, Serial10/0
              10.0.0.0/24 is subnetted, 18 subnets
                O IA 10.0.10.0 [110/850] via 10.0.21.1, 00:00:20, Serial10/0
                O IA 10.0.11.0 [110/850] via 10.0.21.1, 00:00:20, Serial10/0
                O IA 10.0.14.0 [110/851] via 10.0.21.1, 00:00:20, Serial10/0
                O IA 10.0.15.0 [110/851] via 10.0.21.1, 00:00:20, Serial10/0
                O IA 10.0.12.0 [110/851] via 10.0.21.1, 00:00:20, Serial10/0
                O IA 10.0.13.0 [110/851] via 10.0.21.1, 00:00:21, Serial10/0
                O IA 10.0.2.0 [110/1247] via 10.0.21.1, 00:00:22, Serial10/0
                O IA 10.0.3.0 [110/1247] via 10.0.21.1, 00:00:22, Serial10/0
                O IA 10.0.0.0 [110/1246] via 10.0.21.1, 00:00:22, Serial10/0
                O IA 10.0.1.0 [110/1246] via 10.0.21.1, 00:00:22, Serial10/0
                O IA 10.0.4.0 [110/1247] via 10.0.21.1, 00:00:22, Serial10/0
                O IA 10.0.5.0 [110/1247] via 10.0.21.1, 00:00:22, Serial10/0
                C 10.0.24.0 is directly connected, FastEthernet0/0
                C 10.0.25.0 is directly connected, FastEthernet0/1
                O 10.0.22.0 [110/455] via 10.0.21.1, 00:00:22, Serial10/0
                O 10.0.23.0 [110/455] via 10.0.21.1, 00:00:22, Serial10/0
                O 10.0.20.0 [110/454] via 10.0.21.1, 00:00:22, Serial10/0
                C 10.0.21.0 is directly connected, Serial10/0

#config-router#
```

```
MS6(config)#  
MS6(config)#do show ip protocol  
show ip protocol  
^  
!  
% Invalid input detected at '^' marker.  
  
MS6(config)#do show ip protocol  
*** IP Routing is NSF aware ***  
  
MS6(config)#router os 1  
MS6(config-router)#do show ip route conn  
C 192.168.60.0/24 is directly connected, Vlan60  
    10.0.0.0/24 is subnetted, 2 subnets  
    C 10.0.24.0 is directly connected, FastEthernet0/8  
    C 10.0.23.0 is directly connected, FastEthernet0/7  
    C 192.168.70.0/24 is directly connected, Vlan70  
I  
MS6(config-router)#  
MS6(config-router)#  
MS6(config-router)#network 192.168.60.0 0.0.0.255 area 2  
MS6(config-router)#network 192.168.70.0 0.0.0.255 area 2  
MS6(config-router)#network 10.0.24.0 0.0.0.255 area 2  
MS6(config-router)#  
I020h: #OSPF-5-ADJCHG: Process 1, Nbr 10.0.25.2 on FastEthernet0/8 from LOADING to FULL, Loading Done  
MS6(config-router)#network 10.0.23.0 0.0.0.255 area 2  
MS6(config-router)#  
I020h: #OSPF-5-ADJCHG: Process 1, Nbr 10.0.23.2 on FastEthernet0/7 from LOADING to FULL, Loading Done  
MS6(config-router)#
```

```
[ZXR10-#] display interface brief
          Flag  Interface,       MTU,        IP-Address, Status
 0 IA    10.0.0.0 [110/1247] via 10.0.25.2, 00:00:04, FastEthernet0/8
          [110/1247] via 10.0.22.2, 00:00:04, FastEthernet0/7
 0 IA    10.0.1.0 [110/1247] via 10.0.25.2, 00:00:04, FastEthernet0/8
          [110/1247] via 10.0.22.2, 00:00:04, FastEthernet0/7
 0 IA    10.0.4.0 [110/1248] via 10.0.25.2, 00:00:05, FastEthernet0/8
          [110/1248] via 10.0.22.2, 00:00:05, FastEthernet0/7
 0 IA    10.0.5.0 [110/1248] via 10.0.25.2, 00:00:05, FastEthernet0/8
          [110/1248] via 10.0.22.2, 00:00:05, FastEthernet0/7
 0      10.0.24.0 [110/2] via 192.168.60.3, 00:00:05, Vlan60
          [110/2] via 192.168.70.3, 00:00:05, Vlan70
          [110/2] via 10.0.25.2, 00:00:05, FastEthernet0/8
C      10.0.25.0 is directly connected, FastEthernet0/8
C      10.0.22.0 is directly connected, FastEthernet0/7
 0      10.0.23.0 [110/2] via 192.168.60.3, 00:00:05, Vlan60
          [110/2] via 192.168.70.3, 00:00:05, Vlan70
          [110/2] via 10.0.22.2, 00:00:06, FastEthernet0/7
 0      10.0.20.0 [110/65] via 10.0.22.2, 00:00:06, FastEthernet0/7
 0      10.0.21.0 [110/65] via 10.0.25.2, 00:00:06, FastEthernet0/8
C      192.168.70.0/24 is directly connected, Vlan70
MS5(config-router)#

```

Step 7: Load Balancing in OSPF and Area Summarization:

```

COM3 - PUTTY
ABR2(config)#do show ip route
Codes: 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

Gateway of last resort is not set

O  192.168.60.0/24 [110/392] via 10.0.21.2, 02:33:39, Serial0/0/1
   [110/392] via 10.0.20.2, 02:33:39, Serial0/0/0
  20.0.0.0/26 is subnetted, 2 subnets
O  20.0.0.0 [110/786] via 20.0.0.65, 00:04:50, Serial0/0/2
C  20.0.0.64 is directly connected, Serial0/0/2
O  192.168.40.0/24 [110/492] via 20.0.0.65, 00:04:50, Serial0/0/2
  10.0.0.0/8 is variably subnetted, 13 subnets, 2 masks
O  10.0.10.0/24 [110/556] via 20.0.0.65, 00:04:50, Serial0/0/2
O  10.0.11.0/24 [110/490] via 20.0.0.65, 00:04:51, Serial0/0/2
O  10.0.14.0/24 [110/491] via 20.0.0.65, 00:04:51, Serial0/0/2
O  10.0.15.0/24 [110/491] via 20.0.0.65, 00:04:51, Serial0/0/2
O  10.0.12.0/24 [110/493] via 20.0.0.65, 00:04:51, Serial0/0/2
O  10.0.13.0/24 [110/493] via 20.0.0.65, 00:04:51, Serial0/0/2
O  IA  10.0.0.0/21 [110/886] via 20.0.0.65, 00:04:52, Serial0/0/2
O  10.0.24.0/24 [110/391] via 10.0.21.2, 02:33:41, Serial0/0/1
O  10.0.25.0/24 [110/391] via 10.0.21.2, 02:33:42, Serial0/0/1
O  10.0.22.0/24 [110/391] via 10.0.20.2, 02:33:42, Serial0/0/0
O  10.0.23.0/24 [110/391] via 10.0.20.2, 02:33:42, Serial0/0/0
O  10.0.20.0/24 is directly connected, Serial0/0/0
C  10.0.21.0/24 is directly connected, Serial0/0/1
O  192.168.50.0/24 [110/492] via 20.0.0.65, 00:04:53, Serial0/0/2
O  192.168.70.0/24 [110/392] via 10.0.21.2, 02:33:42, Serial0/0/1
   [110/392] via 10.0.20.2, 02:33:42, Serial0/0/0
O  IA 192.168.0.0/19 [110/888] via 20.0.0.65, 00:04:54, Serial0/0/2
ABR2(config)#

```



```

COM3 - PUTTY
ABR2(config-if)#do show ip route
Codes: 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

Gateway of last resort is not set

O  192.168.60.0/24 [110/102] via 10.0.21.2, 00:00:25, Serial0/0/1
  20.0.0.0/26 is subnetted, 2 subnets
O  20.0.0.0 [110/786] via 20.0.0.65, 00:02:26, Serial0/0/2
C  20.0.0.64 is directly connected, Serial0/0/2
O  192.168.40.0/24 [110/492] via 20.0.0.65, 00:02:26, Serial0/0/2
  10.0.0.0/8 is variably subnetted, 14 subnets, 3 masks
O  10.0.10.0/24 [110/556] via 20.0.0.65, 00:02:26, Serial0/0/2
O  10.0.11.0/24 [110/490] via 20.0.0.65, 00:02:26, Serial0/0/2
O  10.0.14.0/24 [110/491] via 20.0.0.65, 00:02:27, Serial0/0/2
O  10.0.15.0/24 [110/491] via 20.0.0.65, 00:02:27, Serial0/0/2
O  10.0.12.0/24 [110/493] via 20.0.0.65, 00:02:27, Serial0/0/2
O  10.0.13.0/24 [110/493] via 20.0.0.65, 00:02:27, Serial0/0/2
O  IA  10.0.0.0/21 [110/886] via 20.0.0.65, 00:00:26, Serial0/0/2
O  10.0.24.0/24 [110/101] via 10.0.21.2, 00:00:28, Serial0/0/1
O  10.0.25.0/24 [110/101] via 10.0.21.2, 00:00:28, Serial0/0/1
O  10.0.16.0/20 is a summary, 00:00:29, Null0
O  10.0.22.0/24 [110/102] via 10.0.21.2, 00:00:29, Serial0/0/1
O  10.0.23.0/24 [110/102] via 10.0.21.2, 00:00:29, Serial0/0/1
C  10.0.20.0/24 is directly connected, Serial0/0/0
C  10.0.21.0/24 is directly connected, Serial0/0/1
O  192.168.50.0/24 [110/492] via 20.0.0.65, 00:02:31, Serial0/0/2
O  192.168.70.0/24 [110/102] via 10.0.21.2, 00:00:30, Serial0/0/1
O  IA 192.168.0.0/19 [110/888] via 20.0.0.65, 00:00:31, Serial0/0/2
O  192.168.0.0/17 is a summary, 00:00:31, Null0
ABR2(config-if)#

```



```

COM3 - PUTTY
o - ODR, P - periodic downloaded static route
Gateway of last resort is not set

C  192.168.60.0/24 is directly connected, Vlan60
  20.0.0.0/26 is subnetted, 2 subnets
O  IA  20.0.0.0 [110/851] via 10.0.24.2, 02:20:45, FastEthernet0/8
   [110/851] via 10.0.23.2, 02:20:45, FastEthernet0/7
O  IA  20.0.0.64 [110/455] via 10.0.24.2, 02:20:45, FastEthernet0/8
   [110/455] via 10.0.23.2, 02:20:45, FastEthernet0/7
O  IA 192.168.40.0/24 [110/557] via 10.0.24.2, 00:05:41, FastEthernet0/8
   [110/557] via 10.0.23.2, 00:05:41, FastEthernet0/7
  10.0.0.0/8 is variably subnetted, 13 subnets, 2 masks
O  IA  10.0.10.0/24 [110/555] via 10.0.24.2, 00:05:42, FastEthernet0/8
   [110/555] via 10.0.23.2, 00:05:42, FastEthernet0/7
O  IA  10.0.11.0/24 [110/622] via 10.0.24.2, 00:03:27, FastEthernet0/8
   [110/622] via 10.0.23.2, 00:03:27, FastEthernet0/7
O  IA  10.0.14.0/24 [110/558] via 10.0.24.2, 00:03:28, FastEthernet0/8
   [110/558] via 10.0.23.2, 00:03:28, FastEthernet0/7
O  IA  10.0.15.0/24 [110/566] via 10.0.24.2, 00:02:12, FastEthernet0/8
   [110/566] via 10.0.23.2, 00:02:12, FastEthernet0/7
O  IA  10.0.12.0/24 [110/556] via 10.0.24.2, 00:05:44, FastEthernet0/8
   [110/556] via 10.0.23.2, 00:05:44, FastEthernet0/7
O  IA  10.0.13.0/24 [110/565] via 10.0.24.2, 00:03:29, FastEthernet0/8
   [110/565] via 10.0.23.2, 00:03:29, FastEthernet0/7
O  IA  10.0.0.0/21 [110/951] via 10.0.24.2, 01:41:46, FastEthernet0/9
   [110/951] via 10.0.23.2, 01:41:46, FastEthernet0/7
C  10.0.24.0/24 is directly connected, FastEthernet0/8
O  10.0.25.0/24 [110/2] via 192.168.70.2, 02:20:49, Vlan70
   [110/2] via 192.168.60.2, 02:20:49, Vlan60
   [110/2] via 10.0.24.2, 02:20:50, FastEthernet0/8
O  10.0.22.0/24 [110/2] via 192.168.70.2, 02:21:04, Vlan70
   [110/2] via 192.168.60.2, 02:21:04, Vlan60
   [110/2] via 10.0.23.2, 02:21:04, FastEthernet0/7
C  10.0.23.0/24 is directly connected, FastEthernet0/7
O  10.0.20.0/24 [110/65] via 10.0.23.2, 02:21:04, FastEthernet0/7
   [110/65] via 10.0.24.2, 00:06:01, FastEthernet0/8
O  IA 192.168.50.0/24 [110/557] via 10.0.24.2, 00:06:01, FastEthernet0/7
   [110/557] via 10.0.23.2, 00:06:01, FastEthernet0/7
C  192.168.70.0/24 is directly connected, Vlan70
O  IA 192.168.0.0/19 [110/953] via 10.0.24.2, 01:42:06, FastEthernet0/8
   [110/953] via 10.0.23.2, 01:42:06, FastEthernet0/7
MS6(config)#
MS6(config)#

```



```

COM3 - PUTTY
C  192.168.70.0/24 is directly connected, Vlan70
  20.0.0.0/26 is subnetted, 2 subnets
O  IA 192.168.0.0/19 [110/953] via 10.0.24.2, 01:42:06, FastEthernet0/8
   [110/953] via 10.0.23.2, 01:42:06, FastEthernet0/7
MS6(config)#
MS6(config)#
MS6(config)#
MS6(config)#int Fa0/7
MS6(config-if)#ip ospf cost 10
MS6(config-if)#do show ip route ospf
  20.0.0.0/26 is subnetted, 2 subnets
O  IA  20.0.0.0 [110/851] via 10.0.24.2, 00:00:06, FastEthernet0/8
O  IA  20.0.0.64 [110/455] via 10.0.24.2, 00:00:06, FastEthernet0/8
O  IA 192.168.40.0/24 [110/557] via 10.0.24.2, 00:00:06, FastEthernet0/8
  10.0.0.0/8 is variably subnetted, 13 subnets, 2 masks
O  IA  10.0.10.0/24 [110/555] via 10.0.24.2, 00:00:06, FastEthernet0/8
O  IA  10.0.11.0/24 [110/622] via 10.0.24.2, 00:00:06, FastEthernet0/8
O  IA  10.0.14.0/24 [110/558] via 10.0.24.2, 00:00:06, FastEthernet0/8
O  IA  10.0.15.0/24 [110/556] via 10.0.24.2, 00:00:06, FastEthernet0/8
O  IA  10.0.12.0/24 [110/556] via 10.0.24.2, 00:00:06, FastEthernet0/8
O  IA  10.0.0.0/24 [110/951] via 10.0.24.2, 00:00:06, FastEthernet0/8
O  10.0.25.0/24 [110/2] via 192.168.70.2, 00:00:06, Vlan70
   [110/2] via 192.168.60.2, 00:00:06, Vlan60
   [110/2] via 10.0.24.2, 00:00:06, FastEthernet0/8
O  10.0.22.0/24 [110/2] via 192.168.70.2, 00:00:07, Vlan70
   [110/2] via 192.168.60.2, 00:00:07, Vlan60
O  10.0.20.0/24 [110/66] via 192.168.70.2, 00:00:07, Vlan70
   [110/66] via 192.168.60.2, 00:00:07, Vlan60
O  10.0.21.0/24 [110/65] via 10.0.24.2, 00:00:07, FastEthernet0/8
O  IA 192.168.50.0/24 [110/557] via 10.0.24.2, 00:00:07, FastEthernet0/8
O  IA 192.168.0.0/19 [110/953] via 10.0.24.2, 00:00:07, FastEthernet0/8
MS6(config-if)#exit
MS6(config-if)#int vln 70
MS6(config-if)#ip ospf cost 10
MS6(config-if)#do show ip route
Codes: 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

Gateway of last resort is not set

```

```

MS6(config)#int vlan 60
MS6(config-if)#ip ospf cost 20
MS6(config-if)#do show ip route ospf
 20.0.0.0/26 is subnetted, 2 subnets
 0 IA  20.0.0.0 [110/851] via 10.0.24.2, 00:00:17, FastEthernet0/8
 0 IA  20.0.0.64 [110/455] via 10.0.24.2, 00:00:17, FastEthernet0/8
 0 IA 192.168.40.0/24 [110/557] via 10.0.24.2, 00:00:17, FastEthernet0/8
    10.0.0.0/8 is variably subnetted, 13 subnets, 2 masks
 0 IA  10.0.10.0/24 [110/558] via 10.0.24.2, 00:00:17, FastEthernet0/8
 0 IA  10.0.11.0/24 [110/622] via 10.0.24.2, 00:00:17, FastEthernet0/8
 0 IA  10.0.14.0/24 [110/558] via 10.0.24.2, 00:00:17, FastEthernet0/8
 0 IA  10.0.15.0/24 [110/566] via 10.0.24.2, 00:00:18, FastEthernet0/8
 0 IA  10.0.12.0/24 [110/556] via 10.0.24.2, 00:00:18, FastEthernet0/8
 0 IA  10.0.13.0/24 [110/565] via 10.0.24.2, 00:00:18, FastEthernet0/8
 0 IA  10.0.0.0/21 [110/951] via 10.0.24.2, 00:00:18, FastEthernet0/8
 0 IA  10.0.25.0/24 [110/2] via 10.0.24.2, 00:00:18, FastEthernet0/8
 0 IA  10.0.22.0/24 [110/3] via 10.0.24.2, 00:00:18, FastEthernet0/8
 0 IA  10.0.20.0/24 [110/67] via 10.0.24.2, 00:00:18, FastEthernet0/8
 0 IA  10.0.21.0/24 [110/65] via 10.0.24.2, 00:00:18, FastEthernet0/8
 0 IA 192.168.50.0/24 [110/557] via 10.0.24.2, 00:00:18, FastEthernet0/8
 0 IA 192.168.0.0/19 [110/953] via 10.0.24.2, 00:00:18, FastEthernet0/8
MS6(config-if)#
MS6(config-if)#
MS6(config-if)#
MS6(config-if)#do wr
Building configuration...
[OK]
MS6(config-if)#

```

```

MS5>
MS5>en
MS5#conf t
Enter configuration commands, one per line. End with CNTL/Z.
MS5(config)#do show ip route ospf
 20.0.0.0/26 is subnetted, 2 subnets
 0 IA  20.0.0.0 [110/851] via 10.0.22.2, 00:02:14, FastEthernet0/7
    [110/851] via 10.0.25.2, 00:02:14, FastEthernet0/8
 0 IA  20.0.0.64 [110/455] via 10.0.22.2, 00:02:14, FastEthernet0/7
    [110/455] via 10.0.25.2, 00:02:14, FastEthernet0/8
 0 IA 192.168.40.0/24 [110/557] via 10.0.25.2, 00:02:14, FastEthernet0/8
    10.0.0.0/8 is variably subnetted, 13 subnets, 2 masks
 0 IA  10.0.10.0/24 [110/558] via 10.0.25.2, 00:02:14, FastEthernet0/8
    [110/558] via 10.0.22.2, 00:02:14, FastEthernet0/7
 0 IA  10.0.11.0/24 [110/622] via 10.0.25.2, 00:02:14, FastEthernet0/8
    [110/622] via 10.0.22.2, 00:02:14, FastEthernet0/7
 0 IA  10.0.14.0/24 [110/558] via 10.0.25.2, 00:02:14, FastEthernet0/8
    [110/558] via 10.0.22.2, 00:02:14, FastEthernet0/7
 0 IA  10.0.15.0/24 [110/566] via 10.0.25.2, 00:02:15, FastEthernet0/8
    [110/566] via 10.0.22.2, 00:02:15, FastEthernet0/7
 0 IA  10.0.12.0/24 [110/556] via 10.0.25.2, 00:02:15, FastEthernet0/8
    [110/556] via 10.0.22.2, 00:02:15, FastEthernet0/7
 0 IA  10.0.13.0/24 [110/565] via 10.0.25.2, 00:02:15, FastEthernet0/8
    [110/565] via 10.0.22.2, 00:02:15, FastEthernet0/7
 0 IA  10.0.0.0/21 [110/951] via 10.0.25.2, 00:02:15, FastEthernet0/8
    [110/951] via 10.0.22.2, 00:02:15, FastEthernet0/7
 0 10.0.24.0/24 [110/2] via 192.168.70.3, 00:02:16, Vlan70
    [110/2] via 192.168.60.3, 00:02:16, Vlan60
    [110/2] via 10.0.25.2, 00:02:16, FastEthernet0/8
 0 10.0.23.0/24 [110/2] via 10.0.22.2, 00:02:17, FastEthernet0/7
 0 10.0.20.0/24 [110/65] via 10.0.22.2, 00:02:17, FastEthernet0/7
 0 10.0.21.0/24 [110/65] via 10.0.25.2, 00:02:17, FastEthernet0/8
 0 IA 192.168.50.0/24 [110/557] via 10.0.25.2, 00:02:17, FastEthernet0/8
    [110/557] via 10.0.22.2, 00:02:17, FastEthernet0/7
 0 IA 192.168.0.0/19 [110/953] via 10.0.25.2, 00:02:18, FastEthernet0/8
    [110/953] via 10.0.22.2, 00:02:18, FastEthernet0/7
MS5(config)#

```

```

[110/953] via 10.0.22.2, 00:02:18, FastEthernet0/7
MS5(config)#
MS5(config)#int Fa0/8
MS5(config-if)#ip ospf cost 10
MS5(config-if)#exit
MS5(config)#int vlan 70
MS5(config-if)#ip ospf cost 10
MS5(config-if)#exit
MS5(config)#int vlan 60
MS5(config-if)#ip ospf cost 20
MS5(config-if)#
MS5(config-if)#do show ip route ospf
 20.0.0.0/26 is subnetted, 2 subnets
 0 IA  20.0.0.0 [110/851] via 10.0.22.2, 00:00:09, FastEthernet0/7
 0 IA  20.0.0.64 [110/455] via 10.0.22.2, 00:00:09, FastEthernet0/7
 0 IA 192.168.40.0/24 [110/557] via 10.0.22.2, 00:00:09, FastEthernet0/7
    10.0.0.0/8 is variably subnetted, 13 subnets, 2 masks
 0 IA  10.0.10.0/24 [110/558] via 10.0.22.2, 00:00:09, FastEthernet0/7
 0 IA  10.0.11.0/24 [110/622] via 10.0.22.2, 00:00:09, FastEthernet0/7
 0 IA  10.0.14.0/24 [110/558] via 10.0.22.2, 00:00:09, FastEthernet0/7
 0 IA  10.0.15.0/24 [110/566] via 10.0.22.2, 00:00:09, FastEthernet0/7
 0 IA  10.0.12.0/24 [110/556] via 10.0.22.2, 00:00:09, FastEthernet0/7
 0 IA  10.0.13.0/24 [110/565] via 10.0.22.2, 00:00:09, FastEthernet0/7
 0 IA  10.0.0.0/21 [110/951] via 10.0.22.2, 00:00:09, FastEthernet0/7
 0 IA  10.0.24.0/24 [110/3] via 10.0.22.2, 00:00:09, FastEthernet0/7
 0 IA  10.0.23.0/24 [110/2] via 10.0.22.2, 00:00:09, FastEthernet0/7
 0 IA  10.0.20.0/24 [110/65] via 10.0.22.2, 00:00:09, FastEthernet0/7
 0 IA  10.0.21.0/24 [110/67] via 10.0.22.2, 00:00:10, FastEthernet0/7
 0 IA 192.168.50.0/24 [110/557] via 10.0.22.2, 00:00:10, FastEthernet0/7
 0 IA 192.168.0.0/19 [110/953] via 10.0.22.2, 00:00:10, FastEthernet0/7
MS5(config-if)#
MS5(config-if)#

```

```

ABR2(config)#int Se0/0/0
ABR2(config-if)#ip ospf cost 100
ABR2(config-if)#do show ip route e
ABR2(config-if)#do show ip route ospf
 20.0.0.0/24 [110/121] via 10.0.20.2, 00:00:12, Serial0/0/0
 20.0.0.0/26 is subnetted, 2 subnets
 0 20.0.0.0 [110/786] via 20.0.0.65, 00:11:26, Serial0/0/2
 0 192.168.40.0/24 [110/492] via 20.0.0.65, 00:11:26, Serial0/0/2
 10.0.0.0/8 is variably subnetted, 14 subnets, 3 masks
 0 10.0.10.0/24 [110/490] via 20.0.0.65, 00:11:26, Serial0/0/2
 0 10.0.11.0/24 [110/557] via 20.0.0.65, 00:11:26, Serial0/0/2
 0 10.0.14.0/24 [110/493] via 20.0.0.65, 00:11:26, Serial0/0/2
 0 10.0.15.0/24 [110/501] via 20.0.0.65, 00:11:26, Serial0/0/2
 0 10.0.12.0/24 [110/491] via 20.0.0.65, 00:11:26, Serial0/0/2
 0 10.0.13.0/24 [110/500] via 20.0.0.65, 00:11:26, Serial0/0/2
 0 IA 10.0.0.0/21 [110/866] via 20.0.0.65, 00:00:12, Serial0/0/2
 0 10.0.24.0/24 [110/102] via 10.0.20.2, 00:00:12, Serial0/0/0
 0 10.0.25.0/24 [110/103] via 10.0.20.2, 00:00:12, Serial0/0/0
 0 10.0.16.0/20 is a summary, 00:00:12, Null0
 0 10.0.22.0/24 [110/101] via 10.0.20.2, 00:00:12, Serial0/0/0
 0 10.0.23.0/24 [110/101] via 10.0.20.2, 00:00:13, Serial0/0/0
 0 192.168.50.0/24 [110/492] via 20.0.0.65, 00:11:27, Serial0/0/2
 0 192.168.70.0/24 [110/111] via 10.0.20.2, 00:00:13, Serial0/0/0
 0 IA 192.168.0.0/19 [110/888] via 20.0.0.65, 00:00:13, Serial0/0/2
 0 192.168.0.0/17 is a summary, 00:00:13, Null0
ABR2(config-if)#

```

Step 8: Border Gateway Protocol (BGP):

- We created three Autonomous Systems and configured the BGP (inter-domain routing protocol). In the AS 2000 we configured the EIGRP (internal routing protocol).
- We configured two ISPs and the backbone routers (Router1, Router2 and Router3).
- Figures below show the routing table of both ISPs, Router1, Router2 and Router3.

```

ISPI(config)#
ISPI(config)#
ISPI(config)#int lo0
ISPI(config-if)#
*Jan 1 00:48:09.691: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback0, changed state to up
ISPI(config-if)#ip add 200.165.10.0 255.255.255.240
Bad mask /28 for address 200.165.10.0
ISPI(config-if)#ip add 200.165.10.1 255.255.255.240
ISPI(config-if)#exit
ISPI(config)#int Se0/0/0
ISPI(config-if)#no shut
ISPI(config-if)#
ISPI(config-if)#
*Jan 1 00:52:15.327: %LINK-3-UPDOWN: Interface Serial0/0/0, changed state to up
*Jan 1 00:52:16.327: %LINKEROTD-5-UPDOWN: Line protocol on Interface Serial0/0/0, changed state to up
ISPI(config-if)#ip add 200.165.20.1 255.255.255.252
ISPI(config-if)#do show ip int bri
Enter configuration commands, one per line. End with CNTL/Z.
Interface          IP-Address      OK? Method Status      Protocol
FastEthernet0/0     unassigned      YES unset administratively down down
FastEthernet0/1     unassigned      YES unset administratively down down
Serial0/0/0         200.165.20.1   YES manual up        up
Serial0/0/1         unassigned      YES unset administratively down down
Serial0/0/2         unassigned      YES unset administratively down down
Serial0/0/3         unassigned      YES unset administratively down down
Loopback0           200.165.10.1   YES manual up        up
ISPI(config-if)#

```

```

Router1#en
Router1#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Router1(config)#do show ip int bri
Interface          IP-Address      OK? Method Status      Protocol
FastEthernet0/0     unassigned      YES unset administratively down down
FastEthernet0/1     unassigned      YES unset administratively down down
FastEthernet0/1/0   unassigned      YES unset up        down
FastEthernet0/1/1   unassigned      YES unset up        down
FastEthernet0/1/2   unassigned      YES unset up        down
FastEthernet0/1/3   unassigned      YES unset up        down
Serial0/0/0         unassigned      YES unset up        up
Serial0/0/1         unassigned      YES unset up        up
Vlan1              unassigned      YES unset up        down
Router1(config)#int Se0/0/1
Router1(config-if)no shut
Router1(config-if)#ip add 200.165.20.2 255.255.255.252
Router1(config-if)#exit
^
% Invalid input detected at '^' marker.

Router1(config-if)#
Router1(config)#
Router1(config)#int Se0/0/1
Router1(config-if)no shut
Router1(config-if)#
Router1(config)#int Se0/0/0
Router1(config-if)no shut
Router1(config-if)#
Router1(config-if)ip add 200.165.30.2 255.255.255.252
Router1(config-if)#
Router1(config)#
Router1(config)#do show ip int bri
Enter configuration commands, one per line. End with CNTL/Z.
Interface          IP-Address      OK? Method Status      Protocol
FastEthernet0/0     unassigned      YES unset administratively down down
FastEthernet0/1     unassigned      YES unset administratively down down
FastEthernet0/1/0   unassigned      YES unset up        down
FastEthernet0/1/1   unassigned      YES unset up        down
FastEthernet0/1/2   unassigned      YES unset up        down
FastEthernet0/1/3   unassigned      YES unset up        down
Serial0/0/0         200.165.30.2   YES manual up        up
Serial0/0/1         200.165.20.2   YES manual up        up
Vlan1              unassigned      YES unset up        down
Router1(config)#

```

```

Router2#show ip int bri
^
% Invalid input detected at '^' marker.

Router2#show ip int bri
Enter configuration commands, one per line. End with CNTL/Z.
Interface          IP-Address      OK? Method Status      Protocol
FastEthernet0/0     unassigned      YES unset administratively down down
Serial0/0           unassigned      YES unset up        up
Serial0/1           unassigned      YES unset up        up
Router2#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Router2(config)#int Se0/0
Router2(config-if)#no shut
Router2(config-if)#ip add 200.165.30.1 255.255.255.252
Router2(config-if)#exit
Router2(config)#int Se0/1
Router2(config-if)#no shut
Router2(config-if)#ip add 200.165.40.1 255.255.255.252
Router2(config-if)#exit
Router2(config)#exit
Router2#show i
01:23:11: %SYS-5-CONFIG_I: Configured from console by console
Interface          IP-Address      OK? Method Status      Protocol
FastEthernet0/0     unassigned      YES unset administratively down down
Serial0/0           200.165.30.1   YES manual up        up
Serial0/1           200.165.40.1   YES manual up        up
Router2#
Router2#
Router2#

```

```

Router3#show i
01:35:10: %SYS-5-CONFIG_I: Configured from console by console
Interface          IP-Address      OK? Method Status      Protocol
FastEthernet0/0     unassigned      YES unset administratively down down
FastEthernet0/1     unassigned      YES unset administratively down down
Serial1/0           unassigned      YES unset up        up
Serial1/1           unassigned      YES unset up        up
Serial1/2           unassigned      YES unset administratively down down
Serial1/3           unassigned      YES unset administratively down down
Router3#
Router3#
Router3#int Se1/0
Router3(config-if)no shut
Router3(config-if)#
Router3(config-if)ip add 200.165.40.2 255.255.255.252
Router3(config-if)#
Router3(config)#
Router3(config)#do show ip int bri
Enter configuration commands, one per line. End with CNTL/Z.
Interface          IP-Address      OK? Method Status      Protocol
FastEthernet0/0     unassigned      YES unset administratively down down
FastEthernet0/1     unassigned      YES unset administratively down down
Serial1/0           200.165.40.2   YES manual up        up
Serial1/1           200.165.50.2   YES manual up        up
Serial1/2           unassigned      YES unset administratively down down
Serial1/3           unassigned      YES unset administratively down down
Router3#

```

```

ISP2(config)#
ISP2(config)#
ISP2(config)#do show ip int bri
Interface          IP-Address      OK? Method Status       Protocol
FastEthernet0/0    unassigned     YES unset administratively down down
FastEthernet0/1    unassigned     YES unset administratively down down
FastEthernet0/1/0   unassigned     YES unset up         down
FastEthernet0/1/1   unassigned     YES unset up         down
FastEthernet0/1/2   unassigned     YES unset up         down
FastEthernet0/1/3   unassigned     YES unset up         down
Serial0/0/0        unassigned     YES unset up         up
Serial0/0/1        unassigned     YES unset administratively down down
Vlan1              unassigned     YES unset up         down
ISP2(config)#int Se0/0/0
ISP2(config-if)#no shut
ISP2(config-if)#ip add 200.165.50.1 255.255.255.252
ISP2(config-if)#exit
ISP2(config)#int lo0
ISP2(config)#exit
*Jan 1 01:41:00.108: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback0, changed state to u
ISP2(config)#ip add 200.165.60.1 255.255.255.240
ISP2(config-if)#exit
ISP2(config)#do show ip int bri
Interface          IP-Address      OK? Method Status       Protocol
FastEthernet0/0    unassigned     YES unset administratively down down
FastEthernet0/1    unassigned     YES unset administratively down down
FastEthernet0/1/0   unassigned     YES unset up         down
FastEthernet0/1/1   unassigned     YES unset up         down
FastEthernet0/1/2   unassigned     YES unset up         down
FastEthernet0/1/3   unassigned     YES unset up         down
Serial0/0/0        200.165.50.1  YES manual up        up
Serial0/0/1        unassigned     YES unset administratively down down
Vlan1              unassigned     YES unset up         down
Loopback0          200.165.60.1  YES manual up        up
ISP2(config)#

```

- EIGRP configuration inside the backbone for Router1, Router2 and Router 3.

```

Router1>
Router1>en
Router1#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Router1(config)#do show ip pro
% Ambiguous command: "show ip pro"
Router1(config)#exit
Router1#show i
*Jan 1 01:58:24.595: %SYS-5-CONFIG_I: Configured from console by console protocol

Router1#show ip protocol

Router1#router eigrp 1
^
% Invalid input detected at '^' marker.

Router1#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Router1(config)#router eigrp 1
Router1(config-router)#no auto-summary
Router1(config-router)#network 192.165.30.0 0.0.0.3
Router1(config-router)#exit
Router1(config)#do wr
Building configuration...
[OK]
Router1(config)#

```

```

Router2>
Router2>en
Router2#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Router2(config)#do show ip protocol
^
% Invalid input detected at '^' marker.

Router2(config)#exit
Router2#d
02:00:42: %SYS-5-CONFIG_I: Configured from console by console
% Ambiguous command: "d"
Router2#show ip protocol

Router2#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Router2(config)#router eigrp 1
Router2(config-router)#no auto-summary
Router2(config-router)#network 200.165.30.0 0.0.0.3
Router2(config-router)#network 200.165.40.0 0.0.0.3
Router2(config-router)#exit
Router2(config)#do wr
^
% Invalid input detected at '^' marker.

Router2(config)#exit
Router2#wr
Building configuration...

02:02:45: %SYS-5-CONFIG_I: Configured from console by console[OK]
Router2#

```

```

Router3#show ip protocol

Router3#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Router3(config)#router eigrp 1
Router3(config-router)#no auto-summary
^
$ Invalid input detected at '^' marker.

Router3(config-router)#no auto-summary
Router3(config-router)#network 200.165.40.0 0.0.0.3
Router3(config-router)#
02:07:59: %DUAL-5-NBRCHANGE: IP-EIGRP 1: Neighbor 200.165.40.1 (Serial1/0) is up: new adjacency
Router3(config-router)#exit
Router3(config)#exit
Router3#
02:08:09: %SYS-5-CONFIG_I: Configured from console by console
Router3#wr
Building configuration...
[OK]

```

```

Router1#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Router1(config)#router eigrp 1
Router1(config-router)#no network 192.165.30.0 0.0.0.3
Router1(config-router)#network 200.165.30.0 0.0.0.3
Router1(config-router)#
*Jan 1 02:06:21.607: %DUAL-5-NBRCHANGE: IP-EIGRP(0) 1: Neighbor 200.165.30.1 (Serial0/0/0) is up: new adjacency
Router1(config-router)#
Router1(config-router)#
Router1(config-router)#
Router1(config-router)#
do wr
Building configuration...
[OK]
Router1(config-router)#

```

- The BGP configuration ISP1, Router1, Router3 and ISP2.

```

ISP1>
ISP1>en
ISP1#conf t
Enter configuration commands, one per line. End with CNTL/Z.
ISP1(config)#do show ip protocol

ISP1(config)#router bgp 100
ISP1(config-router)#bgp router-id 1.1.1.1
ISP1(config-router)#neighbor 200.165.20.2 remote-as 200
ISP1(config-router)#network 200.165.10.0 mask 255.255.255.240
ISP1(config-router)#exit
ISP1(config)#do wr
Building configuration...
[OK]
ISP1(config)#

```

```

Router1(config-router)#
Router1(config-router)#
Router1(config)#
Router1(config)#router bgp 200
Router1(config-router)#bgp router-id 2.2.2.2
Router1(config-router)#neighbor 200.165.20.1 remote-as 100
Router1(config-router)#
*Jan 1 02:17:08.071: %BGP-5-ADJCHANGE: neighbor 200.165.20.1 Up
Router1(config-router)#
do wr
Building configuration...
[OK]
Router1(config-router)#

```

```

Router3#
Router3#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Router3(config)#router bgp 200
Router3(config-router)#bgp router-id 3.3.3.3
Router3(config-router)#neighbor 200.165.50.1 remote-as 300
Router3(config-router)#exit
Router3(config)#do wr
^
% Invalid input detected at '^' marker.

Router3(config)#exi
Router3#wr
02:19:09: %SYS-5-CONFIG_I: Configured from console by console
Building configuration...
[OK]
Router3#

```

```

ISP2#
ISP2#conf t
Enter configuration commands, one per line. End with CNTL/Z.
ISP2(config)#do show ip protocol

ISP2(config)#router bgp 300
ISP2(config-router)#bgp router-id 4.4.4.4
ISP2(config-router)#neighbor 200.165.50.2 remote-as 200
ISP2(config-router)#
*Jan 1 02:24:06.195: %BGP-5-ADJCHANGE: neighbor 200.165.50.2 Up
ISP2(config-router)#network 200.165.60.0 mask 255.255.255.240
ISP2(config-router)#exit
ISP2(config)#do wr
Building configuration...
[OK]
ISP2(config)#

```

- Checking the routing table of both ISPs, Router1, Router2 and Router3.

```

Router1>en
Router1#show ip route
Codes: 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

Gateway of last resort is not set

  200.165.20.0/30 is subnetted, 1 subnets
C    200.165.20.0 is directly connected, Serial0/0/1
  200.165.30.0/30 is subnetted, 1 subnets
C    200.165.30.0 is directly connected, Serial0/0/0
  200.165.10.0/28 is subnetted, 1 subnets
B    200.165.10.0 [20/0] via 200.165.20.1, 00:11:18
  200.165.40.0/30 is subnetted, 1 subnets
D    200.165.40.0 [90/2681856] via 200.165.30.1, 00:22:33, Serial0/0/0
Router1#
Router1#
Router1#
Router1#
Router1#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Router1(config)#router bgp 1
BGP is already running; AS is 200
Router1(config)#router bgp 200
Router1(config-router)#network 200.165.10.0 mask 255.255.255.240
Router1(config-router)#exit
Router1(config)#do wr
Building configuration...
[OK]
Router1(config)#

```

```

Router1>en
Router1#show ip route
Codes: 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

Gateway of last resort is not set

  200.165.20.0/30 is subnetted, 1 subnets
C    200.165.20.0 is directly connected, Serial0/0/1
  200.165.30.0/30 is subnetted, 1 subnets
C    200.165.30.0 is directly connected, Serial0/0/0
  200.165.10.0/28 is subnetted, 1 subnets
B    200.165.10.0 [20/0] via 200.165.20.1, 00:11:18
  200.165.40.0/30 is subnetted, 1 subnets
D    200.165.40.0 [90/2681856] via 200.165.30.1, 00:22:33, Serial0/0/0
Router1#
Router1#
Router1#
Router1#
Router1#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Router1(config)#router bgp 1
BGP is already running; AS is 200
Router1(config)#router bgp 200
Router1(config)#network 200.165.10.0 mask 255.255.255.240
Router1(config-router)#exit
Router1(config)#do wr
Building configuration...
[OK]
Router1(config)#

```

```

Router3#
Router3#show ip route
Codes: C - connected, S - static, I - IGRP, 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, E - EGP
      i - IS-IS, 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

Gateway of last resort is not set

      200.165.50.0/30 is subnetted, 1 subnets
C        200.165.50.0 is directly connected, Serial1/1
      200.165.30.0/30 is subnetted, 1 subnets
D        200.165.30.0 [90/21024000] via 200.165.40.1, 00:26:12, Serial1/0
      200.165.60.0/28 is subnetted, 1 subnets
B        200.165.60.0 [20/0] via 200.165.50.1, 00:10:14
      200.165.40.0/30 is subnetted, 1 subnets
C        200.165.40.0 is directly connected, Serial1/0
Router3#

```

```

ISP1>en
ISP1#conf t
Enter configuration commands, one per line. End with CNTL/Z.
ISP1(config)#do show ip route
Codes: 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, E - EGP
      i - IS-IS, 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

Gateway of last resort is not set

      200.165.20.0/30 is subnetted, 1 subnets
C        200.165.20.0 is directly connected, Serial0/0/0
      200.165.10.0/28 is subnetted, 1 subnets
C        200.165.10.0 is directly connected, Loopback0
ISP1(config)#

```

- Redistribution BGP in EIGRP for Router1, Router2 and Router3.

```

Router1>en
Router1#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Router1(config)#router eigrp 1
Router1(config-router)#redistribute bgp 200 metric 10000 100 255 1 1500
Router1(config-router)#exit
Router1(config)#do wr
Building configuration...
[OK]
Router1(config)#
Router1(config)#do show ip route
Codes: 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, E - EGP
      i - IS-IS, 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

Gateway of last resort is not set

      200.165.20.0/30 is subnetted, 1 subnets
C        200.165.20.0 is directly connected, Serial10/0/1
      200.165.30.0/30 is subnetted, 1 subnets
C        200.165.30.0 is directly connected, Serial10/0/0
      200.165.60.0/28 is subnetted, 1 subnets
D EX   200.165.60.0 [170/2707456] via 200.165.30.1, 00:05:47, Serial10/0/0
      200.165.10.0/28 is subnetted, 1 subnets
B        200.165.10.0 [20/0] via 200.165.20.1, 00:26:01
      200.165.40.0/30 is subnetted, 1 subnets
D        200.165.40.0 [90/2681856] via 200.165.30.1, 00:37:16, Serial10/0/0
Router1(config)#

```

```

Router2#show ip route
Codes: C - connected, S - static, I - IGRP, 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, E - EGP
      i - IS-IS, 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

Gateway of last resort is not set

      200.165.30.0/30 is subnetted, 1 subnets
C        200.165.30.0 is directly connected, Serial10/0
      200.165.60.0/28 is subnetted, 1 subnets
D EX   200.165.60.0 [170/2195456] via 200.165.40.2, 00:03:50, Serial10/1
      200.165.40.0/30 is subnetted, 1 subnets
C        200.165.40.0 is directly connected, Serial10/1
Router2#

```

```

Router3#
Router3#show ip route
Codes: C - connected, S - static, I - IGRP, 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, E - EGP
      i - IS-IS, 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

Gateway of last resort is not set

  200.165.50.0/30 is subnetted, 1 subnets
C    200.165.50.0 is directly connected, Serial1/1
  200.165.30.0/30 is subnetted, 1 subnets
D    200.165.30.0 [90/21024000] via 200.165.40.1, 00:37:44, Serial1/0
  200.165.60.0/28 is subnetted, 1 subnets
B    200.165.60.0 [20/0] via 200.165.50.1, 00:21:46
  200.165.10.0/28 is subnetted, 1 subnets
D EX   200.165.10.0 [170/21049600] via 200.165.40.1, 00:03:22, Serial1/0
  200.165.40.0/30 is subnetted, 1 subnets
C    200.165.40.0 is directly connected, Serial1/0
Router3#

```

```

Router2#
Router2#show ip route
Codes: C - connected, S - static, I - IGRP, 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, E - EGP
      i - IS-IS, 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

Gateway of last resort is not set

  200.165.30.0/30 is subnetted, 1 subnets
C    200.165.30.0 is directly connected, Serial0/0
  200.165.60.0/28 is subnetted, 1 subnets
D EX   200.165.60.0 [170/2195456] via 200.165.40.2, 00:08:05, Serial0/1
  200.165.10.0/28 is subnetted, 1 subnets
D EX   200.165.10.0 [170/2195456] via 200.165.30.2, 00:02:33, Serial0/0
  200.165.40.0/30 is subnetted, 1 subnets
C    200.165.40.0 is directly connected, Serial0/1
Router2#

```

- Advertising the reachability to network 60 int Router1.
- Advertising the reachability to network 10 in to Router3.

```

Router1(config)#do show ip route
Codes: 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, 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

Gateway of last resort is not set

  200.165.20.0/30 is subnetted, 1 subnets
C    200.165.20.0 is directly connected, Serial0/0/1
  200.165.30.0/30 is subnetted, 1 subnets
C    200.165.30.0 is directly connected, Serial0/0/0
  200.165.60.0/28 is subnetted, 1 subnets
D EX   200.165.60.0 [170/2707456] via 200.165.30.1, 00:10:42, Serial0/0/0
  200.165.10.0/28 is subnetted, 1 subnets
B    200.165.10.0 [20/0] via 200.165.20.1, 00:30:56
  200.165.40.0/30 is subnetted, 1 subnets
D    200.165.40.0 [90/2681856] via 200.165.30.1, 00:42:11, Serial0/0/0
Router1(config)#
Router1(config)#router bgp 200
Router1(config-router)#network 200.165.60.0 mask 255.255.255.240
Router1(config-router)#exit
Router1(config)#do wr
Building configuration...
[OK]
Router1(config)#

```

```

Router3#show ip route
Codes: C - connected, S - static, I - IGRP, 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, E - EGP
      i - IS-IS, 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

Gateway of last resort is not set

  200.165.50.0/30 is subnetted, 1 subnets
C    200.165.50.0 is directly connected, Serial1/1
  200.165.30.0/30 is subnetted, 1 subnets
D    200.165.30.0 [90/21024000] via 200.165.40.1, 00:43:49, Serial1/0
  200.165.60.0/28 is subnetted, 1 subnets
B    200.165.60.0 [20/0] via 200.165.50.1, 00:27:51
  200.165.10.0/28 is subnetted, 1 subnets
D EX   200.165.10.0 [170/21049600] via 200.165.40.1, 00:09:26, Serial1/0
  200.165.40.0/30 is subnetted, 1 subnets
C    200.165.40.0 is directly connected, Serial1/0
Router3(config)#
Enter configuration commands, one per line. End with CNTL/Z.
Router3(config)#router bgp 200
Router3(config-router)#network 200.165.10.0 mask 255.255.255.240
Router3(config-router)#exit

```

- Checking the routing table of both ISPs.

```
ISP1(config)#
ISP1(config)#do show ip route
Codes: 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

Gateway of last resort is not set

  200.165.20.0/30 is subnetted, 1 subnets
C        200.165.20.0 is directly connected, Serial0/0/0
  200.165.60.0/28 is subnetted, 1 subnets
B        200.165.60.0 [20/2707456] via 200.165.20.2, 00:06:17
  200.165.10.0/28 is subnetted, 1 subnets
C        200.165.10.0 is directly connected, Loopback0
ISP1(config)#

```

```
ISP2>en
ISP2#conf t
Enter configuration commands, one per line. End with CNTL/Z.
ISP2(config)#do show ip route
Codes: 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

Gateway of last resort is not set

  200.165.50.0/30 is subnetted, 1 subnets
C        200.165.50.0 is directly connected, Serial0/0/0
  200.165.60.0/28 is subnetted, 1 subnets
C        200.165.60.0 is directly connected, Loopback0
  200.165.10.0/28 is subnetted, 1 subnets
B        200.165.10.0 [20/2104960] via 200.165.50.2, 00:01:18
ISP2(config)#

```

Step 9: IPV6 Configuration:

- We created three Autonomous Systems and configured the BGP (inter-domain routing protocol). In the AS 2000 (the backbone) we configured the OSPF (internal routing protocol).
- We configured two ISPs and the backbone routers (BR1, BR2 and BR3).
- Figures below show the routing table of both ISPs, BR1, BR2 and BR3.

```
via Null0, receive
BR1(config)#
ISP1(config)#
ISP1(config)#
ISP1(config)#do show ipv6 int bri
FastEthernet0/0      [administratively down/down]
FastEthernet0/1      [administratively down/down]
Serial0/0/0          [up/up]
  FE80::225:4FF:FE:C8:ABA0
  2001:FF:4060:2::2
Serial0/0/1          [administratively down/down]
Serial0/0/2          [administratively down/down]
Serial0/0/3          [administratively down/down]
Loopback0            [up/up]
  FE80::225:45FF:FE:C8:ABA0
  2001:FF:4060:1::2
ISP1(config)#

```

```
ISP1(config)#do show run | sec router
router bgp 1000
bgp router-id 1.1.1.1
no bgp default ipv4-unicast
bgp log-neighbor-changes
neighbor 2001:FF:4060:2::1 remote-as 2000
!
address-family ipv6
  neighbor 2001:FF:4060:2::1 activate
  network 2001:FF:4060:1::/64
exit-address-family
ISP1(config)#do show ipv6 route
IPv6 Routing Table - 7 entries
Codes: C - Connected, L - Local, S - Static, R - RIP, B - BGP
      U - Per-user Static route
      I1 - ISIS L1, I2 - ISIS L2, IA - IS-IS interarea, IS - IS-IS summary
      O - OSPF intra, OI - OSPF inter, OE1 - OSPF ext 1, OE2 - OSPF ext 2
      ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2
C  2001:FF:4060:1::/64 [0/0]
  via ::, Loopback0
L  2001:FF:4060:1::2/128 [0/0]
  via ::, Loopback0
C  2001:FF:4060:2::/64 [0/0]
  via ::, Serial0/0/0
L  2001:FF:4060:2::2/128 [0/0]
  via ::, Serial0/0/0
B  2001:FF:4060:6::/64 [20/1]
  via FE80::225:84FF:FE6B:AEC, Serial0/0/0
L  FE80::/10 [0/0]
  via ::, Null0
L  FF00::/8 [0/0]
  via ::, Null0
ISP1(config)#

```

```

BR1#conf t
Enter configuration commands, one per line. End with CNTL/Z.
BR1(config)#do show ipv6 int bri
FastEthernet0/0 [administratively down/down]
  unassigned
FastEthernet0/1 [administratively down/down]
  unassigned
FastEthernet0/1/0 [up/down]
  unassigned
FastEthernet0/1/1 [up/down]
  unassigned
FastEthernet0/1/2 [up/down]
  unassigned
FastEthernet0/1/3 [up/down]
  unassigned
Serial0/0/0 [up/up]
  FE80::225:84FF:FE6B:AEC
  2001:FF:4060:3::1
Serial0/0/1 [up/up]
  FE80::225:84FF:FE6B:AEC
  2001:FF:4060:2::1
Vlan1 [up/down]
  unassigned
BR1(config)#do show run | sec router
router bgp 2000
  bgp router-id 2.2.2.2
  no bgp default ipv4-unicast
  bgp log-neighbor-changes
  neighbor 2001:FF:4060:2::2 remote-as 1000
!
address-family ipv6
  neighbor 2001:FF:4060:2::2 activate
  network 2001:FF:4060:6::/64
exit-address-family
ipv6 router ospf 100
  router-id 2.2.2.2
  log-adjacency-changes
  redistribute bgp 2000
BR1(config)#

```

```

BR2>en
BR2#conf t
Enter configuration commands, one per line. End with CNTL/Z.
BR2(config)#
BR2(config)#
BR2(config)#do show ipv6 int bri
FastEthernet0/0 [administratively down/down]
FastEthernet0/1 [administratively down/down]
Serial0/0/0 [up/up]
  FE80::225:45FF:FECA:A630
  2001:FF:4060:3::2
Serial0/0/1 [up/up]
  FE80::225:45FF:FECA:A630
  2001:FF:4060:4::2
Serial0/0/2 [administratively down/down]
Serial0/0/3 [administratively down/down]
BR2(config)#do show run | sec router
ipv6 router ospf 100
  router-id 3.3.3.3
  log-adjacency-changes
BR2(config)#do show ipv6 route ospf
IPv6 Routing Table - 8 entries
Codes: C - Connected, L - Local, S - Static, R - RIP, B - BGP
      U - Per-user Static route
      I1 - ISIS L1, I2 - ISIS L2, IA - ISIS interarea, IS - ISIS summary
      O - OSPF intra, OI - OSPF inter, OE1 - OSPF ext 1, OE2 - OSPF ext 2
      ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2
OE2 2001:FF:4060:1::/64 [110/1]
  via FE80::225:84FF:FE6B:AEC, Serial0/0/0
OE2 2001:FF:4060:6::/64 [110/1]
  via FE80::225:84FF:FE6B:A20, Serial0/0/1
BR2(config)#

```

```

BR3>en
BR3#conf t
Enter configuration commands, one per line. End with CNTL/Z.
BR3(config)#do show ipv6 int bri
FastEthernet0/0 [administratively down/down]
  unassigned
FastEthernet0/1 [administratively down/down]
  unassigned
FastEthernet0/1/0 [up/down]
  unassigned
FastEthernet0/1/1 [up/down]
  unassigned
FastEthernet0/1/2 [up/down]
  unassigned
FastEthernet0/1/3 [up/down]
  unassigned
Serial0/0/0 [up/up]
  FE80::225:84FF:FE6B:A20
  2001:FF:4060:4::1
Serial0/0/1 [up/up]
  FE80::225:84FF:FE6B:A20
  2001:FF:4060:5::1
Vlan1 [up/down]
  unassigned
BR3(config)#do show run | Sec router
router bgp 2000
  bgp router-id 4.4.4.4
  no bgp default ipv4-unicast
  bgp log-neighbor-changes
  neighbor 2001:FF:4060:5::2 remote-as 3000
!
address-family ipv6
  neighbor 2001:FF:4060:5::2 activate
  network 2001:FF:4060:1::/64
exit-address-family
ipv6 router ospf 100
  router-id 4.4.4.4
  log-adjacency-changes
  redistribute bgp 2000
BR3(config)#

```

```

BRI(config)#do show ipv6 route
IPv6 Routing Table - Default - 8 entries
Codes: C - Connected, L - Local, S - Static, U - Per-user Static route
      B - BGP, M - MIPv6, R - RIP, I1 - ISIS L1
      I2 - ISIS L2, IA - ISIS interarea, IS - ISIS summary, D - EIGRP
      EX - EIGRP external
      O - OSPF Intra, OI - OSPF Inter, OE1 - OSPF ext 1, OE2 - OSPF ext 2
      ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2
B 2001:FF:4060:1::/64 [20/0]
  via FE80::225:45FF:FECA:A630, Serial0/0/1
C 2001:FF:4060:6::/64 [0/0]
  via Serial0/0/1, directly connected
L 2001:FF:4060:2::1/128 [0/0]
  via Serial0/0/1, receive
C 2001:FF:4060:3::/64 [0/0]
  via Serial0/0/0, directly connected
L 2001:FF:4060:3::1/128 [0/0]
  via Serial0/0/0, receive
O 2001:FF:4060:4::/64 [110/454]
  via FE80::225:45FF:FECA:A630, Serial0/0/0
OE2 2001:FF:4060:6::/64 [110/1]
  via FE80::225:84FF:FE6B:A630, Serial0/0/0
L FF00::/8 [0/0]
  via Null0, receive
BRI(config)#

```

```
ISP2(config)#do show ipv6 route bgp
```

```
IPv6 Routing Table - Default - 6 entries
```

```
Codes: C - Connected, L - Local, S - Static, U - Per-user Static route
```

```
B - BGP, M - MIPv6, R - RIP, I1 - ISIS L1
```

```
I2 - ISIS L2, IA - ISIS interarea, IS - ISIS summary, D - EIGRP
```

```
EX - EIGRP external
```

```
O - OSPF Intra, OI - OSPF Inter, OE1 - OSPF ext 1, OE2 - OSPF ext 2
```

```
ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2
```

```
B 2001:FF:4060:1::/64 [20/1]
```

```
    via FE80::225:84FF:FE6B:A20, Serial0/0/1
```

```
ISP2(config)#[
```

```
BR3(config)#do show ipv6 route
IPv6 Routing Table - Default - 8 entries
Codes: C - Connected, L - Local, S - Static, U - Per-user Static route
      B - BGP, M - MIPv6, R - RIP, I1 - ISIS L1
      I2 - ISIS L2, IA - ISIS interarea, IS - ISIS summary, D - EIGRP
      EX - EIGRP external
      O - OSPF Intra, OI - OSPF Inter, OE1 - OSPF ext 1, OE2 - OSPF ext 2
      ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2
OE2 2001:FF:4060:1::/64 [110/1]
    via FE80::225:45FF:FE08:A630, Serial0/0/0
O  2001:FF:4060:3::/64 [110/454]
    via FE80::225:45FF:FE08:A630, Serial0/0/0
C  2001:FF:4060:4::/64 [0/0]
    via Serial0/0/0, directly connected
L  2001:FF:4060:4::1/128 [0/0]
    via Serial0/0/0, receive
C  2001:FF:4060:5::/64 [0/0]
    via Serial0/0/1, directly connected
L  2001:FF:4060:5::1/128 [0/0]
    via Serial0/0/1, receive
B  2001:FF:4060:6::/64 [20/0]
    via FE80::225:84FF:FE6B:AA8, Serial0/0/1
L  FF00::/8 [0/0]
    via Null0, receive
BR3(config)#[
```

CHAPTER8:

TESTING

8.1 Testing in designing stage:

❖ BLOCK 1

- Testing the connectivity in block 1 from PC0 to PC1 and PC 4 to PC5 in same VLAN.

PC0 Command Prompt window output:

```
C:\>ping 192.168.10.1
Pinging 192.168.10.1 with 32 bytes of data:
Reply from 192.168.10.1: bytes=32 time<1ms TTL=255

Ping statistics for 192.168.10.1:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 0ms, Average = 0ms

C:\>
```

PC1 Command Prompt window output:

```
C:\>ping 192.168.10.4
Pinging 192.168.10.4 with 32 bytes of data:
Reply from 192.168.10.4: bytes=32 time<1ms TTL=128

Ping statistics for 192.168.10.4:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 0ms, Average = 0ms

C:\>
```

- Testing the connectivity in block1 from PC3 to PC5 and PC4 to PC6 between VLAN20 and VLAN30.

PC3 Command Prompt window output:

```
C:\>ping 192.168.30.5
Pinging 192.168.30.5 with 32 bytes of data:
Request timed out.
Reply from 192.168.30.5: bytes=32 time<1ms TTL=127
Reply from 192.168.30.5: bytes=32 time<1ms TTL=127
Reply from 192.168.30.5: bytes=32 time<1ms TTL=127

Ping statistics for 192.168.30.5:
    Packets: Sent = 4, Received = 3, Lost = 1 (25% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 1ms, Average = 0ms

C:\>ping 192.168.30.5

Pinging 192.168.30.5 with 32 bytes of data:
Reply from 192.168.30.5: bytes=32 time<1ms TTL=127

Ping statistics for 192.168.30.5:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 0ms, Average = 0ms

C:\>
```

PC4 Command Prompt window output:

```
C:\>ping 192.168.20.6
Pinging 192.168.20.6 with 32 bytes of data:
Request timed out.
Reply from 192.168.20.6: bytes=32 time<1ms TTL=127
Reply from 192.168.20.6: bytes=32 time=2ms TTL=127
Reply from 192.168.20.6: bytes=32 time<1ms TTL=127

Ping statistics for 192.168.20.6:
    Packets: Sent = 4, Received = 3, Lost = 1 (25% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 11ms, Average = 4ms

C:\>PING 192.168.20.6

Pinging 192.168.20.6 with 32 bytes of data:
Reply from 192.168.20.6: bytes=32 time<1ms TTL=127
Reply from 192.168.20.6: bytes=32 time<1ms TTL=127
Reply from 192.168.20.6: bytes=32 time=1ms TTL=127
Reply from 192.168.20.6: bytes=32 time<1ms TTL=127

Ping statistics for 192.168.20.6:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 11ms, Average = 2ms

C:\>
```

- Testing the connectivity in block1 from PC5 to PC0 and PC1 to PC4 between VLAN30 and VLAN10.

PC5 Command Prompt:

```
C:\>ping 192.168.10.4

Pinging 192.168.10.4 with 32 bytes of data:

Reply from 192.168.10.4: bytes=32 time<1ms TTL=127

Ping statistics for 192.168.10.4:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 1ms, Average = 0ms

C:\>
```

PC1 Command Prompt:

```
C:\>ping 192.168.10.4

Pinging 192.168.10.4 with 32 bytes of data:

Reply from 192.168.10.4: bytes=32 time<1ms TTL=128

Ping statistics for 192.168.10.4:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 0ms, Average = 0ms

C:\>
C:\>ping 192.168.30.4

Pinging 192.168.30.4 with 32 bytes of data:

Reply from 192.168.30.4: bytes=32 time<1ms TTL=127

Ping statistics for 192.168.30.4:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 1ms, Average = 0ms

C:\>
```

- Testing the connectivity in block1 from PC7 to PC1 and PC0 to PC2 between VLAN10 and VLAN20.

PC7 Command Prompt:

```
C:\>ping 192.168.10.5

Pinging 192.168.10.5 with 32 bytes of data:

Reply from 192.168.10.5: bytes=32 time<1ms TTL=127

Ping statistics for 192.168.10.5:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 0ms, Average = 0ms

C:\>
```

PC0 Command Prompt:

```
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 0ms, Average = 0ms

C:\>ping 192.168.20.7

Pinging 192.168.20.7 with 32 bytes of data:

Request timed out.
Reply from 192.168.20.7: bytes=32 time<1ms TTL=127
Reply from 192.168.20.7: bytes=32 time<1ms TTL=127
Reply from 192.168.20.7: bytes=32 time<1ms TTL=127

Ping statistics for 192.168.20.7:
    Packets: Sent = 4, Received = 3, Lost = 1 (25% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 1ms, Average = 0ms

C:\>
C:\>ping 192.168.20.7

Pinging 192.168.20.7 with 32 bytes of data:

Reply from 192.168.20.7: bytes=32 time<1ms TTL=127

Ping statistics for 192.168.20.7:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 1ms, Average = 0ms

C:\>
```

❖ BLOCK 2

- Testing the connectivity in block 2 from PC12 to PC14 and PC 15 to PC13 in same VLAN.

PC12 Command Prompt:

```
C:\>ping 192.168.60.10
Pinging 192.168.60.10 with 32 bytes of data:
Reply from 192.168.60.10: bytes=32 time<1ms TTL=128

Ping statistics for 192.168.60.10:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 0ms, Average = 0ms

C:\>
```

PC15 Command Prompt:

```
C:\>ping 192.168.60.8
Pinging 192.168.60.8 with 32 bytes of data:
Reply from 192.168.60.8: bytes=32 time<1ms TTL=128

Ping statistics for 192.168.60.8:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 0ms, Average = 0ms

C:\>
```

- Testing the connectivity in block2 from PC10 to PC14 and PC11 to PC13 between VLAN50 and VLAN60.

PC10 Command Prompt:

```
C:\>ping 192.168.60.10
Pinging 192.168.60.10 with 32 bytes of data:
Request timed out.
Reply from 192.168.60.10: bytes=32 time<1ms TTL=127
Reply from 192.168.60.10: bytes=32 time<1ms TTL=127
Reply from 192.168.60.10: bytes=32 time<1ms TTL=127

Ping statistics for 192.168.60.10:
    Packets: Sent = 4, Received = 3, Lost = 1 (25% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 1ms, Average = 0ms

C:\>ping 192.168.60.10
Pinging 192.168.60.10 with 32 bytes of data:
Reply from 192.168.60.10: bytes=32 time<1ms TTL=127

Ping statistics for 192.168.60.10:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 1ms, Average = 2ms

C:\>
```

PC11 Command Prompt:

```
C:\>ping 192.168.60.8
Pinging 192.168.60.8 with 32 bytes of data:
Reply from 192.168.60.8: bytes=32 time<1ms TTL=127

Ping statistics for 192.168.60.8:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 0ms, Average = 0ms

C:\>
```

- Testing the connectivity in block2 from PC8 to PC15 and PC14 to PC9 between VLAN60 and VLAN40.

PC8 Command Prompt:

```
Cisco Packet Tracer PC Command Line 1.0
C:\>ping 192.168.60.7

Pinging 192.168.60.7 with 32 bytes of data:

Request timed out.
Reply from 192.168.60.7: bytes=32 time<1ms TTL=127
Reply from 192.168.60.7: bytes=32 time<1ms TTL=127
Reply from 192.168.60.7: bytes=32 time<1ms TTL=127

Ping statistics for 192.168.60.7:
    Packets: Sent = 4, Received = 3, Lost = 1 (25% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 1ms, Average = 3ms

C:\>ping 192.168.60.7

Pinging 192.168.60.7 with 32 bytes of data:

Reply from 192.168.60.7: bytes=32 time<1ms TTL=127

Ping statistics for 192.168.60.7:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 0ms, Average = 0ms

C:\>|
```

PC14 Command Prompt:

```
Cisco Packet Tracer PC Command Line 1.0
C:\>ping 192.168.40.5

Pinging 192.168.40.5 with 32 bytes of data:

Request timed out.
Reply from 192.168.40.5: bytes=32 time<1ms TTL=127
Reply from 192.168.40.5: bytes=32 time<1ms TTL=127
Reply from 192.168.40.5: bytes=32 time<1ms TTL=127

Ping statistics for 192.168.40.5:
    Packets: Sent = 4, Received = 3, Lost = 1 (25% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 1ms, Average = 0ms

C:\>ping 192.168.40.5

Pinging 192.168.40.5 with 32 bytes of data:

Reply from 192.168.40.5: bytes=32 time<1ms TTL=127
Reply from 192.168.40.5: bytes=32 time=2ms TTL=127
Reply from 192.168.40.5: bytes=32 time=5ms TTL=127
Reply from 192.168.40.5: bytes=32 time<1ms TTL=127

Ping statistics for 192.168.40.5:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 5ms, Average = 2ms

C:\>|
```

- Testing the connectivity in block2 from PC8 to PC10 and PC9 to PC11 between VLAN40 and VLAN50.

PC8 Command Prompt:

```
Physical Config Desktop Programming Attributes
Physical Config Desktop Programming Attributes
Command Prompt
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 1ms, Average = 0ms
C:\>ping 192.168.60.7

Pinging 192.168.60.7 with 32 bytes of data:

Reply from 192.168.60.7: bytes=32 time<1ms TTL=127

Ping statistics for 192.168.60.7:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 0ms, Average = 0ms

C:\>ping 192.168.50.3

Pinging 192.168.50.3 with 32 bytes of data:

Reply from 192.168.50.3: bytes=32 time<1ms TTL=127

Ping statistics for 192.168.50.3:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 0ms, Average = 0ms

C:\>|
```

PC9 Command Prompt:

```
Physical Config Desktop Programming Attributes
Physical Config Desktop Programming Attributes
Command Prompt
Cisco Packet Tracer PC Command Line 1.0
C:\>ping 192.168.50.4

Pinging 192.168.50.4 with 32 bytes of data:

Reply from 192.168.50.4: bytes=32 time<1ms TTL=127

Ping statistics for 192.168.50.4:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 0ms, Average = 0ms

C:\>|
```

❖ BLOCK 3

- Testing the connectivity in block 3 from PC16 to PC17 and PC17 TO PC16 in same VLAN.

PC16 Command Prompt window output:

```
Cisco Packet Tracer PC Command Line 1.0
C:\>ping 192.168.70.6

Pinging 192.168.70.6 with 32 bytes of data:

Reply from 192.168.70.6: bytes=32 time=6ms TTL=128
Reply from 192.168.70.6: bytes=32 time<1ms TTL=128
Reply from 192.168.70.6: bytes=32 time=15ms TTL=128
Reply from 192.168.70.6: bytes=32 time<1ms TTL=128

Ping statistics for 192.168.70.6:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 15ms, Average = 5ms

C:\>
```

PC17 Command Prompt window output:

```
Cisco Packet Tracer PC Command Line 1.0
C:\>ping 192.168.70.3

Pinging 192.168.70.3 with 32 bytes of data:

Reply from 192.168.70.3: bytes=32 time<1ms TTL=128
Reply from 192.168.70.3: bytes=32 time<1ms TTL=128
Reply from 192.168.70.3: bytes=32 time<1ms TTL=128
Reply from 192.168.70.3: bytes=32 time=<1ms TTL=128

Ping statistics for 192.168.70.3:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 1ms, Average = 0ms

C:\>
```

- Testing the connectivity in block3 from PC17 to PC18 and PC18 to PC16 between VLAN70 and VLAN80.

PC17 Command Prompt window output:

```
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 14ms, Average = 4ms

C:\>ping 192.168.80.4

Pinging 192.168.80.4 with 32 bytes of data:

Request timed out.
Reply from 192.168.80.4: bytes=32 time<1ms TTL=127

Ping statistics for 192.168.80.4:
    Packets: Sent = 4, Received = 3, Lost = 1 (25% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 0ms, Average = 0ms

C:\>ping 192.168.80.4

Pinging 192.168.80.4 with 32 bytes of data:

Reply from 192.168.80.4: bytes=32 time<1ms TTL=127

Ping statistics for 192.168.80.4:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 0ms, Average = 0ms

C:\>
```

PC18 Command Prompt window output:

```
Cisco Packet Tracer PC Command Line 1.0
C:\>ping 192.168.70.3

Pinging 192.168.70.3 with 32 bytes of data:

Reply from 192.168.70.3: bytes=32 time<1ms TTL=127
Reply from 192.168.70.3: bytes=32 time<1ms TTL=127
Reply from 192.168.70.3: bytes=32 time<1ms TTL=127
Reply from 192.168.70.3: bytes=32 time=<1ms TTL=127

Ping statistics for 192.168.70.3:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 0ms, Average = 0ms

C:\>
```

❖ Testing Between The Blocks

- Testing the connectivity between block 1 and block 2 from PC3 to PC13 and PC 8 to PC4.

PC3 Command Prompt:

```
C:\>ipconfig
FastEthernet0 Connection:(default port)
  Connection-specific DNS Suffix.:: FE80::102:4AFF:FE4B:777C
  Link-local IPv6 Address.....:: FE80::102:4AFF:FE4B:777C
  IPv4 Address.....:: 192.168.20.6
  Subnet Mask.....:: 255.255.255.0
  Default Gateway.....:: 192.168.20.1

Bluetooth Connection:
  Connection-specific DNS Suffix.::
  Link-local IPv6 Address.....:: ::
  IPv4 Address.....:: ::
  IPv6 Address.....:: ::
  Subnet Mask.....:: 0.0.0.0
  Default Gateway.....:: 0.0.0.0

C:\>ping 192.168.60.5
Pinging 192.168.60.5 with 32 bytes of data:
Request timed out.
Reply from 192.168.60.5: bytes=32 time=11ms TTL=122
Reply from 192.168.60.5: bytes=32 time=1ms TTL=122
Reply from 192.168.60.5: bytes=32 time=1ms TTL=122

Ping statistics for 192.168.60.5:
  Packets: Sent = 4, Received = 3, Lost = 1 (25% loss),
  Approximate round trip times in milli-seconds:
    Minimum = 3ms, Maximum = 13ms, Average = 9ms
C:\>
```

PC8 Command Prompt:

```
C:\>ipconfig
FastEthernet0 Connection:(default port)
  Connection-specific DNS Suffix.:: FE80::207:ECFF:FED6:D328
  Link-local IPv6 Address.....:: FE80::207:ECFF:FED6:D328
  IPv4 Address.....:: 192.168.40.5
  Subnet Mask.....:: 255.255.255.0
  Default Gateway.....:: 192.168.40.1

Bluetooth Connection:
  Connection-specific DNS Suffix.::
  Link-local IPv6 Address.....:: ::
  IPv4 Address.....:: ::
  IPv6 Address.....:: ::
  Subnet Mask.....:: 0.0.0.0
  Default Gateway.....:: 0.0.0.0

C:\>ping 192.168.30.4
Pinging 192.168.30.4 with 32 bytes of data:
Request timed out.
Reply from 192.168.30.4: bytes=32 time=3ms TTL=122
Reply from 192.168.30.4: bytes=32 time=14ms TTL=122
Reply from 192.168.30.4: bytes=32 time=6ms TTL=122

Ping statistics for 192.168.30.4:
  Packets: Sent = 4, Received = 3, Lost = 1 (25% loss),
  Approximate round trip times in milli-seconds:
    Minimum = 3ms, Maximum = 14ms, Average = 7ms
C:\>
```

- Testing the connectivity between block 2 and block 3 from PC10 to PC16 and PC 18 to PC15.

PC10 Command Prompt:

```
C:\>ipconfig
FastEthernet0 Connection:(default port)
  Connection-specific DNS Suffix.:: FE80::200:CFF:FE3A:2C8A
  Link-local IPv6 Address.....:: FE80::200:CFF:FE3A:2C8A
  IPv4 Address.....:: 192.168.50.4
  Subnet Mask.....:: 255.255.255.0
  Default Gateway.....:: 192.168.50.1

Bluetooth Connection:
  Connection-specific DNS Suffix.::
  Link-local IPv6 Address.....:: ::
  IPv4 Address.....:: ::
  IPv6 Address.....:: ::
  Subnet Mask.....:: 0.0.0.0
  Default Gateway.....:: 0.0.0.0

C:\>ping 192.168.70.4
Pinging 192.168.70.4 with 32 bytes of data:
Request timed out.
Reply from 192.168.70.4: bytes=32 time=1ms TTL=122
Reply from 192.168.70.4: bytes=32 time=1ms TTL=122
Reply from 192.168.70.4: bytes=32 time=1ms TTL=122

Ping statistics for 192.168.70.4:
  Packets: Sent = 4, Received = 3, Lost = 1 (25% loss),
  Approximate round trip times in milli-seconds:
    Minimum = 3ms, Maximum = 1ms, Average = 6ms
C:\>
```

PC18 Command Prompt:

```
C:\>ipconfig
FastEthernet0 Connection:(default port)
  Connection-specific DNS Suffix.:: FE80::201:C7FF:FE7D:EE86
  Link-local IPv6 Address.....:: FE80::201:C7FF:FE7D:EE86
  IPv4 Address.....:: 192.168.80.5
  Subnet Mask.....:: 255.255.255.0
  Default Gateway.....:: 192.168.80.1

Bluetooth Connection:
  Connection-specific DNS Suffix.::
  Link-local IPv6 Address.....:: ::
  IPv4 Address.....:: ::
  IPv6 Address.....:: ::
  Subnet Mask.....:: 0.0.0.0
  Default Gateway.....:: 0.0.0.0

C:\>ping 192.168.60.6
Pinging 192.168.60.6 with 32 bytes of data:
Request timed out.
Reply from 192.168.60.6: bytes=32 time=13ms TTL=122
Reply from 192.168.60.6: bytes=32 time=1ms TTL=122
Reply from 192.168.60.6: bytes=32 time=1ms TTL=122

Ping statistics for 192.168.60.6:
  Packets: Sent = 4, Received = 3, Lost = 1 (25% loss),
  Approximate round trip times in milli-seconds:
    Minimum = 1ms, Maximum = 13ms, Average = 11ms
C:\>
```

- Testing the connectivity between block 1 and block 3 from PC0 to PC1 and PC 4 to PC5.

PC7 Command Prompt:

```
C:\>ipconfig
FastEthernet0 Connection:(default port)
  Connection-specific DNS Suffix..:
  Link-local IPv6 Address.....: FE80::290:21FF:FE35:747C
  IPv4 Address.....: 192.168.20.5
  Subnet Mask.....: 255.255.255.0
  Default Gateway.....: 192.168.20.1

Bluetooth Connection:
  Connection-specific DNS Suffix..:
  Link-local IPv6 Address.....: ::1
  IPv4 Address.....: ::0.0.0.0
  Subnet Mask.....: ::0.0.0.0
  Default Gateway.....: ::0.0.0.0

C:\>ping 192.168.80.4
Pinging 192.168.80.4 with 32 bytes of data:
Request timed out.
Reply from 192.168.80.4: bytes=32 time=10ms TTL=121
Reply from 192.168.80.4: bytes=32 time=6ms TTL=121
Reply from 192.168.80.4: bytes=32 time=6ms TTL=121

Ping statistics for 192.168.80.4:
  Packets: Sent = 4, Received = 3, Lost = 1 (25% loss),
  Approximate round trip times in milli-seconds:
    Minimum = 6ms, Maximum = 10ms, Average = 7ms
C:\>
```

PC17 Command Prompt:

```
C:\>ipconfig
FastEthernet0 Connection:(default port)
  Connection-specific DNS Suffix..:
  Link-local IPv6 Address.....: FE80::201:69FF:FE0B:27A6
  IPv4 Address.....: 192.168.70.5
  Subnet Mask.....: 255.255.255.0
  Default Gateway.....: 192.168.70.1

Bluetooth Connection:
  Connection-specific DNS Suffix..:
  Link-local IPv6 Address.....: ::1
  IPv4 Address.....: ::0.0.0.0
  Subnet Mask.....: ::0.0.0.0
  Default Gateway.....: ::0.0.0.0

C:\>ping 192.168.10.5
Pinging 192.168.10.5 with 32 bytes of data:
Request timed out.
Reply from 192.168.10.5: bytes=32 time=19ms TTL=121
Reply from 192.168.10.5: bytes=32 time=5ms TTL=121
Reply from 192.168.10.5: bytes=32 time=4ms TTL=121

Ping statistics for 192.168.10.5:
  Packets: Sent = 4, Received = 3, Lost = 1 (25% loss),
  Approximate round trip times in milliseconds:
    Minimum = 4ms, Maximum = 19ms, Average = 9ms
C:\>
```

- Sending ICMP packet from the Management VLAN to the DNS server.

```

PC2U
Physical Config Desktop Programming Attributes
Command Prompt X
Pinging 192.168.80.4 with 32 bytes of data:
Reply from 192.168.80.4: bytes=32 time=6ms TTL=124
Reply from 192.168.80.4: bytes=32 time=2ms TTL=124
Reply from 192.168.80.4: bytes=32 time=3ms TTL=124
Reply from 192.168.80.4: bytes=32 time=4ms TTL=124

Ping statistics for 192.168.80.4:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 2ms, Maximum = 6ms, Average = 3ms

C:\>ping 172.16.0.10

Pinging 172.16.0.10 with 32 bytes of data:

Request timed out.
Reply from 172.16.0.10: bytes=32 time<1ms TTL=127
Reply from 172.16.0.10: bytes=32 time<1ms TTL=127
Reply from 172.16.0.10: bytes=32 time<1ms TTL=127

Ping statistics for 172.16.0.10:
    Packets: Sent = 4, Received = 3, Lost = 1 (25% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 0ms, Average = 0ms

C:\>ping 172.16.0.10

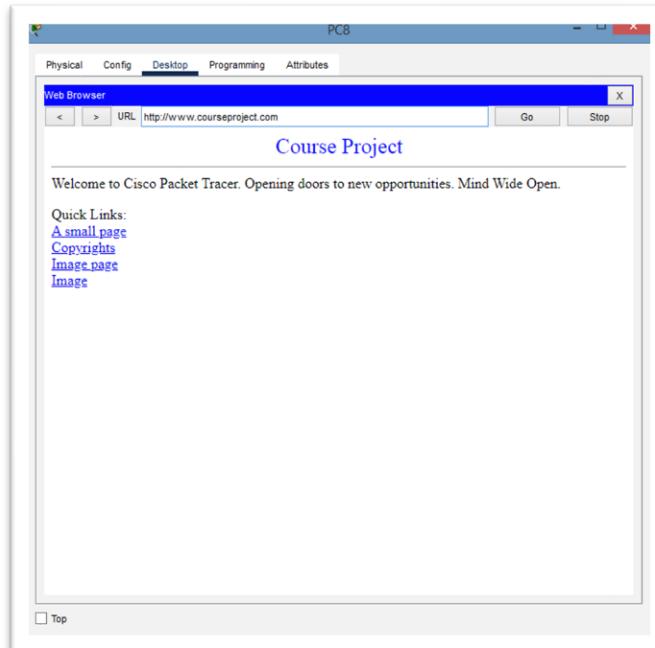
Pinging 172.16.0.10 with 32 bytes of data:
Reply from 172.16.0.10: bytes=32 time<1ms TTL=127

Ping statistics for 172.16.0.10:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss)

```

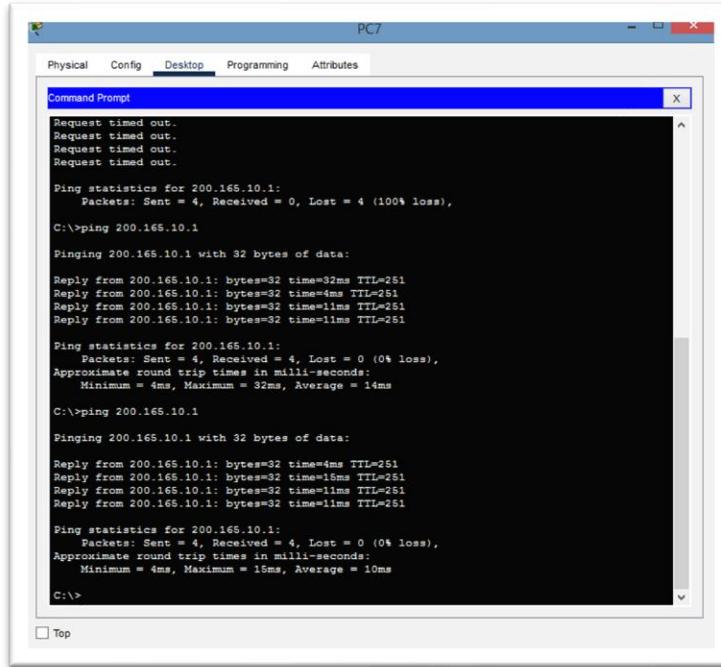
 Top

- From the Finance VLAN in the second block, trying to reach the www.courseproject.com website. (that means reaching the DNS server and the HTTP server that are situated in the server room in the block 2).



❖ Testing The Validation of NAT Configuration

We tried to ping the 200.165.10.1 (which is an external IP address) from host in HR VLAN in block 1.



The screenshot shows a Windows Command Prompt window titled "PC7". The window contains the following text output:

```
Physical Config Desktop Programming Attributes
Command Prompt
Request timed out.
Request timed out.
Request timed out.
Request timed out.

Ping statistics for 200.165.10.1:
  Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),
C:\>ping 200.165.10.1

Pinging 200.165.10.1 with 32 bytes of data:
Reply from 200.165.10.1: bytes=32 time=32ms TTL=251
Reply from 200.165.10.1: bytes=32 time=4ms TTL=251
Reply from 200.165.10.1: bytes=32 time=1ms TTL=251
Reply from 200.165.10.1: bytes=32 time=11ms TTL=251

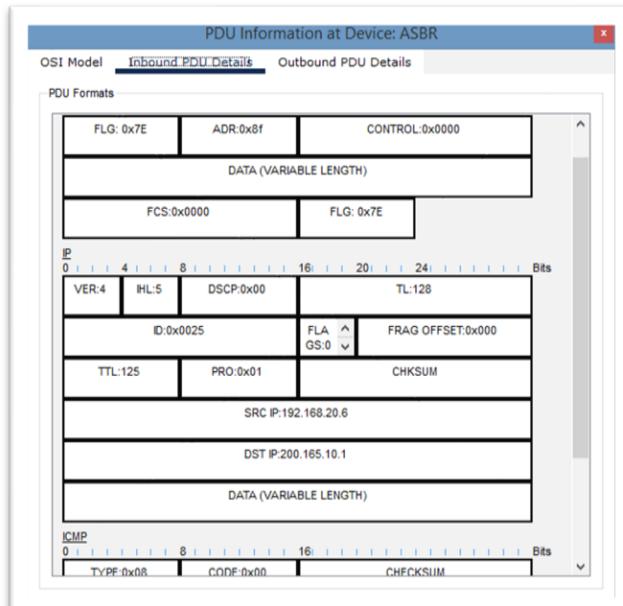
Ping statistics for 200.165.10.1:
  Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
  Minimum = 4ms, Maximum = 32ms, Average = 14ms
C:\>ping 200.165.10.1

Pinging 200.165.10.1 with 32 bytes of data:
Reply from 200.165.10.1: bytes=32 time=4ms TTL=251
Reply from 200.165.10.1: bytes=32 time=15ms TTL=251
Reply from 200.165.10.1: bytes=32 time=1ms TTL=251
Reply from 200.165.10.1: bytes=32 time=11ms TTL=251

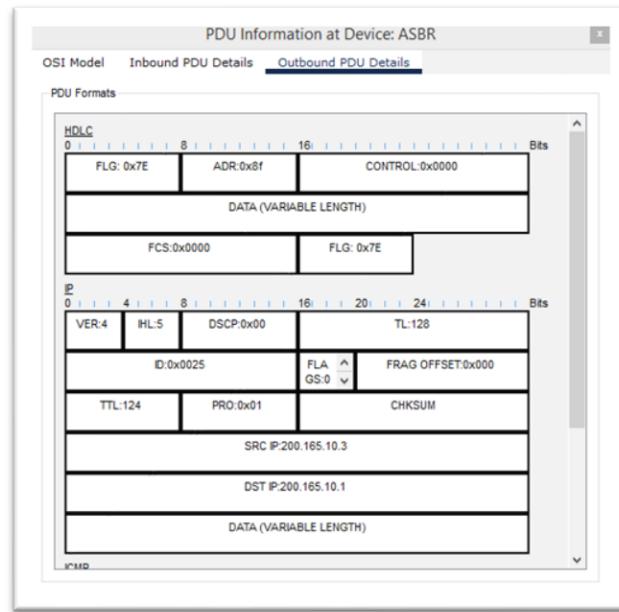
Ping statistics for 200.165.10.1:
  Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
  Minimum = 4ms, Maximum = 15ms, Average = 10ms
C:\>
```

The figure below shows how the translation between the IPs is done in the NAT router (ASBR).

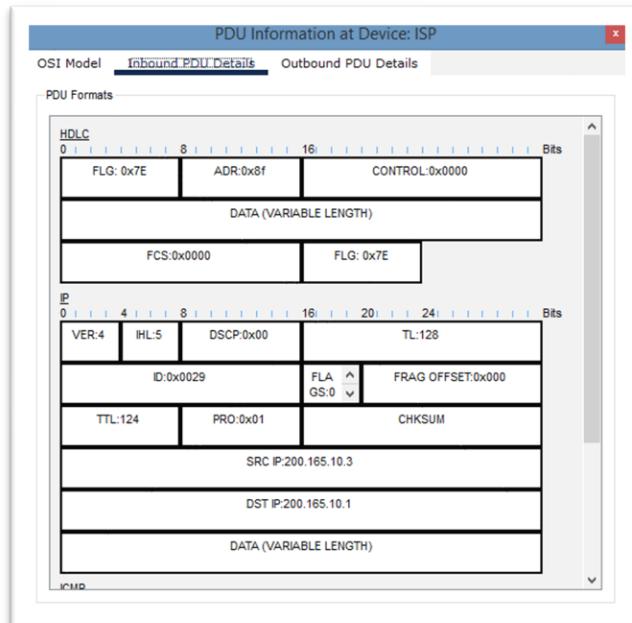
The inbound packet.

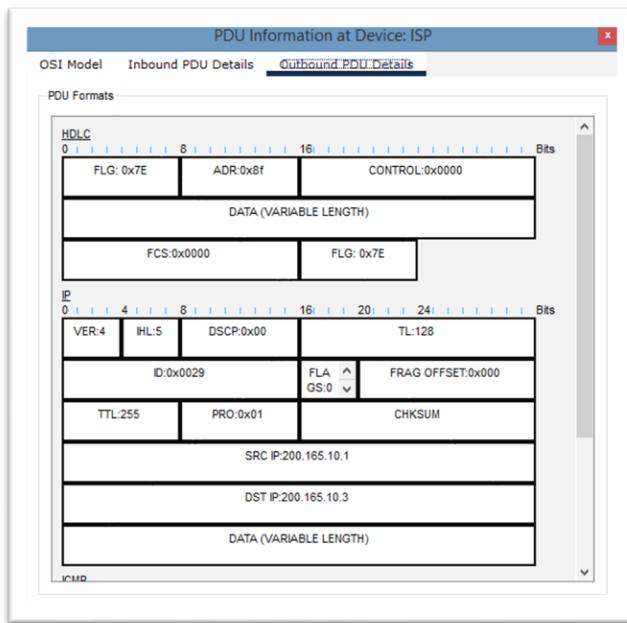


The outbound packet.



The figure below shows the IP addresses of inbound and outbound packets at the ISP router.





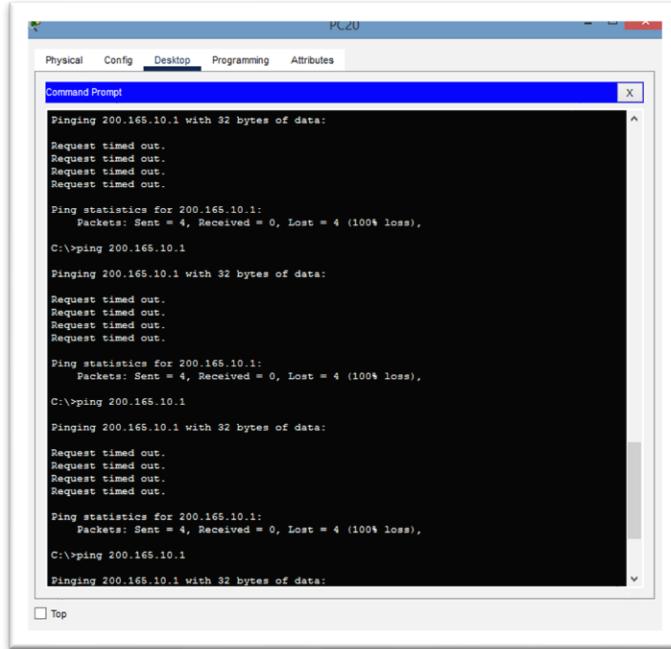
As we can see in the figure below, we have configured the interface Fa0/0 in the ASBR router as an ip nat inside.

```

ASBR
Physical Config CLI Attributes
IOS Command Line Interface
!
!
!
!
!
!
!
!
!
interface FastEthernet0/0
no ip address
ip nat inside
duplex auto
speed auto
!
interface FastEthernet0/0.7
encapsulation dot1Q 7
ip address 172.16.0.1 255.255.255.0
!
interface FastEthernet0/0.99
encapsulation dot1Q 99
ip address 192.168.99.1 255.255.255.0
!
interface FastEthernet0/1

```

But when we tried to check the NATing translation for the 172.16.0.0/24 and 192.168.99.0/24 networks by sending an ICMP packet from them to an external host we found that the translation between the local an global IP addresses did not work. See figure..



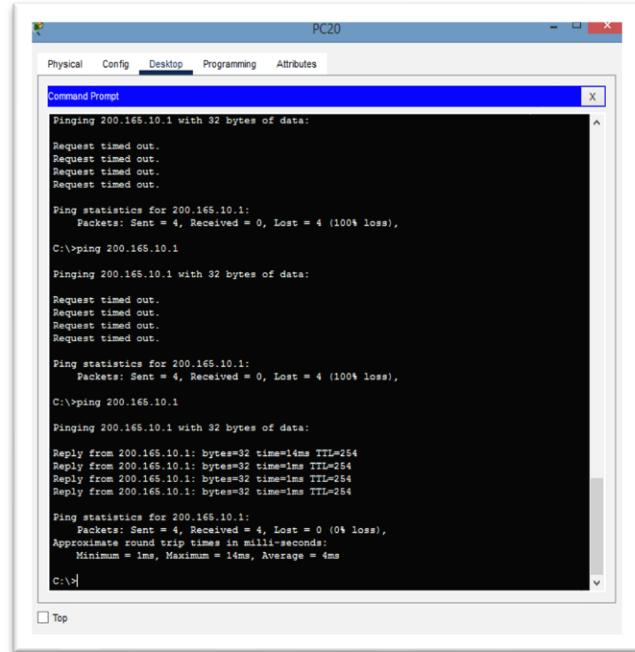
```
Pinging 200.165.10.1 with 32 bytes of data:  
Request timed out.  
Request timed out.  
Request timed out.  
Request timed out.  
  
Ping statistics for 200.165.10.1:  
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),  
C:\>ping 200.165.10.1  
  
Pinging 200.165.10.1 with 32 bytes of data:  
Request timed out.  
Request timed out.  
Request timed out.  
Request timed out.  
  
Ping statistics for 200.165.10.1:  
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),  
C:\>ping 200.165.10.1  
  
Pinging 200.165.10.1 with 32 bytes of data:  
Request timed out.  
Request timed out.  
Request timed out.  
Request timed out.  
  
Ping statistics for 200.165.10.1:  
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),  
C:\>ping 200.165.10.1  
  
Pinging 200.165.10.1 with 32 bytes of data:
```

When we were trying to solve this problem, we found that, since we have configured two sub-interfaces (one for the 172.16.0.0/24 network and the other for the 192.168.99.0/24 network) on the Fa0/0 interface in ASBR router, we have to configure each one of these sub-interfaces as ip nat inside. See figure

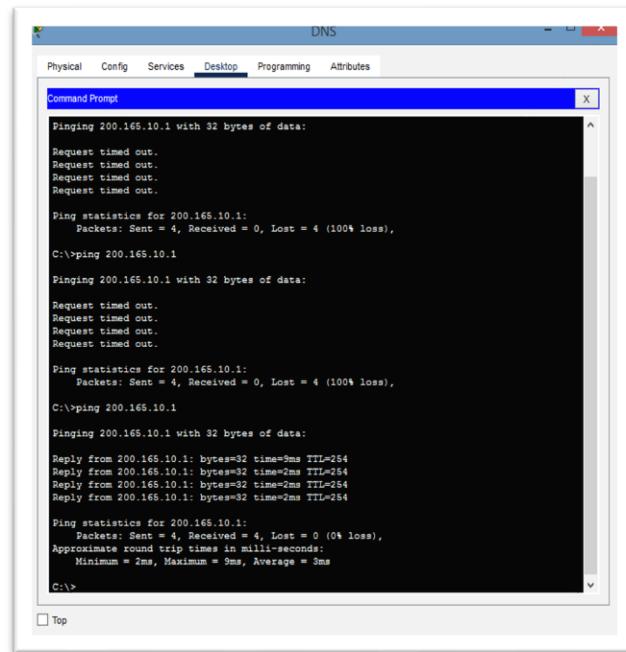


```
ASBR#  
ASBR#config  
ASBR#config terminal  
ASBR(config)#int Fa0/0.0  
ASBR(config-subif)#ip nat inside  
ASBR(config-subif)#int Fa0/0.99  
ASBR(config-subif)#ip nat inside  
ASBR(config-subif)#exit
```

And now, when we tried to send an ICMP packet to an external host from these two networks the Netting translation worked properly.



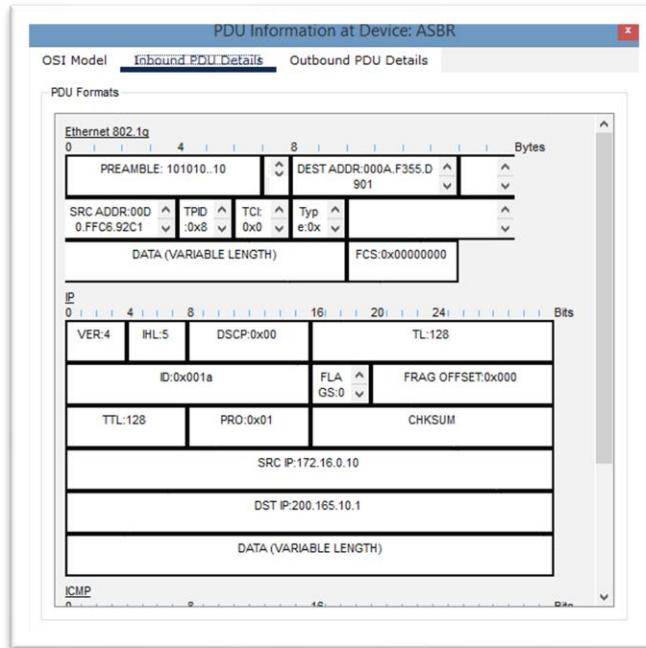
```
Pinging 200.165.10.1 with 32 bytes of data:  
Request timed out.  
Request timed out.  
Request timed out.  
Request timed out.  
  
Ping statistics for 200.165.10.1:  
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),  
C:\>ping 200.165.10.1  
  
Pinging 200.165.10.1 with 32 bytes of data:  
Request timed out.  
Request timed out.  
Request timed out.  
Request timed out.  
  
Ping statistics for 200.165.10.1:  
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),  
C:\>ping 200.165.10.1  
  
Pinging 200.165.10.1 with 32 bytes of data:  
Reply from 200.165.10.1: bytes=32 time=1ms TTL=254  
  
Ping statistics for 200.165.10.1:  
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),  
Approximate round trip times in milli-seconds:  
    Minimum = 1ms, Maximum = 1ms, Average = 4ms  
C:\>
```



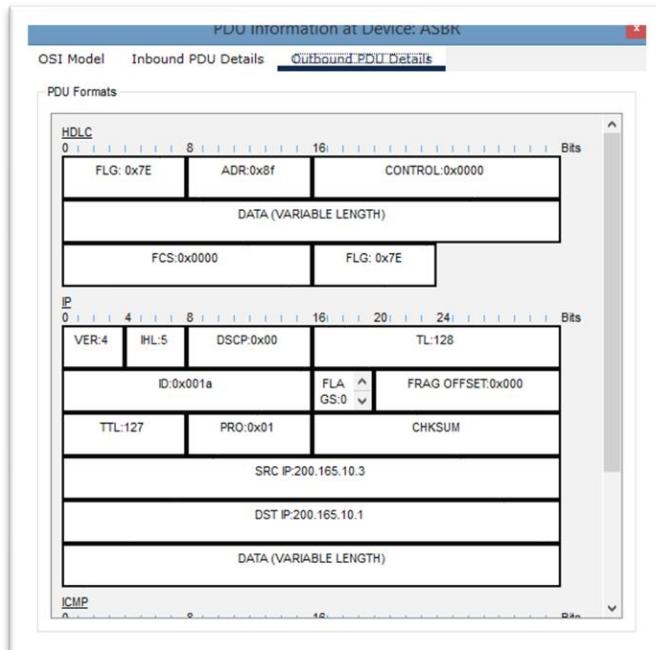
```
Pinging 200.165.10.1 with 32 bytes of data:  
Request timed out.  
Request timed out.  
Request timed out.  
Request timed out.  
  
Ping statistics for 200.165.10.1:  
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),  
C:\>ping 200.165.10.1  
  
Pinging 200.165.10.1 with 32 bytes of data:  
Request timed out.  
Request timed out.  
Request timed out.  
Request timed out.  
  
Ping statistics for 200.165.10.1:  
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),  
C:\>ping 200.165.10.1  
  
Pinging 200.165.10.1 with 32 bytes of data:  
Reply from 200.165.10.1: bytes=32 time=3ms TTL=254  
Reply from 200.165.10.1: bytes=32 time=2ms TTL=254  
Reply from 200.165.10.1: bytes=32 time=2ms TTL=254  
Reply from 200.165.10.1: bytes=32 time=2ms TTL=254  
  
Ping statistics for 200.165.10.1:  
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),  
Approximate round trip times in milli-seconds:  
    Minimum = 2ms, Maximum = 9ms, Average = 3ms  
C:\>
```

The figure below shows how the translation between the IPs is done in the NAT router (ASBR).

The inbound packet



The outbound packet.



8.2 Testing in implementation stage:

❖ BLOCK 1

- Testing the connectivity in block 1 from PC0 to PC1 and PC5 to PC4 in same VLAN.

The image contains two side-by-side screenshots of a Windows Command Prompt window. Both screenshots show the output of the 'ipconfig' command followed by a ping test to 192.168.10.5 or 192.168.30.4.

Screenshot 1 (Left):

```
Windows Command Prompt
Microsoft Windows [Version 10.0.10240]
(c) 2015 Microsoft Corporation. All rights reserved.

C:\Users\Student>ipconfig

Windows IP Configuration

Ethernet adapter Ethernet:
  Connection-specific DNS Suffix . :
  Link-local IPv6 Address . . . . . : fe80::cbe:177:ee11:10c3
  IPv4 Address . . . . . : 192.168.10.5
    Subnet Mask . . . . . : 255.255.255.0
  Default Gateway . . . . . : 192.168.10.1

Tunnel adapter isatap.{2B86600A-1063-4716-8094-4E383FB054BC}:
  Media State . . . . . : Media disconnected
  Connection-specific DNS Suffix . :

C:\Users\Student>ping 192.168.10.5

Pinging 192.168.10.5 with 32 bytes of data:
Reply From 192.168.10.5: bytes=32 time=1ms TTL=128

Ping statistics for 192.168.10.5:
  Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
  Approximate round trip times in milli-seconds:
    Minimum = 1ms, Maximum = 1ms, Average = 1ms

C:\Users\Student>
```

Screenshot 2 (Right):

```
Default Gateway . . . . . : 192.168.30.1
Tunnel adapter isatap.{2B09303C-2B4C-4052-A001-5E007E1465BD}:
  Media State . . . . . : Media disconnected
  Connection-specific DNS Suffix . :

C:\Users\Student>ipconfig

Windows IP Configuration

Ethernet adapter Ethernet:
  Connection-specific DNS Suffix . :
  Link-local IPv6 Address . . . . . : fe80::3991:4d81:47e9:15af%3
  IPv4 Address . . . . . : 192.168.30.5
    Subnet Mask . . . . . : 255.255.255.0
  Default Gateway . . . . . : 192.168.30.1

Tunnel adapter isatap.{2B09303C-2B4C-4052-A001-5E007E1465BD}:
  Media State . . . . . : Media disconnected
  Connection-specific DNS Suffix . :

C:\Users\Student>ping 192.168.30.4

Pinging 192.168.30.4 with 32 bytes of data:
Reply From 192.168.30.4: bytes=32 time=1ms TTL=128

Ping statistics for 192.168.30.4:
  Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
  Approximate round trip times in milli-seconds:
    Minimum = 1ms, Maximum = 1ms, Average = 1ms

C:\Users\Student>
```

- Testing the connectivity in block1 from PC1 to PC4 between VLAN10 and VLAN30.

A single screenshot of a Windows Command Prompt window showing the output of the 'ipconfig' command and a ping test between two hosts in different VLANs.

```
Windows Command Prompt
Windows IP Configuration

Ethernet adapter Ethernet:
  Connection-specific DNS Suffix . :
  Link-local IPv6 Address . . . . . : fe80::fbde:e87a:3a7:47b6%3
  IPv4 Address . . . . . : 192.168.10.5
    Subnet Mask . . . . . : 255.255.255.0
  Default Gateway . . . . . : 192.168.10.1

Tunnel adapter isatap.{2B86600A-1063-4716-8094-4E383FB054BC}:
  Media State . . . . . : Media disconnected
  Connection-specific DNS Suffix . :

C:\Users\Student>ping 192.168.30.4

Pinging 192.168.30.4 with 32 bytes of data:
Reply From 192.168.30.4: bytes=32 time=1ms TTL=127

Ping statistics for 192.168.30.4:
  Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
  Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 0ms, Average = 0ms

C:\Users\Student>
```

- Testing the connectivity in block1 from PC5 to PC3 and from PC4 to PC7 between VLAN20 and VLAN30.

```

Microsoft Windows [Version 10.0.10240]
(c) 2015 Microsoft Corporation. All rights reserved.

C:\Users\Student>ipconfig

Windows IP Configuration

Ethernet adapter Ethernet:

Connection-specific DNS Suffix . :
Link-local IPv6 Address . . . . . : fe80::3901:48ff%14:47e9:15af%3
IPv4 Address . . . . . : 192.168.38.5
Subnet Mask . . . . . : 255.255.255.0
Default Gateway . . . . . : 0.0.0.0
                           192.168.38.1

Tunnel adapter isatap.{2609303C-204C-4852-A001-5E867E1465B0}:

Media State . . . . . : Media disconnected
Connection-specific DNS Suffix . :

C:\Users\Student>ping 192.168.20.5

Pinging 192.168.20.5 with 32 bytes of data:
Reply from 192.168.20.5: bytes=32 time=1ms TTL=127

Ping statistics for 192.168.20.5:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 1ms, Maximum = 2ms, Average = 1ms

C:\Users\Student>

```



```

Microsoft Windows [Version 10.0.10240]
(c) 2015 Microsoft Corporation. All rights reserved.

C:\Users\Student>ipconfig

Windows IP Configuration

Ethernet adapter Ethernet:

Connection-specific DNS Suffix . :
Link-local IPv6 Address . . . . . : fe80::3901:48ff%14:47e9:15af%3
IPv4 Address . . . . . : 192.168.38.5
Subnet Mask . . . . . : 255.255.255.0
Default Gateway . . . . . : 0.0.0.0
                           192.168.38.1

Tunnel adapter isatap.{2609303C-204C-4852-A001-5E867E1465B0}:

Media State . . . . . : Media disconnected
Connection-specific DNS Suffix . :

C:\Users\Student>ping 192.168.20.5

Pinging 192.168.20.5 with 32 bytes of data:
Reply from 192.168.20.5: bytes=32 time=2ms TTL=127

Ping statistics for 192.168.20.5:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 2ms, Maximum = 2ms, Average = 2ms

C:\Users\Student>

```

❖ BLOCK 2

- Testing the connectivity in block2 from PC10 to PC8 between VLAN50 and VLAN40.
- Testing the connectivity in block2 from PC12 to PC10 between VLAN60 and VLAN50.

```

Microsoft Windows [Version 10.0.10240]
(c) 2015 Microsoft Corporation. All rights reserved.

C:\Users\Student>ipconfig

Windows IP Configuration

Ethernet adapter Ethernet:

Connection-specific DNS Suffix . :
Link-local IPv6 Address . . . . . : fe80::3901:48ff%14:47e9:15af%4
IPv4 Address . . . . . : 192.168.50.4
Subnet Mask . . . . . : 255.255.255.0
Default Gateway . . . . . : 192.168.50.1

Tunnel adapter isatap.{1A35634A-6314-488B-829A-9805A74D3C2E}:

Media State . . . . . : Media disconnected
Connection-specific DNS Suffix . :

C:\Users\Student>ping 192.168.40.4

Pinging 192.168.40.4 with 32 bytes of data:
Reply from 192.168.40.4: bytes=32 time=1ms TTL=127

Ping statistics for 192.168.40.4:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 1ms, Average = 0ms

C:\Users\Student>

```



```

Microsoft Windows [Version 10.0.10240]
(c) 2015 Microsoft Corporation. All rights reserved.

C:\Users\Student>ipconfig

Windows IP Configuration

Ethernet adapter Ethernet:

Connection-specific DNS Suffix . :
Link-local IPv6 Address . . . . . : fe80::4d1c:1121%14:47e9:22cd%5
IPv4 Address . . . . . : 192.168.50.4
Subnet Mask . . . . . : 255.255.255.0
Default Gateway . . . . . : 192.168.60.1

Tunnel adapter isatap.{2B86660A-1063-4716-B894-4E3B3FB054BC}:

Media State . . . . . : Media disconnected
Connection-specific DNS Suffix . :

C:\Users\Student>ping 192.168.20.4

Pinging 192.168.20.4 with 32 bytes of data:
Reply from 192.168.20.4: bytes=32 time=4ms TTL=123

Ping statistics for 192.168.20.4:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 4ms, Maximum = 4ms, Average = 4ms

C:\Users\Student>ping 192.168.50.4

Pinging 192.168.50.4 with 32 bytes of data:
Reply from 192.168.50.4: bytes=32 time=2ms TTL=122

Ping statistics for 192.168.50.4:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 2ms, Maximum = 2ms, Average = 2ms

C:\Users\Student>ping 192.168.30.4

Pinging 192.168.30.4 with 32 bytes of data:
Reply from 192.168.30.4: bytes=32 time=4ms TTL=121

Ping statistics for 192.168.30.4:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 4ms, Maximum = 4ms, Average = 4ms

C:\Users\Student>

```

- Testing the connectivity between block 1 and block 2 from PC7 to PC8 and PC12 to PC10 and PC5.

```

C:\> Command Prompt
Microsoft Windows [Version 10.0.10240]
(c) 2015 Microsoft Corporation. All rights reserved.

C:\Users\Student>ipconfig

Windows IP Configuration

Ethernet adapter Ethernet:
  Connection-specific DNS Suffix . :
  Link-local IPv6 Address . . . . . fe80::e05f:197e%1961:IPv6
  IPv4 Address . . . . . 192.168.20.4
  Subnet Mask . . . . . 255.255.255.0
  Default Gateway . . . . . 0.0.0.0
                           192.168.20.1

Tunnel adapter isatap.{2B8660AA-1063-4716-B894-4E3B3FB054BC}:
  Media State . . . . . : Media disconnected
  Connection-specific DNS Suffix . :

C:\Users\Student>ping 192.168.4.4

Pinging 192.168.4.4 with 32 bytes of data:
Reply from 192.168.4.4: bytes=32 time=1ms TTL=122

Ping statistics for 192.168.4.4:
  Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
  Approximate round trip times in milli-seconds:
    Minimum = 1ms, Maximum = 1ms, Average = 1ms

C:\Users\Student>

C:\> Command Prompt
Microsoft Windows [Version 10.0.10240]
(c) 2015 Microsoft Corporation. All rights reserved.

C:\Users\Student>ipconfig

Windows IP Configuration

Ethernet adapter Ethernet:
  Connection-specific DNS Suffix . :
  Link-local IPv6 Address . . . . . fe80::e05f:197e%1961:IPv6
  IPv4 Address . . . . . 192.168.60.4
  Subnet Mask . . . . . 255.255.255.0
  Default Gateway . . . . . 192.168.60.1

Tunnel adapter isatap.{2B8660AA-1063-4716-B894-4E3B3FB054BC}:
  Media State . . . . . : Media disconnected
  Connection-specific DNS Suffix . :

C:\Users\Student>ping 192.168.20.4

Pinging 192.168.20.4 with 32 bytes of data:
Reply from 192.168.20.4: bytes=32 time=1ms TTL=122

Ping statistics for 192.168.20.4:
  Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
  Approximate round trip times in milli-seconds:
    Minimum = 1ms, Maximum = 1ms, Average = 1ms

C:\Users\Student>

```

- Testing the connectivity between block 2 and block 3 from PC12 to PC17.

```

C:\> Command Prompt
Microsoft Windows [Version 10.0.10240]
(c) 2015 Microsoft Corporation. All rights reserved.

C:\Users\Student>ipconfig

Windows IP Configuration

Ethernet adapter Ethernet:
  Connection-specific DNS Suffix . :
  Link-local IPv6 Address . . . . . fe80::4d1c:1121%1961:IPv6
  IPv4 Address . . . . . 192.168.60.4
  Subnet Mask . . . . . 255.255.255.0
  Default Gateway . . . . . 192.168.60.1

Tunnel adapter isatap.{2B8660AA-1063-4716-B894-4E3B3FB054BC}:
  Media State . . . . . : Media disconnected
  Connection-specific DNS Suffix . :

C:\Users\Student>ping 192.168.70.4

Pinging 192.168.70.4 with 32 bytes of data:
Reply from 192.168.70.4: bytes=32 time=1ms TTL=127

Ping statistics for 192.168.70.4:
  Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
  Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 1ms, Average = 0ms

C:\Users\Student>

C:\> Command Prompt
Microsoft Windows [Version 10.0.10240]
(c) 2015 Microsoft Corporation. All rights reserved.

C:\Users\Student>ipconfig

Windows IP Configuration

Ethernet adapter Ethernet:
  Connection-specific DNS Suffix . :
  Link-local IPv6 Address . . . . . fe80::f9b6:972f%706b:bc87%3
  IPv4 Address . . . . . 192.168.70.4
  Subnet Mask . . . . . 255.255.255.0
  Default Gateway . . . . . 192.168.70.1

Tunnel adapter isatap.{2B8660AA-1063-4716-B894-4E3B3FB054BC}:
  Media State . . . . . : Media disconnected
  Connection-specific DNS Suffix . :

C:\Users\Student>ping 192.168.60.4

Pinging 192.168.60.4 with 32 bytes of data:
Reply from 192.168.60.4: bytes=32 time=1ms TTL=127

Ping statistics for 192.168.60.4:
  Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
  Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 1ms, Average = 0ms

C:\Users\Student>

```

- Testing the connectivity between the two ISPs, Router1, Router2 and Router3 in BGP.

```

ping -I lo0 200.165.60.1
^
% Invalid input detected at '^' marker.

ISP1(config)#do ping ?
LINE <>>

ISP1(config)#do ping?
LINE <>>

ISP1(config)#do ping ?
LINE <>>

ISP1(config)#do ping 200.165.60.1 source lo0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 200.165.60.1, timeout is 2 seconds:
Packet sent with a source address of 200.165.10.1
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 44/44/44 ms
ISP1(config)#
ISP2>
ISP2>
ISP2>
ISP2#ping 200.165.10.1 source lo0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 200.165.10.1, timeout is 2 seconds:
Packet sent with a source address of 200.165.60.1
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 44/44/44 ms
ISP2#

```



```

ISP1#
ISP1#show ip route
Codes: 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

Gateway of last resort is not set

200.165.20.0/30 is subnetted, 1 subnets
C    200.165.20.0 is directly connected, Serial0/0/0
200.165.60.0/28 is subnetted, 1 subnets
B    200.165.60.0 [20/2707456] via 200.165.20.2, 03:36:15
200.165.10.0/28 is subnetted, 1 subnets
C    200.165.10.0 is directly connected, Loopback0
ISP1#

```



```

ISP1#
Router1>en
Router1#show ip route
Codes: 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

Gateway of last resort is not set

200.165.20.0/30 is subnetted, 1 subnets
C    200.165.20.0 is directly connected, Serial0/0/1
200.165.30.0/30 is subnetted, 1 subnets
C    200.165.30.0 is directly connected, Serial0/0/0
200.165.60.0/28 is subnetted, 1 subnets
D EX   200.165.60.0 [170/2707456] via 200.165.30.1, 03:37:02, Serial10/0/0
200.165.10.0/28 is subnetted, 1 subnets
B    200.165.10.0 [20/0] via 200.165.20.1, 03:36:45
200.165.40.0/30 is subnetted, 1 subnets
D    200.165.40.0 [90/2681856] via 200.165.30.1, 03:37:02, Serial10/0/0
Router1#

```



```

Router2>
Router2>en
Router2#show ip route
Codes: C - connected, S - static, I - IGRP, 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, E - EGP
      i - IS-IS, 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

Gateway of last resort is not set

200.165.30.0/30 is subnetted, 1 subnets
C    200.165.30.0 is directly connected, Serial10/0/0
200.165.60.0/28 is subnetted, 1 subnets
D EX   200.165.60.0 [170/2135456] via 200.165.40.2, 03:37:27, Serial10/1
200.165.10.0/28 is subnetted, 1 subnets
D EX   200.165.10.0 [170/2135456] via 200.165.30.2, 03:37:10, Serial10/0
200.165.40.0/30 is subnetted, 1 subnets
C    200.165.40.0 is directly connected, Serial10/1
Router2#

```



```

Router3#en
Router3#show ip route
Codes: C - connected, S - static, I - IGRP, 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

Gateway of last resort is not set

200.165.50.0/30 is subnetted, 1 subnets
C    200.165.50.0 is directly connected, Serial1/1
200.165.40.0/30 is subnetted, 1 subnets
D    200.165.40.0 [20/0] via 200.165.50.1, 03:38:29, Serial1/0
200.165.50.0/28 is subnetted, 1 subnets
B    200.165.50.0 [20/0] via 200.165.50.1, 03:37:49
200.165.10.0/28 is subnetted, 1 subnets
D EX   200.165.10.0 [170/1049400] via 200.165.40.1, 03:37:32, Serial1/0/0
200.165.40.0/30 is subnetted, 1 subnets
C    200.165.40.0 is directly connected, Serial1/0
Router3#
ISP2#
ISP2#show ip route
Codes: 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

Gateway of last resort is not set

200.165.50.0/30 is subnetted, 1 subnets
C    200.165.50.0 is directly connected, Serial10/0/0
200.165.40.0/28 is subnetted, 1 subnets
C    200.165.40.0 is directly connected, Loopback0
200.165.10.0/28 is subnetted, 1 subnets
B    200.165.10.0 [20/2135460] via 200.165.50.1, 03:38:17
ISP2#

```

CHAPTER9:

TROUBLESHOOTIN

G AND DEBUGGING

9.1 Troubleshooting and Debugging in designing stage:

- After configured HSRP for R1 and R2 The two routers are being active at the same time, it seems like they do not talk with each other so we thought that because of the switches that they are connected through, but when we replaced the routers with new ones and connected them with the same switches and configured their interfaces with just one LAN it work properly, so the problem may related to the VLANs segmentation using router.
 - We tried another solution by doing VLAN balancing between the two routers, we try to make R1 as an active router for VLAN 10, 30 and 50, and standby for VLAN 20and 40, and R2 as an active router for VLAN 20 and 40, and as standby for VLAN 10,30 and 50, but unfortunately, the problem still present.

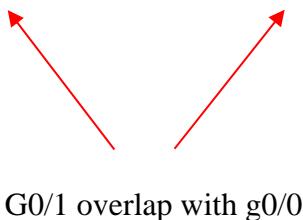
Here when we tried to do VLAN balancing between the routers.

- Another problem we faced in HSRP configuration is that each router has two interfaces connected to two backup switches, which means that two interfaces on the same router will have the same subnet, and this will generate overlap between these interfaces.
- At the beginning we thought to configure HSRP not just between the two routers, but also between the two interfaces on each router as well.
- We thought to give g0/0 on R1 a standby priority 150, and g0/1 on the same router (R1) standby priority 120, and g0/0 on R2 a standby priority 100 (the default), and g0/1 on the same router (R2) a standby priority 80. But actually, this will generate overlap between the interfaces on the same router, for example on R1:

```

• #int g0/0                                #int g0/1
                                         
• #no shutdown                               #no shut
                                         
• #ip add 192.168.10.2 255.255.255.0      #ip add 192.168.10.3 255.255.255.0

```



- We read to solve this we can do bridging on router, means configure bridge on both router interfaces, and to make the interfaces able to route traffic we need to configure IRB (Integrated Routing and Bridging) with BVI (Bridge Virtual Interface), but Packet Tracer does not support this functionality.

- **9.2 Troubleshooting and Debugging in Implementation stage:**

1. Host flapping between ports

- Two ports in one of our switches keeps flapping, a MAC flap is caused when a switch receives packets from two different interfaces with the same source mac address that most likely is layer 2 loop although we configured STP, and later we found that this is because the misconfiguration that we did in this switch because we've configured this switch with PAGP protocol for the etherchannel whereas the other switches were configured with LACP.
 - Since this switch does not support LACP protocol, we removed the configuration from all other switches and reload the switches then we reconfigured them with PAGP Cisco protocol.

2. Multi-switch IOS image does not support OSPF

- In configure OSPF protocol in multi-switches when we try to configure OSPF "**router ospf 1**" this message shows "Protocol not in this image" this because the multi-switches have an IPBASE feature which includes some routing protocols but not OSPF.
- So, if we need to run OSPF then we need to upgrade the IOS to a different feature set, to solve this problem, we were having two option first is to run OSPF in the current device by upgrading IOS to a different feature set, this will be costly and need more time.
- The second choose is to change our multi-switches with other multi-switches devices in the lab that support OSPF and reconfigure the previous protocol that's needs to be before configuring OSPF. In the figure it shows the old and new configuration for MS.

```

MS3(config)# do sh ip protocol
*** IP Routing is NSF aware ***

MS3(config)#router ospf 1
Protocol not in this image
MS3(config)#

```



```

MS1>en
MS1#conf t
Enter configuration commands, one per line. End with CNTL/Z.
MS1(config)#do show versionf
show versionf
^
! Invalid input detected at '^' marker.

MS1(config)#do show version
Cisco IOS Software, C3560 Software (C3560-IPBASE-M), Version 12.2(35)SE5, RELEASE SOFTWARE (fc1)
Copyright (c) 1984-2007 by Cisco Systems, Inc.
Compiled Thu 19-Jul-07 16:15 by nachen
Image text-base: 0x00000000, data-base: 0x01000000
MS1# Bootstrapping program is C3560 boot loader
BOOTLER: C3560 Boot Loader (C3560-HBOOT-M) Version 12.2(25r)SEC, RELEASE SOFTWARE (fc1)

MS1 uptime is 2 hours, 59 minutes
System returned to ROM by power-on
System image file is "flash:/c3560-ipbase-mz.122-35.SE5/c3560-ipbase-mz.122-35.SE5.bin"
Processor board ID F0D1249YSLX
Last reset from power-on
Virtual Ethernet interfaces
24 FastEthernet interfaces
2 Gigabit Ethernet interfaces
The password-recovery mechanism is enabled.

MS1(config)#erslion 12.1(2)E1a, RELEASE SOFTWARE [f
^
! Invalid input detected at '^' marker.

```

3. Interface protocol is down

- We faced problem in one of serial interfaces of ABR 2 router it shows the line protocol is down after we use the command "**no shutdown**" and give it IP address.
 - To solve this problem, we try with command " **show controllers se0/0/0** " this command displays very detailed controller and interface information like speed, duplex, and clock.
 - In older versions of the OS, the command could be removed from the interface, but this is a common configuration mistake. The line protocol would not work properly because the clock rate was not set, which prevented data from being transmitted through the link. New versions of the OS automatically add the clock rate setting to the interface.
 - For that we must manually setting the Clock rate by using command "clock rate 128000" in the interface s0/0/0 (DCE-type cable).

```

COM3 - PUTTY

ASR2(config-if)#clock rate ?
  Speed (bits per second)
  1200   2400   4800   9600   14400   19200
 28800  32000  38400  48000  56000  57600
 44800  72000  115200 128000  230400  252000

<300-10000000>  Choose clockrate from list above

ASR2(config-if)#clock rate 128000
ASR2(config-if)#do show
<0> 1 00:25:10.765: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/0/0, changed state to up
# Type "show ?" for a list of subcommands
ASR2(config-if)#
ASR2(config-if)#
ASR2(config-if)#do show ip int bri
ASR2(config-if)#
Interface      IP-Address      OK? Method Status      Protocol
FastEthernet0/0  unassigned      YES NVRAM administratively down down
FastEthernet0/1  unassigned      YES NVRAM administratively down down
Serial10/0/0    10.0.21.1      YES manual up        up
Serial10/0/1    10.0.21.1      YES NVRAM up        up
Serial10/0/2    20.0.0.66      YES NVRAM down       down
Serial10/0/3    unassigned      YES NVRAM administratively down down
ASR2(config-if)#
^C
% Invalid input detected at '***' marker.

ASR2(config-if)#
  10.0.21.1      YES NVRAM up        up
Serial10/0/1    10.0.21.1      YES NVRAM up        up

% Invalid input detected at '***' marker.

ASR2(config-if)#
  Fast/0/0/2
ASR2(config-if)#
ASR2(config-if)#
<0> 1 00:26:10.031: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/0/0, changed state to down
ASR2(config-if)#
ASR2(config-if)#
ASR2(config-if)#do show ip int bri
ASR2(config-if)#
Interface      IP-Address      OK? Method Status      Protocol
FastEthernet0/0  unassigned      YES NVRAM administratively down down
FastEthernet0/1  unassigned      YES NVRAM administratively down down
Serial10/0/0    10.0.21.1      YES manual up        down
Serial10/0/1    10.0.21.1      YES NVRAM up        up

```

4. Interfaces state is down

- The interfaces state of switches and multi-layer switches in block 2 and block 3 keeps down even if we're trying to make them up by using command "no shutdown".
 - To solve this problem, we found that to connect Catalyst 3560 Series with Catalyst 2960 Series we should use crossover cables.

```

# COM1>PUTV
3#config#Int camp 2/0 / - 4
3#config#if-range#shutdown
3#config#int range#
01:01:51: VLINK-3-UNKNOWN: Interface FastEthernet0/3, changed state to administratively down
01:01:52: VLINK-3-UNKNOWN: Interface FastEthernet0/4, changed state to administratively down
01:01:52: VLINK-PROT0-5-UNKNOWN: Line protocol on Interface FastEthernet0/3, changed state to down
01:01:52: VLINK-PROT0-5-UNKNOWN: Line protocol on Interface FastEthernet0/4, changed state to down
3#config#int range#chassis-group 2 mode active
3# Invalid input detected at " *** marker.

3#config#if-range#chassis-group 2 mode on
Creating a port-channel interface Port-channel2
3#config#if-range#no shut
3#config#int range#
01:04:27: VLINK-3-UNKNOWN: Interface FastEthernet0/2, changed state to up
01:04:28: VLINK-3-UNKNOWN: Interface FastEthernet0/4, changed state to up
01:06:31: VLINK-PROT0-5-UNKNOWN: Line protocol on Interface FastEthernet0/4, changed state to up
01:06:31: VLINK-PROT0-5-UNKNOWN: Line protocol on Interface FastEthernet0/5, changed state to up
01:06:32: VLINK-3-UNKNOWN: Interface Port-channel2, changed state to up
01:06:32: VLINK-3-UNKNOWN: Line protocol on Interface Port-channel2, changed state to up
3#config#int range#exit
3#config#int port-channel 2
3#config#ip address 10.0.0.1 255.255.255.0
3#config#int range 10/5 - 6
3#config#if-range#shutdown
3#config#int range#
01:01:50: VLINK-3-UNKNOWN: Line protocol on Interface FastEthernet0/3, changed state to down
01:01:51: VLINK-3-UNKNOWN: Line protocol on Interface FastEthernet0/4, changed state to down
01:01:52: VLINK-PROT0-5-UNKNOWN: Line protocol on Interface Port-channel1, changed state to down
01:01:53: VLINK-3-UNKNOWN: Interface FastEthernet0/3, changed state to down
01:01:54: VLINK-3-UNKNOWN: Interface FastEthernet0/4, changed state to down
01:01:54: VLINK-5-CHANGED: Interface FastEthernet0/4, changed state to administratively down
01:01:55: VLINK-PROT0-5-UNKNOWN: Line protocol on Interface FastEthernet0/5, changed state to down
01:01:55: VLINK-PROT0-5-UNKNOWN: Line protocol on Interface FastEthernet0/6, changed state to down
3#config#int range#chassis-group 3
3# incomplete command.

3#config#if-range#chassis-group 3 mode on
Creating a port-channel interface Port-channel3
3#config#int range#exit
3#config#int range 10/5 - 6
3#config#int range#no shutdown
3#config#int range#
01:06:26: VLINK-3-UNKNOWN: Interface FastEthernet0/5, changed state to up
01:06:26: VLINK-3-UNKNOWN: Interface FastEthernet0/6, changed state to up
01:06:30: VLINK-PROT0-5-UNKNOWN: Line protocol on Interface FastEthernet0/5, changed state to up

```

```

COM1-PUTY

S4>show int Fa0/1
FastEthernet0/1 is administratively down, line protocol is down
  Hardware is Fast Ethernet, address is 000a.b7cd.5844 (bia 000a.b7cd.5844)
  MTU 1500 bytes, BW 10000 Kbit, DLY 1000 usec,
  reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation ARPA, loopback not set
  Keepalive 0 sec (0 send)
  Autonegotiate, Auto-negotiated
  input flow-control is off, output flow-control is off
  ARP type: ARPA, ARP Timeout 04:00:00
  Last input 00:00:00.00000000, output hang never
  Last clearing of "show interface" counters never
  Input queue: 0/75/0/0 (sin/mx/drops/flushes); Total output drops: 0
  Queueing strategy: fifo
  Output queue: 0/0 (normal/max)
  Interface input rate 0 bits/sec, 0 packets/sec
  5 minute input rate 0 bits/sec, 0 packets/sec
  52111 packets input, 400126 bytes, 0 no buffer
  Received 0 errors, 0 dropped, 0 overruns, 0 giants, 0 throttles
  Input queue: 0 CMC, 0 frame, 0 overuse, 0 ignored
  0 watchdog, 4765 multicast, 0 pause input
  0 input packets with dribble condition detected
  72325 packets output, 699719 bytes, 0 underruns
  0 output errors, 0 collisions, 0 interface resets
  0 collisions, 0 late collision, 0 deferred

S4(config)#
S4(config)#
Enter configuration commands, one per line. End with CNTL/Z.
S4(config)#int Fa0/3
S4(config-if)#no shut
S4(config-if)#

02:15:04: WLINK-3-UPDOWN: Interface FastEthernet0/3, changed state to up
02:15:04: WLINERD0-5-UPDOWN: Line protocol on Interface FastEthernetnet/3, changed state to up
S4(config-if)#
02:15:04: WLINK-3-UPDOWN: Interface Port-channel, changed state to up
02:15:04: WLINERD0-5-UPDOWN: Line protocol on Interface Port-channel2, changed state to up
S4(config-if)#
S4(config)#
S4(config)#exit
S4(config)#
S4(config)#int Fa0/4
S4(config-if)#no shut
S4(config-if)#
S4(config-if)#
02:15:21: WLINK-3-UPDOWN: Interface FastEthernet0/4, changed state to up
02:15:30: WLINERD0-5-UPDOWN: Line protocol on Interface FastEthernetnet/4, changed state to up
S4(config-if)#
S4(config)#
S4(config)#
S4(config)#
02:15:51: WLINERD0-5-UPDOWN: Line protocol on Interface FastEthernet0/3, changed state to down
02:15:50: WLINK-3-UPDOWN: Interface FastEthernet0/3, changed state to down
S4(config)#

```

```

COMS-PTV

$5[config-if-range]#
$5[config-if-range]#00:26:03: WLINE-5-CHANGED: Interface FastEthernet0/5, changed state to administratively down
$5[config-if-range]#00:26:03: WLINE-5-CHANGED: Interface FastEthernet0/6, changed state to administratively down
$5[config-if-range]#00:26:03: WLINE-5-CHANGED: Line protocol on Interface FastEthernet0/5, changed state to down
$5[config-if-range]#00:26:03: WLINE-5-CHANGED: Line protocol on Interface FastEthernet0/6, changed state to down
$5[config-if-range]#00:26:03: WLINE-5-CHANGED: Channel-group 3 made active
Creating a port-channel interface Port-channel 3

$5[config-if-range]#no shutdown
$5[config-if-range]#
$5[config-if-range]#00:28:21: WLINE-1-UNKNOWN: Interface FastEthernet0/3, changed state to up
$5[config-if-range]#00:28:21: WLINE-1-UNKNOWN: Interface FastEthernet0/4, changed state to up
$5[config-if-range]#00:28:32: WLINE-PROTOS-5-UNKNOWN: Line protocol on Interface FastEthernet0/5, changed state to up
$5[config-if-range]#00:28:33: WLINE-PROTOS-5-UNKNOWN: Line protocol on Interface FastEthernet0/6, changed state to up
$5[config-if-range]#exit
$5[config-if]#int port-channel 3
$5[config-if]#sw trunk encapsulation dot1q
$5[config-if]#no mode trunk
$5[config-if]#exit
$5[unconfig]#show ether summary
Flags: d - down F - in port-channel
      I - stand-alone s - suspended
      H - Hot-standby (LACP only)
      B - Layer3 S - Layer2
      u - unsuitable for bundling
      U - in use      f - failed to allocate aggregator
      D - default port

Number of channel-groups in use: 3
Number of aggregators: 3

Group Port-channel Protocol Ports
-----+
1   Po1(3D)    LACP  Fa0/1(D)  Fa0/2(D)
2   Po2(3D)    LACP  Fa0/3(F)  Fa0/4(F)
3   Po3(3D)    LACP  Fa0/5(S)  Fa0/6(I)

$5[config]#do wr
Building configuration...
[OK]
$5[config]#do wr
Building configuration...
[OK]
$5[config]#

```

5. Interfaces state and protocol is down

- In some routers there were many interfaces being down because the weak and damaged cables that we used, so that we replaced them with other good cables.

```

Router(config)#host R4
R4(config)#do show ip int bri
Interface          IP-Address      OK? Method Status      Protocol
FastEthernet0/0    unassigned      YES unset administratively down down
Serial0/0          unassigned      YES unset administratively down down
FastEthernet0/1    unassigned      YES unset administratively down down
Serial0/1          unassigned      YES unset administratively down down
Serial1/0          unassigned      YES unset administratively down down
Serial1/1          unassigned      YES unset administratively down down
Serial1/2          unassigned      YES unset administratively down down
Serial1/3          unassigned      YES unset administratively down down

R4(config)#int Fa0/0
R4(config)#no shut
R4(config)#
R4(config)#
Mar 1 01:43:57.763 :LINEPROTO-5-UPDOWN: Interface FastEthernet0/0, changed state to up
Mar 1 01:43:50.237 :LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
R4(config)#ip add 10.14.2 255.255.255.0
R4(config)#
R4(config)#!exit
R4(config)#
R4(config)#int Fa0/1
R4(config)#no shut
R4(config)#
R4(config)#
Mar 1 01:44:16.555 :LINEPROTO-5-UPDOWN: Interface FastEthernet0/1, changed state to up
Mar 1 01:44:19.271 :LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to up
R4(config)#ip add 10.14.2 255.255.255.0
R4(config)#!exit
R4(config)#
R4(config)#int Se0/0
R4(config)#
R4(config)#!no shut
R4(config)#
R4(config)#
Mar 1 01:44:43.323 :LINEPROTO-5-UPDOWN: Interface Serial0/0, changed state to down
R4(config)#ip add 10.11.2 255.255.255.0
R4(config)#!exit
R4(config)#
Building configuration...
(OR)
R4(config)# do show ip int bri
Interface          IP-Address      OK? Method Status      Protocol
FastEthernet0/0    10.0.14.2      YES manual up        up
Serial0/0          10.0.11.2      YES manual down     down
FastEthernet0/1    10.0.15.2      YES manual up        up
Serial0/1          unassigned      YES unset administratively down down
Serial1/0          unassigned      YES unset administratively down down
Serial1/1          unassigned      YES unset administratively down down
Serial1/2          unassigned      YES unset administratively down down

```

```

P
Router(config)#
Router(config)#
Router(config)#host R3
R3(config)#int Fa0/0
R3(config-if)#no shut
R3(config-if)#
R3# Jan 1 03:05:44.603: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to up
R3# Jan 1 03:05:45.603: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
R3(config-if)#ip add 10.0.12.2 255.255.255.0
R3(config-if)#exit
R3(config)#int Fa0/1
R3(config-if)#no shut
R3(config-if)#
R3# Jan 1 03:06:19.723: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to up
R3(config-if)#ip add 10.0.13.2 255.255.255.0
R3(config-if)#exit
R3(config)#do show ip int brief
Interface          IP-Address      OK? Method Status       Protocol
FastEthernet0/0    10.0.12.2      YES manual up        up
FastEthernet0/1    10.0.13.2      YES manual up        up
FastEthernet0/1/0   unassigned     YES unset up       down
FastEthernet0/1/1   unassigned     YES unset up       down
FastEthernet0/1/2   unassigned     YES unset up       down
FastEthernet0/1/3   unassigned     YES unset up       down
Serial0/0/0        unassigned     YES unset administratively down
Serial0/0/1        unassigned     YES unset administratively down
Vlan1              unassigned     YES unset up       down
R3(config)#int Se0/0/0
R3(config-if)#no shut
R3(config-if)#
R3# Jan 1 03:07:22.079: %LINK-3-UPDOWN: Interface Serial0/0/0, changed state to up
R3# Jan 1 03:07:23.079: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/0/0, changed state to up
R3(config-if)#ip add 10.0.10.2 255.255.255.0
R3(config-if)#exit
R3(config)#do show ip int brief
Interface          IP-Address      OK? Method Status       Protocol
FastEthernet0/0    10.0.12.2      YES manual up        up
FastEthernet0/1    10.0.13.2      YES manual up        up
FastEthernet0/1/0   unassigned     YES unset up       down
FastEthernet0/1/1   unassigned     YES unset up       down
FastEthernet0/1/2   unassigned     YES unset up       down
FastEthernet0/1/3   unassigned     YES unset up       down
Serial0/0/0        10.0.10.2      YES manual up        up
Serial0/0/1        unassigned     YES unset administratively down

```

CHAPTER10:

CONCLUSION

Conclusion:

The enterprise network is the most critical component of any Small to Medium Enterprise (SME). It enables them to connect with their multiple supply chain partners. The enterprise network allows employees to access business information and communicate effectively with each other. To consistently meet the demands of businesses, network architecture is becoming more complex. The project involves designing and implementing a network system that is suitable for an Enterprise Campus.

Our project presents a topology that contains three-building, with different networks and different types of devices. In each building, we provide a different VLANs for the end devices for security purposes. The objective is to provide a network that achieves the required scalability, security, redundant, and both cost-effective and high-quality.

By the end of this project, we can say that this project has nailed our networking design, configuration, and implementation skills. Good networks aren't created by chance. They're the product of a lot of hard work by network designers and technicians who assess network requirements and choose the finest solutions to fulfil a company's demands.

Networks with good designs are more robust and perform better. This phase has taken a lot of our time and effort to collect information about the main steps involved in the design process and best design practices. Actually, we redesigned the network many times until we finally reached the best one that we could possibly make with the available switches and routers.

As a result of simulation and implementation chapters, we gained a better understanding of the practice in the real world, along with the challenges we can face, especially in configuring and adapting to different types of devices and systems. Being there is the hardest part. However, we could develop a wealth of information and be capable of handling any issues that might arise with basic knowledge of networking and hours of practicing. Finally, we must acknowledge the shortcomings in the weak resources we utilized to create this entire network.

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APPENDIX A:

1 - Time Line

1- Project due date

TABLE 8 ROLES AND RESPONSIBILITIES

Title ↑	T/M	Start	End	↻
Project Proposal	T ➔	23/01/22	02/02/22	8 days
Analysis	T ➔	03/02/22	10/02/22	6 days
Design	T ➔	11/02/22	17/02/22	5 days
Simulation	T ➔	18/02/22	14/07/22	105 days
Documentation	T ➔	20/03/22	31/03/22	9 days
Implementation	T ➔	21/07/22	06/08/22	12 days
Review Documentation	T ➔	01/07/22	21/07/22	15 days
Testing	T ➔	01/06/22	29/07/22	43 days
Poster	T ➔	17/07/22	31/07/22	10 days
Final Report	T ➔	25/07/22	30/08/22	27 days

2- Gantt chart of the project

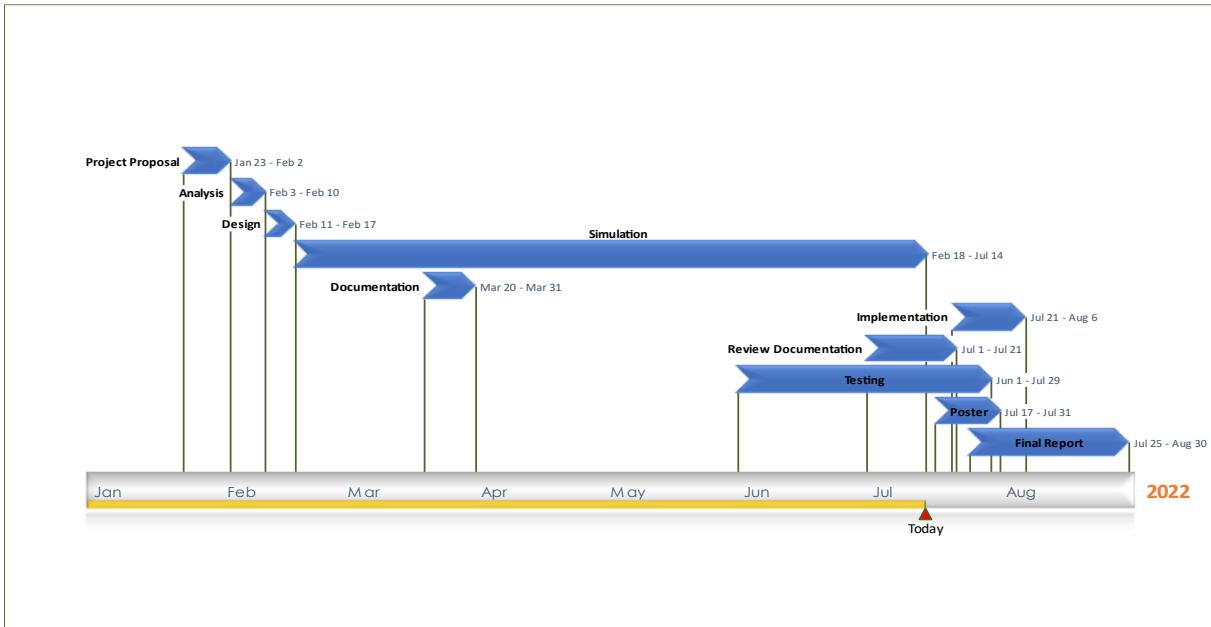


FIGURE 8 TIMELINE GANTT CHART

2 - Roles and Responsibility

TABLE 9 ROLES AND RESPONSIBILITIES

Role	Responsibilities	Participant (s)
Project Leader	<ul style="list-style-type: none">• Managing and leading the project team.• Developing and maintaining a detailed project plan.• Managing project deliverables.• Recognize and celebrate team and open the communication.• Ensure the decisions between team members and take the final decision.• Contact the supervisor when needed.• Monitoring and checking the final project blog updated periodically.	Waad
Analysis	<ul style="list-style-type: none">• Identify problems to define solution characteristics.• Identification and mapping of information needs.• Defining the requirements for designing and implementation.• Discussion of different network design approaches.• Choosing the appropriate design approach.	All the members lead by Waad and Asma

Design	<ul style="list-style-type: none"> • Making system architecture. • Applying blocks design. 	All the members lead by Rawan and Maryam
Simulation	<ul style="list-style-type: none"> • Designed and analyzed IPV4. • Configure the standard protocols for each device in the network. 	All the members lead by Waad and Asma
Implementation	<ul style="list-style-type: none"> • Connecting the real switches and routers. • Designed and analyzed IPv6 and IPV4. • Implement the needed protocols configurations functions. 	All the members lead by: Maryam and Rawan
Testing	<ul style="list-style-type: none"> • Test the VLANs in block1, block2 and block3 in designing stage. • Test the VLANs between blocks in designing stage. • Test the VLANs in block1, block2 and block3 in implementation stage. • Test the VLANs between blocks in implementation stage. 	All the members lead by: Asma and Waad
Troubleshooting	<ul style="list-style-type: none"> • Troubleshooting and debugging in designing stage. • Troubleshooting and debugging in implementation stage. 	All the members lead by: Maryam and Rawan
Domain Experts	<ul style="list-style-type: none"> • Meeting weekly to make discussion about our project and its progress. • Evaluating our work. 	Dr. Tarek

APPENDIX B:

1. Goals Accomplished

TABLE 10 GOALS ACCOMPLISHED

OBJECTIVES	Achieved	Not Achieved
Design a reliable, scalable and resilient network.	✓	
Establish a high availability of the network that's has a fast link failover and a redundant link.	✓	
Identify the responsibility and the protocols to be used at each layer.	✓	
Prevent both routing and switching loops.	✓	
Set up each router and switch with the required security measures.	✓	
Assigning IP addresses dynamically to users and devices except servers.	✓	
Avoid proprietary protocols as much as possible and use the standard ones.	✓	
Provide users with Internet access.	✓	
End to end connectivity using IPv6 addresses.		✓