DIPLOMADO DE PROFUNDIZACION CISCO

PRUBA DE HABILIDADES PRACTICAS CCNP

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UNIVERSIDAD NACIONAL ABIERTA Y A DISTANCIA UNAD
ESCUELA DE CIENCIAS BÁSICAS TECNOLOGÍA E INGENIERÍA
INGENIERIA DE TELECOMUNICACIONES
VALLEDUPAR
2022

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Diplomado de opción de grado presentado para optar el título de
INGENIERO DE TELECOMUNICACIONES

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GLOSARIO

ETHERCHANNEL: EtherChannel es una tecnología de Cisco construida de acuerdo con los estándares 802.3 full-duplex Fast Ethernet.

GNS3: Es un simulador gráfico de red lanzado en 2008, que te permite diseñar topologías de red complejas y poner en marcha simulaciones sobre ellos, permitiendo la combinación de dispositivos tanto reales como virtuales.

LACP: Es un término que indica el establecimiento de una red de datos que describe cómo utilizar varios enlaces Ethernet full-dúplex en la comunicación entre dos equipos, repartiendo el tráfico entre ellos.

ROUTER: Es un dispositivo de enrutamiento que permite interconectar redes con distintos prefijos en su dirección.

SLAAC (Stateless Address Autoconfiguration): Es un mecanismo muy cómodo y potente propio de IPv6 y que no tiene un equivalente en IPv4, que permite la autoconfiguración de los nodos.

STP (Spanning Tree Protocol): Es un protocolo de red de capa 2 del modelo OSI. Su función es la de gestionar la presencia de bucles en topologías de red debido a la existencia de enlaces redundantes

SWITCH: Es un dispositivo que permite la conexión de computadoras y periféricas a la red pueden comunicarse entre si y otras redes.

VLAN: Conocidas como redes de área local virtuales, es una tecnología de redes que nos permite crear redes lógicas independientes dentro de la misma red física.

.

RESUMEN

A continuación, se mostrarán los conocimientos obtenidos en el transcurso del diplomado y otras asignaturas referentes a redes de datos, para ello se explicará paso a paso, la instalación y configuración de los dispositivos que intervienen en un escenario hipotético, con ayuda del simulador gráfico GNS3 y de la máquina virtual “VirtualBox” se realizaran todas las pruebas y simulaciones requeridas.

En dicho escenario se estructuran redes conmutadas mediante el uso del protocolo STP y la configuración de VLANs.

Además, se muestran imágenes de los resultados de cada una de las etapas que se van desarrollando del proyecto.

PALABRAS CLAVE: CCNP, Cisco, Conmutación, Enrutamiento, Router, Simulador, Protocolo.

ABSTRACT

In the present work, the knowledge obtained in the course of the diploma and other subjects related to data networks will be shown, for this, the installation and configuration of the devices that intervene in a hypothetical scenario will be explained step by step, with the help of the GNS3 graphic simulator. and from the virtual machine "VirtualBox" all the required tests and simulations will be carried out.

In this scenario, switched networks are structured through the use of the STP protocol and the configuration of VLANs.

In addition, images of the results of each of the stages that are being developed in the project are shown.

KEY WORDS: CCNP, Cisco, Protocol, Router, Routing, Simulator, Switching.

INTRODUCCIÓN

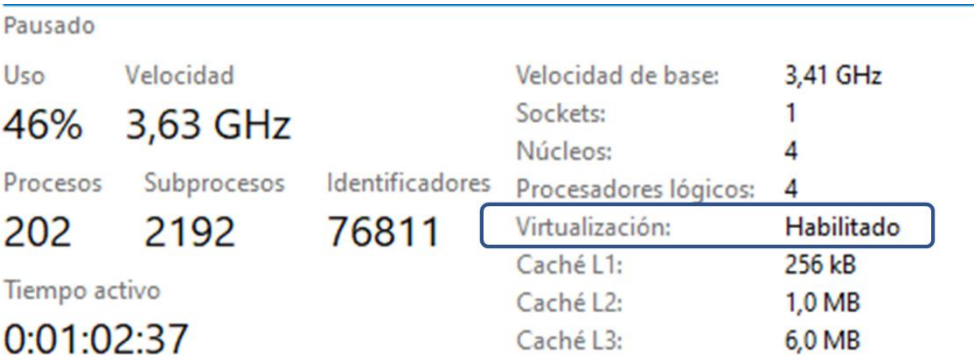
El presente trabajo tiene como finalidad la construcción y configuración de la red para que haya una accesibilidad completa de extremo a extremo, para que los hosts tengan soporte de puerta de enlace predeterminado confiable y para que los protocolos de administración estén operativos dentro de la parte "Red de la empresa" de la topología, además se deben configurar los ajustes básicos del dispositivo y el direccionamiento de la interfaz. Luego se hará una verificación de sus configuraciones para analizar que cumplan con las especificaciones proporcionadas y que los dispositivos funcionen según sea necesario.

Para ello se deben desarrollar una serie de etapas como: configurar las interfaces troncales IEEE 802.1Q en los enlaces de conmutación interconectados, cambiar la VLAN nativa en los enlaces troncales y habilitar el protocolo Rapid Spanning Tree en los conmutadores; configurar los switchs D1 y D2 como raíz para las VLAN adecuadas con prioridades de apoyo mutuo en caso de fallo del conmutador, entre otras.

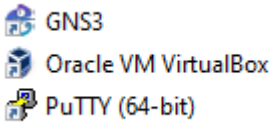
DESARROLLO

Para el desarrollo del proyecto se tuvieron los siguientes requisitos iniciales

- Verificación de estar habilitado en BIOS la opción de virtualización



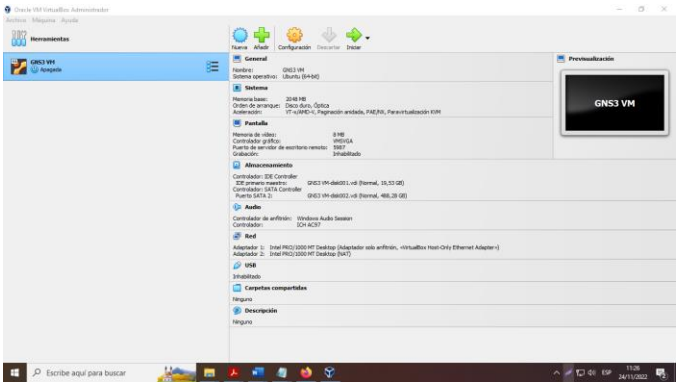
- Instalar los softwares y herramientas (Virtual Box, Putty, GNS3), descargar y cargar la máquina virtual GNS3 en Virtual Box



INSTALACIÓN DE LA VM (MÁQUINA VIRTUAL)

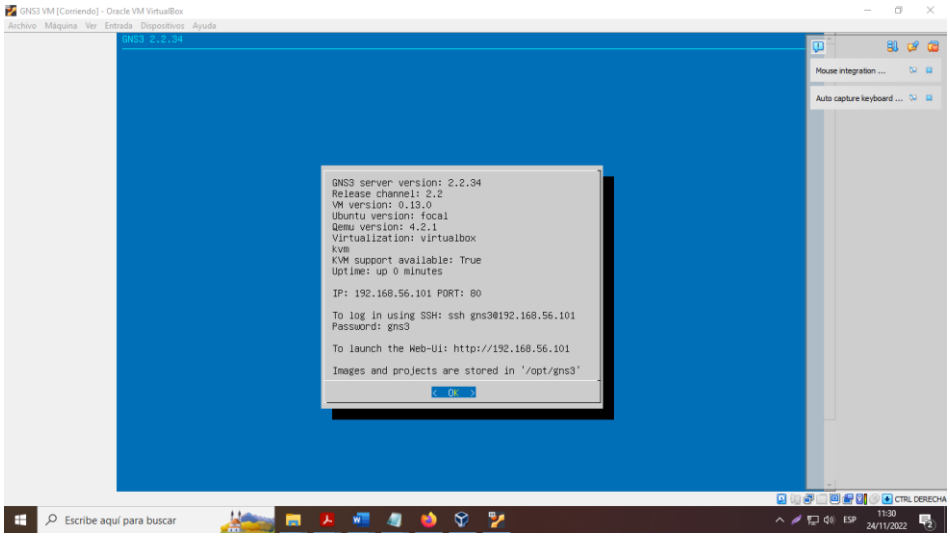
Se descarga y cargar la máquina virtual GNS3 en Virtual Box, se ajusta la configuración dependiendo los recursos del equipo de cómputo.

Figura 1. Máquina virtual GNS3 en Virtual Box



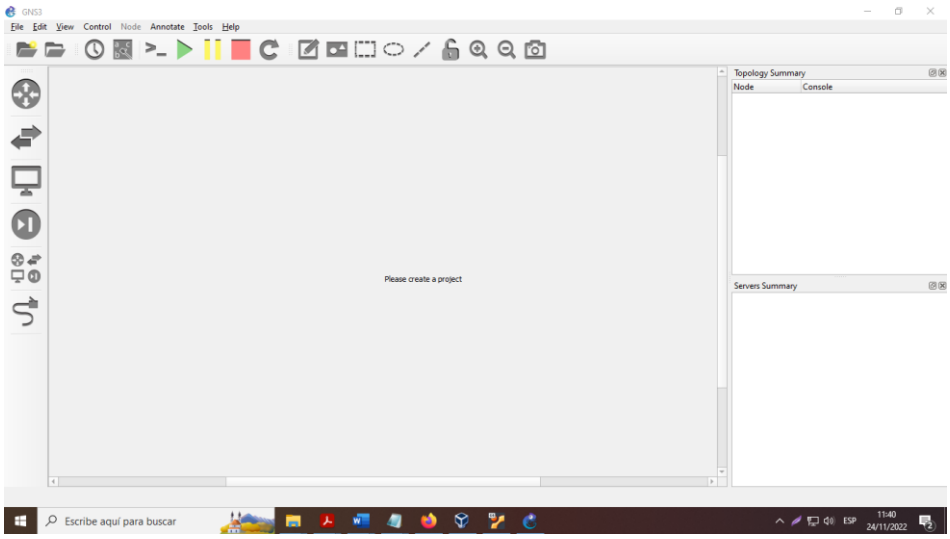
Empieza a correr el servidor GNS3 en la máquina virtual mostrando alguna información de configuración

Figura 2. Servidor GNS3



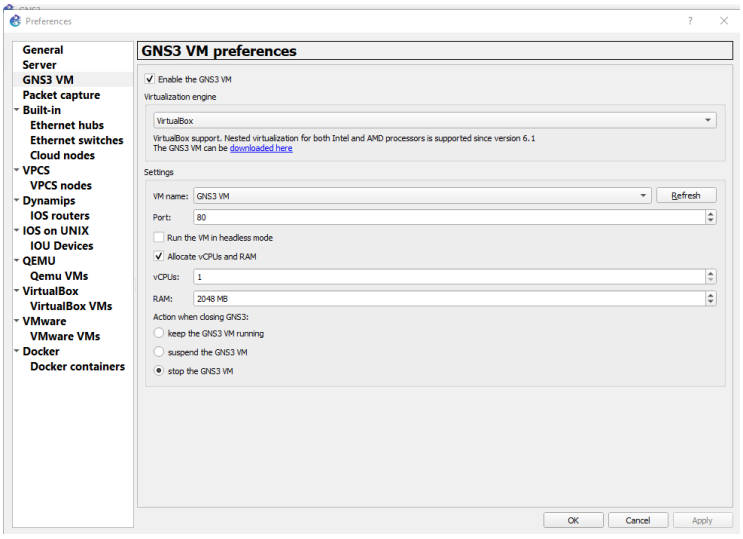
Se ejecuta el software GNS3 para acoplar el entorno local con el servidor que es donde van a correr los escenarios que se van a trabajar

Figura 3. Interfaz de GNS3



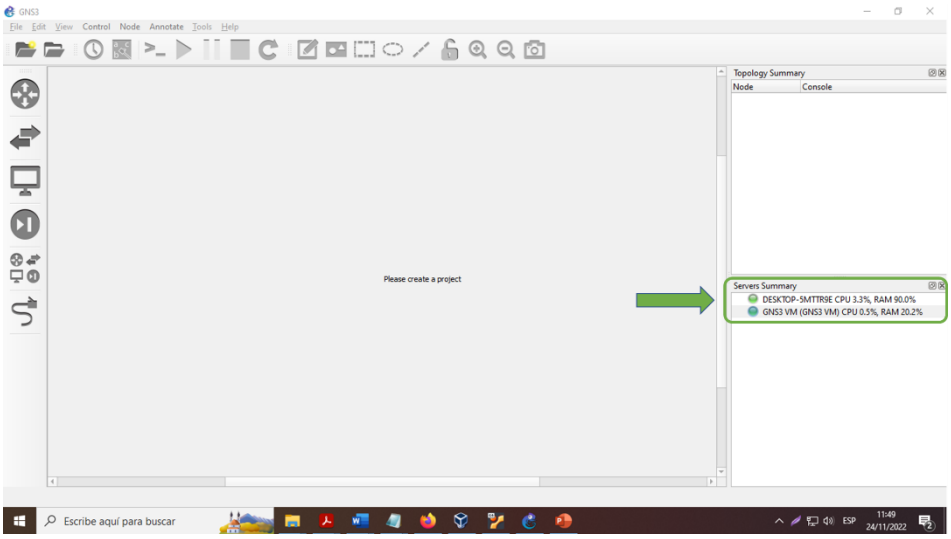
Se configura GNS3 para habilitar el servidor local, configurar los recursos a designar a la VM,

Figura 4. Configuración de VM en GNS3



Una vez hecho todo este proceso se puede observar en el área de trabajo que se tiene el ambiente local y el servidor, indicando que ya se encuentran sincronizados.

Figura 5. Ambiente local y servidor sincronizados en GNS3



Ahora se procede a instalar el router y switch de capa 2 en el servidor GNS3 que está corriendo en la VM de Virtual Box

Figura 6. Características del router instalado

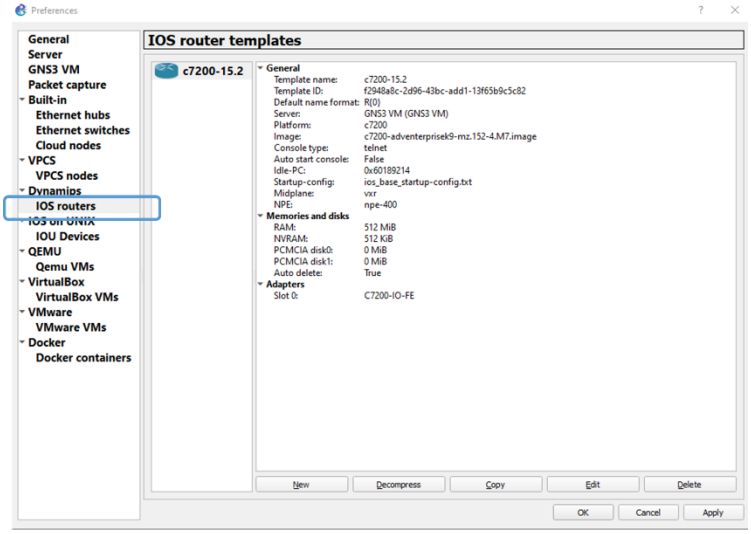
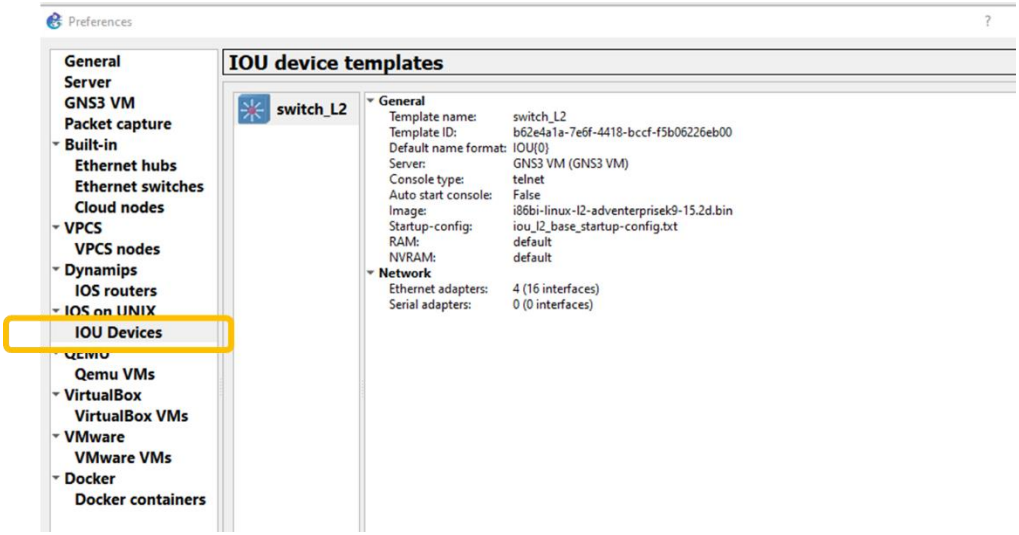


Figura 7. Características del switch instalado



Ya con todo listo se procede a desarrollar la siguiente topología

TOPOLOGÍA

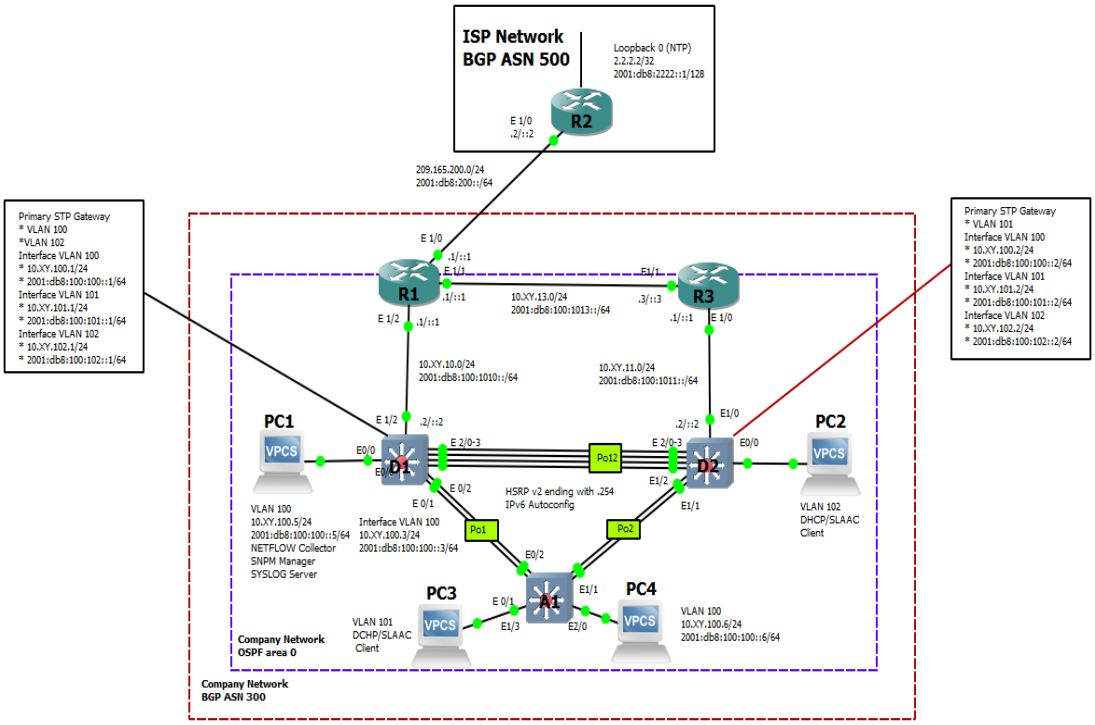


Tabla 1. Direccionamiento

Device	Interface	IPv4 Address	IPv6 Address	IPv6 Link-Local
R1	E1/0	209.165.200.225/27	2001:db8:200::1/64	fe80::1:1
	E1/2	10.91.10.1/24	2001:db8:100:1010::1/64	fe80::1:2
	E1/1	10. 91.13.1/24	2001:db8:100:1013::1/64	fe80::1:3
R2	E1/0	209.165.200.226/27	2001:db8:200::2/64	fe80::2:1
	Loopback0	2.2.2.2/32	2001:db8:2222::1/128	fe80::2:3
R3	E1/0	10. 91.11.1/24	2001:db8:100:1011::1/64	fe80::3:2
	E1/1	10. 91.13.3/24	2001:db8:100:1013::3/64	fe80::3:3
D1	E1/2	10. 91.10.2/24	2001:db8:100:1010::2/64	fe80::d1:1
	VLAN 100	10. 91.100.1/24	2001:db8:100:100::1/64	fe80::d1:2
	VLAN 101	10.91.101.1/24	2001:db8:100:101::1/64	fe80::d1:3
	VLAN 102	10.91.102.1/24	2001:db8:100:102::1/64	fe80::d1:4
D2	E1/0	10.91.11.2/24	2001:db8:100:1011::2/64	fe80::d2:1
	VLAN 100	10.91.100.2/24	2001:db8:100:100::2/64	fe80::d2:2
	VLAN 101	10.91.101.2/24	2001:db8:100:101::2/64	fe80::d2:3
	VLAN 102	10.91.102.2/24	2001:db8:100:102::2/64	fe80::d2:4
A1	VLAN 100	10.91.100.3/23	2001:db8:100:100::3/64	fe80::a1:1
PC1	NIC	10.91.100.5/24	2001:db8:100:100::5/64	EUI-64
PC2	NIC	DHCP	SLAAC	EUI-64
PC3	NIC	DHCP	SLAAC	EUI-64
PC4	NIC	10.91.100.6/24	2001:db8:100:100::6/64	EUI-64

OBJECTIVES

Part 1: Build the Network and Configure Basic Device Settings and Interface Addressing

Part 2: Configure the Layer 2 Network and Host Support

Part 3: Configure Routing Protocols

Part 4: Configure First-Hop Redundancy

BACKGROUND / SCENARIO

In this skills assessment, you are responsible for completing the configuration of the network so there is full end-to-end reachability, so the hosts have reliable default gateway support, and so that management protocols are operational within the “Company Network” part of the topology. Be careful to verify that your configurations meet the provided specifications and that the devices perform as required.

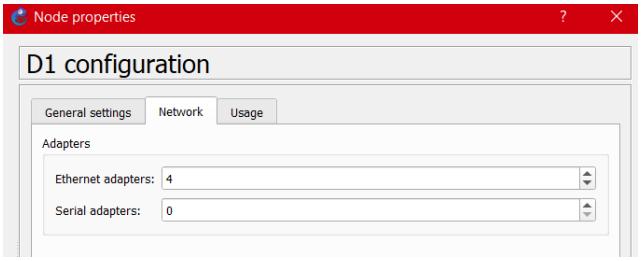
Note: The routers used with CCNP hands-on labs are Cisco 7200 routers. The switches used in the labs are Cisco Catalyst L2 switches Other routers, switches, and Cisco IOS versions can be used. Depending on the model and Cisco IOS version, the commands available and the output produced might vary from what is shown in the labs.

Note: Make sure that the switches have been erased and have no startup configurations. If you are unsure, contact your instructor.

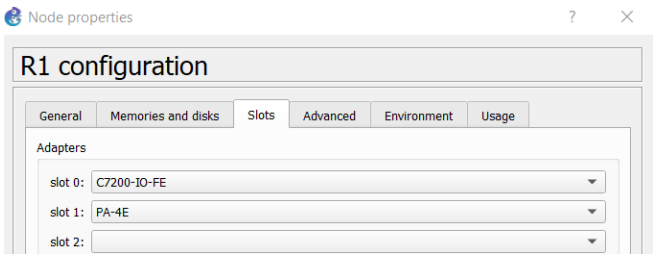
Note: The letters "X, Y" represent the last two digits of your ID number (cédula).

Required Resources

- 3 Routers (Cisco 7200). Click on the download link of the images for GNS3.
- 3 Switches (Cisco IOU L2). Click on the download link of the images for GNS3.
- 4 PCs (Use the GNS3’s VPCS)
- After the configuration of devices in GNS3, the Slots of the network adapters of the SW must be configured as follows:



And of the Routers like this:



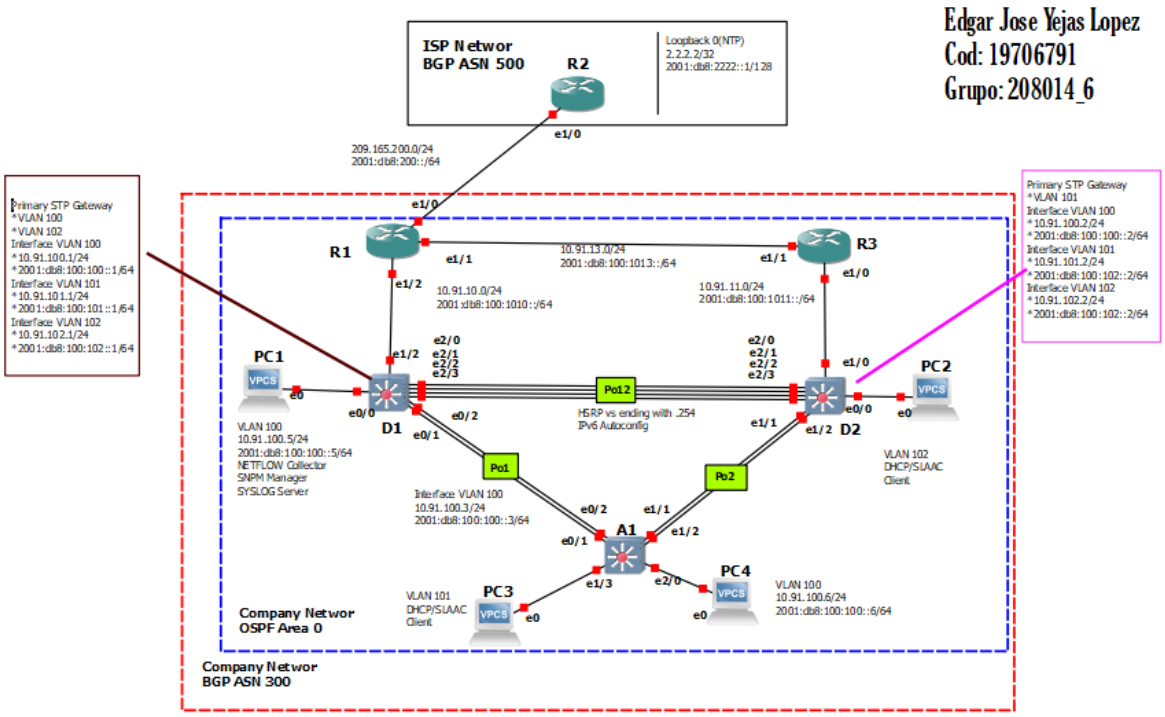
Build the Network and Configure Basic Device Settings and Interface Addressing

In Part 1, you will set up the network topology and configure basic settings and interface addressing.

Cable the network as shown in the topology.

Attach the devices as shown in the topology diagram, and cable as necessary.

Figura 8. Pantallazo Escenario propio



CONFIGURE BASIC SETTINGS FOR EACH DEVICE.

a. Console into each device, enter global configuration mode, and apply the basic settings. The startup configurations for each device are provided below.

Router R1

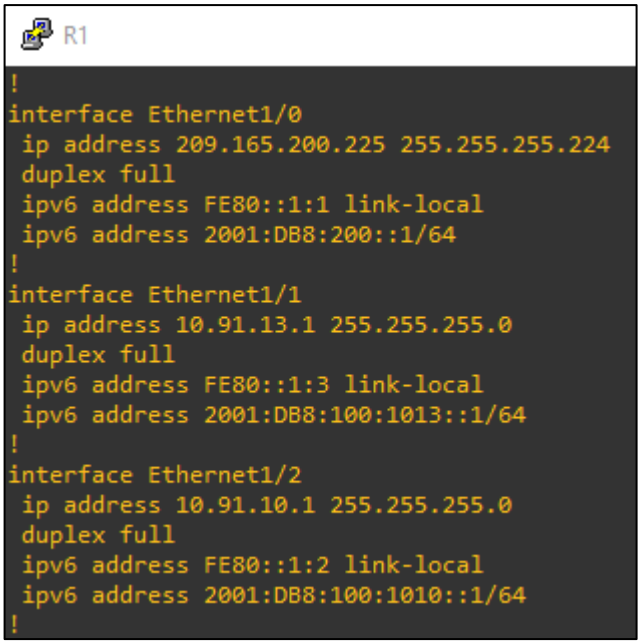
enable

configure terminal

hostname R1

```
ipv6 unicast-routing
no ip domain lookup
banner motd # R1, ENCOR Skills Assessment#
line con 0
exec-timeout 0 0
logging synchronous
exit
interface e1/0
ip address 209.165.200.225 255.255.255.224
ipv6 address fe80::1:1 link-local
ipv6 address 2001:db8:200::1/64
no shutdown
exit
interface e1/2
ip address 10.91.10.1 255.255.255.0
ipv6 address fe80::1:2 link-local
ipv6 address 2001:db8:100:1010::1/64
no shutdown
exit
interface e1/1
ip address 10.91.13.1 255.255.255.0
ipv6 address fe80::1:3 link-local
ipv6 address 2001:db8:100:1013::1/64
no shutdown
exit
```

Figura 9. configuración del router R1

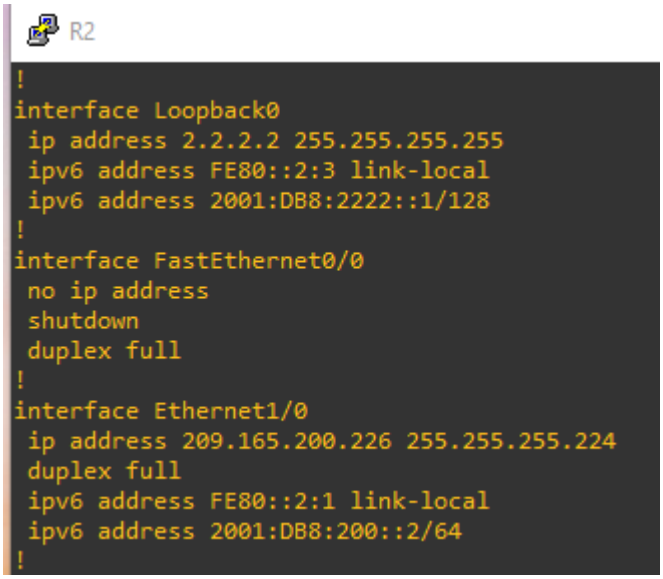


Router R2

enable
config t
hostname R2
ipv6 unicast-routing
no ip domain lookup
banner motd # R2, ENCOR Skills Assessment#
line con 0
exec-timeout 0 0
logging synchronous
exit
interface e1/0
ip address 209.165.200.226 255.255.255.224
ipv6 address fe80::2:1 link-local
ipv6 address 2001:db8:200::2/64
no shutdown
exit
interface Loopback 0
ip address 2.2.2.2 255.255.255.255
ipv6 address fe80::2:3 link-local

ipv6 address 2001:db8:2222::1/128
no shutdown
exit

Figura 10. Configuración del router R2

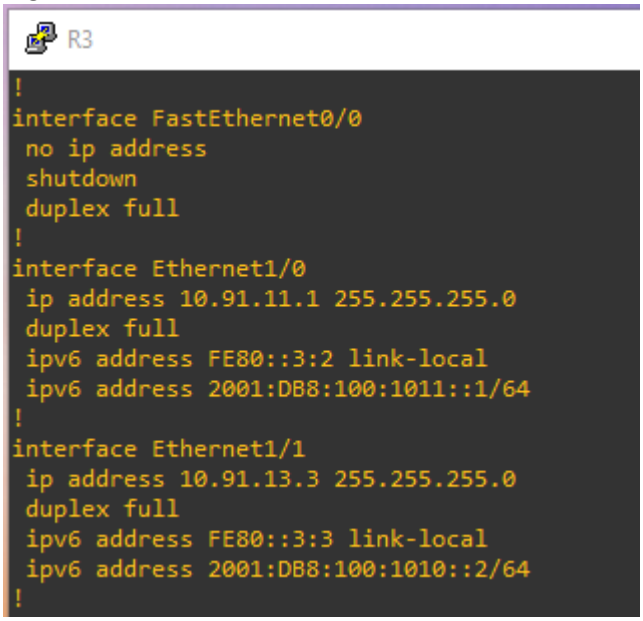


Router R3

Enable
Config t
hostname R3
ipv6 unicast-routing
no ip domain lookup
banner motd # R3, ENCOR Skills Assessment#
line con 0
exec-timeout 0 0
logging synchronous
exit
interface e1/0
ip address 10.91.11.1 255.255.255.0
ipv6 address fe80::3:2 link-local
ipv6 address 2001:db8:100:1011::1/64
no shutdown
exit

interface e1/1
ip address 10.91.13.3 255.255.255.0
ipv6 address fe80::3:3 link-local
ipv6 address 2001:db8:100:1010::2/64
no shutdown
exit

Figura 11. Configuración del router R3



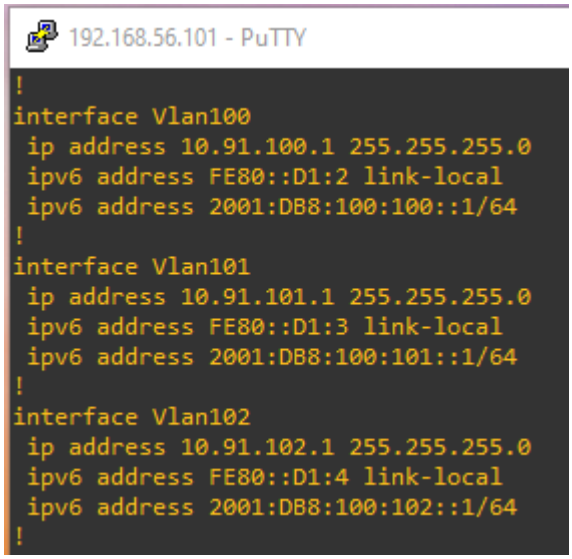
Switch D1

Enable
Config t
hostname D1
ip routing
ipv6 unicast-routing
no ip domain lookup
banner motd # D1, ENCOR Skills Assessment#
line con 0
exec-timeout 0 0
logging synchronous
exit
vlan 100

```
name Management
exit
vlan 101
name UserGroupA
exit
vlan 102
name UserGroupB
exit
vlan 999
name NATIVE
exit
interface e1/2
no switchport
ip address 10.91.10.2 255.255.255.0
ipv6 address fe80::d1:1 link-local
ipv6 address 2001:db8:100:1010::2/64
no shutdown
exit
interface vlan 100
ip address 10.91.100.1 255.255.255.0
ipv6 address fe80::d1:2 link-local
ipv6 address 2001:db8:100:100::1/64
no shutdown
exit
interface vlan 101
ip address 10.91.101.1 255.255.255.0
ipv6 address fe80::d1:3 link-local
ipv6 address 2001:db8:100:101::1/64
no shutdown
exit
interface vlan 102
ip address 10.91.102.1 255.255.255.0
ipv6 address fe80::d1:4 link-local
ipv6 address 2001:db8:100:102::1/64
no shutdown
exit
ip dhcp excluded-address 10.91.101.1 10.91.101.109
```

ip dhcp excluded-address 10.91.101.141 10.91.101.254
ip dhcp excluded-address 10.91.102.1 10.91.102.109
ip dhcp excluded-address 10.91.102.141 91.0.102.254
ip dhcp pool VLAN-101
network 10.91.101.0 255.255.255.0
default-router 10.91.101.254
exit
ip dhcp pool VLAN-102
network 10.91.102.0 255.255.255.0
default-router 10.91.102.254
exit
interface range e0/0-3,e1/0-1,e1/3,e2/0-3,e3/0-3
shutdown
exit

Figura 12. Configuración del switch D1



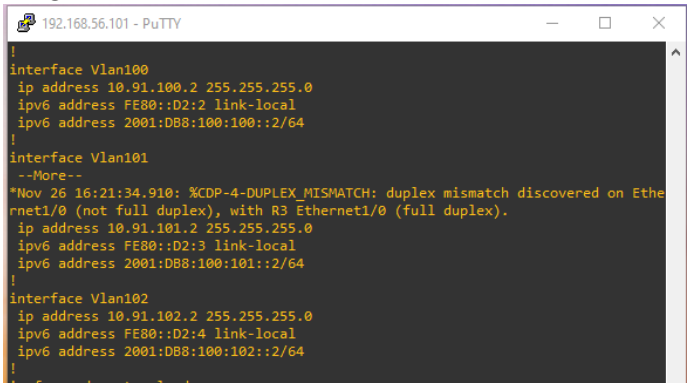
Switch D2

Enable
Config t
hostname D2
ip routing
ipv6 unicast-routing

```
no ip domain lookup
banner motd # D2, ENCOR Skills Assessment#
line con 0
exec-timeout 0 0
logging synchronous
exit
vlan 100
name Management
exit
vlan 101
name UserGroupA
exit
vlan 102
name UserGroupB
exit
vlan 999
name NATIVE
exit
interface e1/0
no switchport
ip address 10.91.11.2 255.255.255.0
ipv6 address fe80::d1:1 link-local
ipv6 address 2001:db8:100:1011::2/64
no shutdown
exit
interface vlan 100
ip address 10.91.100.2 255.255.255.0
ipv6 address fe80::d2:2 link-local
ipv6 address 2001:db8:100:100::2/64
no shutdown
exit
interface vlan 101
ip address 10.91.101.2 255.255.255.0
ipv6 address fe80::d2:3 link-local
ipv6 address 2001:db8:100:101::2/64
no shutdown
exit
```

interface vlan 102
ip address 10.91.102.2 255.255.255.0
ipv6 address fe80::d2:4 link-local
ipv6 address 2001:db8:100:102::2/64
no shutdown
exit
ip dhcp excluded-address 10.91.101.1 10.91.101.209
ip dhcp excluded-address 10.91.101.241 10.91.101.254
ip dhcp excluded-address 10.91.102.1 10.91.102.209
ip dhcp excluded-address 10.91.102.241 10.91.102.254
ip dhcp pool VLAN-101
network 10.91.101.0 255.255.255.0
default-router 91.0.101.254
exit
ip dhcp pool VLAN-102
network 10.91.102.0 255.255.255.0
default-router 10.91.102.254
exit
interface range e0/0-3,e1/1-3,e2/0-3,e3/0-3
shutdown
exit

Figura 13. Configuración del switch D1

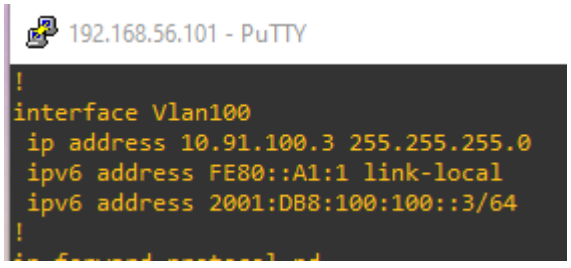


Switch A1

Enable
Config t

```
hostname A1
no ip domain lookup
banner motd # A1, ENCOR Skills Assessment#
line con 0
exec-timeout 0 0
logging synchronous
exit
vlan 100
name Management
exit
vlan 101
name UserGroupA
exit
vlan 102
name UserGroupB
exit
vlan 999
name NATIVE
exit
interface vlan 100
ip address 10.91.100.3 255.255.255.0
ipv6 address fe80::a1:1 link-local
ipv6 address 2001:db8:100:100::3/64
no shutdown
exit
interface range e0/0,e0/3,e1/0,e2/1-3,e3/0-3
shutdown
exit
```

Figura 14. Configuración del switch A1



b. Save the running configuration to startup-config on all devices.

copy running-config startup-config

c. Configure PC 1 and PC 4 host addressing as shown in the addressing table. Assign a default gateway address of 10.91.100.254 which will be the HSRP virtual IP address used in Part 4.

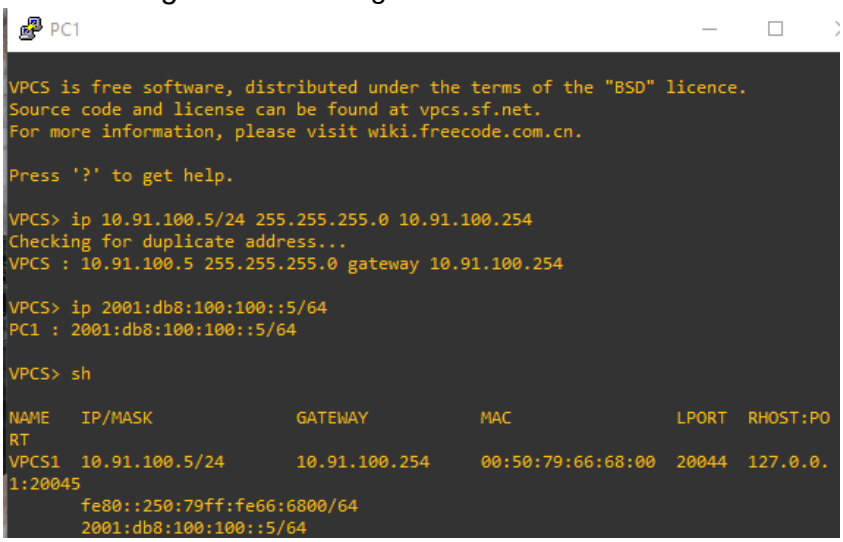
PC1>

PC1> ip 10.91.100.5/24 255.255.255.0 10.91.100.254

ip 2001:db8:100:100::5/64

sh

Figura 15. Configuración de PC1



PC4>

PC4> ip 10.91.100.6/24 255.255.255.0 10.91.100.254

PC4> ip 2001:db8:100:100::6/64

PC4> sh

Figura 16. Configuración de PC4

```
VPCS>
VPCS> ip 10.91.100.6/24 255.255.255.0 10.91.100.254
Checking for duplicate address...
VPCS : 10.91.100.6 255.255.255.0 gateway 10.91.100.254

VPCS> ip 2001:db8:100:100::6/64
PC1 : 2001:db8:100:100::6/64

VPCS> sh

NAME   IP/MASK              GATEWAY           MAC                LPORT  RHOST:PO
RT
VPCS1  10.91.100.6/24       10.91.100.254     00:50:79:66:68:03  20050  127.0.0.
1:20051
       fe80::250:79ff:fe66:6803/64
       2001:db8:100:100::6/64
```

Configure the Layer 2 Network and Host Support

In this part of the Skills Assessment, you will complete the Layer 2 network configuration and set up basic host support. At the end of this part, all the switches should be able to communicate. PC2 and PC3 should receive addressing from DHCP and SLAAC.

PC3> ip auto

GLOBAL SCOPE : 2001:db8:100:101:2050:79ff:fe66:6802/64

ROUTER LINK-LAYER : 00:05:73:a0:00:74

PC2> ip auto

GLOBAL SCOPE : 2001:db8:100:102:2050:79ff:fe66:6801/64

ROUTER LINK-LAYER : 00:05:73:a0:00:6a

Figura 17. Configuración de PC3

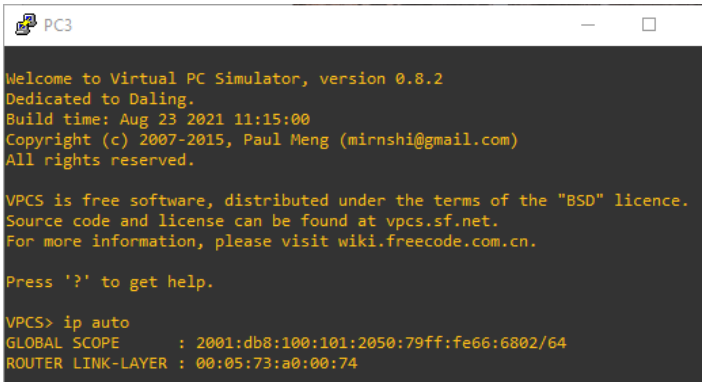


Figura 18. Configuración de PC2

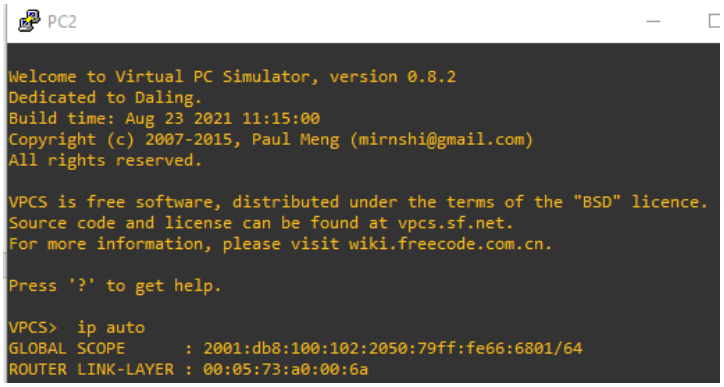


Tabla 2. Tareas

Task#	Task	Specification	Points
2.1	On all switches, configure IEEE 802.1Q trunk interfaces on interconnecting switch links	Enable 802.1Q trunk links between: • D1 and D2 • D1 and A1 • D2 and A1	6
2.2	On all switches, change the native VLAN on trunk links.	Use VLAN 999 as the native VLAN.	6
2.3	On all switches, enable the Rapid Spanning-Tree Protocol.	Use Rapid Spanning Tree.	3
2.4	On D1 and D2, configure the appropriate RSTP root bridges based on the information in the topology diagram. D1 and D2 must provide backup in case of root bridge failure.	Configure D1 and D2 as root for the appropriate VLANs with mutually supporting priorities in case of switch failure.	2
2.5	On all switches, create LACP EtherChannels as shown in the topology diagram.	Use the following channel numbers: • D1 to D2 – Port channel 12 • D1 to A1 – Port channel 1 • D2 to A1 – Port channel 2	3

Task#	Task	Specification	Points
2.6	On all switches, configure host access ports connecting to PC1, PC2, PC3, and PC4.	Configure access ports with appropriate VLAN settings as shown in the topology diagram. Host ports should transition immediately to forwarding state.	4
2.7	Verify IPv4 DHCP services.	PC2 and PC3 are DHCP clients and should be receiving valid IPv4 addresses.	1
2.8	Verify local LAN connectivity.	PC1 should successfully ping: • D1: 10.91.100.1 • D2: 10.91.100.2 • PC4: 10.91.100.6 PC2 should successfully ping: • D1: 10.91.102.1 • D2: 10.91.102.2 PC3 should successfully ping: • D1: 10.91.101.1 • D2: 10.91.101.2 PC4 should successfully ping: • D1: 10.91.100.1 • D2: 10.91.100.2 • PC1: 10.91.100.5	1

COMPROBACIÓN DE LA TABLA TASK # 2.1 – 2.8

Al realizar las pertinentes investigaciones y consultas en el libro, se logra la configuración y así las respectivas soluciones de los ítems mencionados en la tabla anterior:

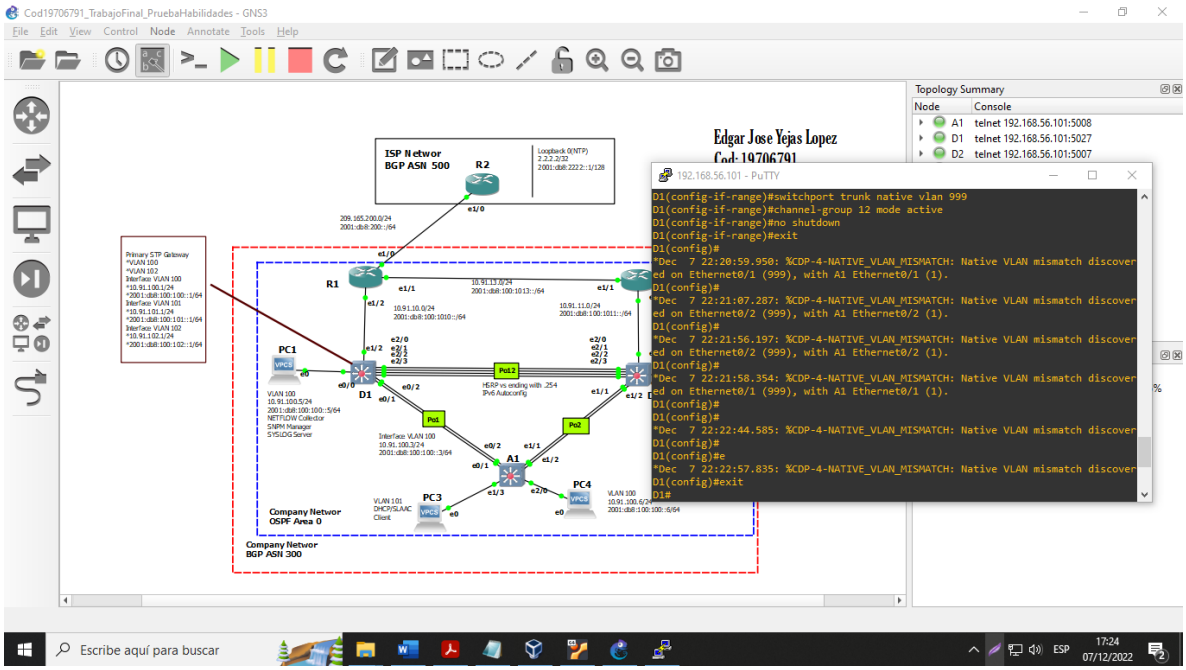
Switch D1

Configuración en D1 a D2 - Port channel 12

Enable
Config t
interface ethernet1/2
duplex full

interface range ethernet2/0-3
switchport trunk encapsulation dot1q
switchport mode trunk
switchport trunk native vlan 999
channel-group 12 mode active
no shutdown
exit

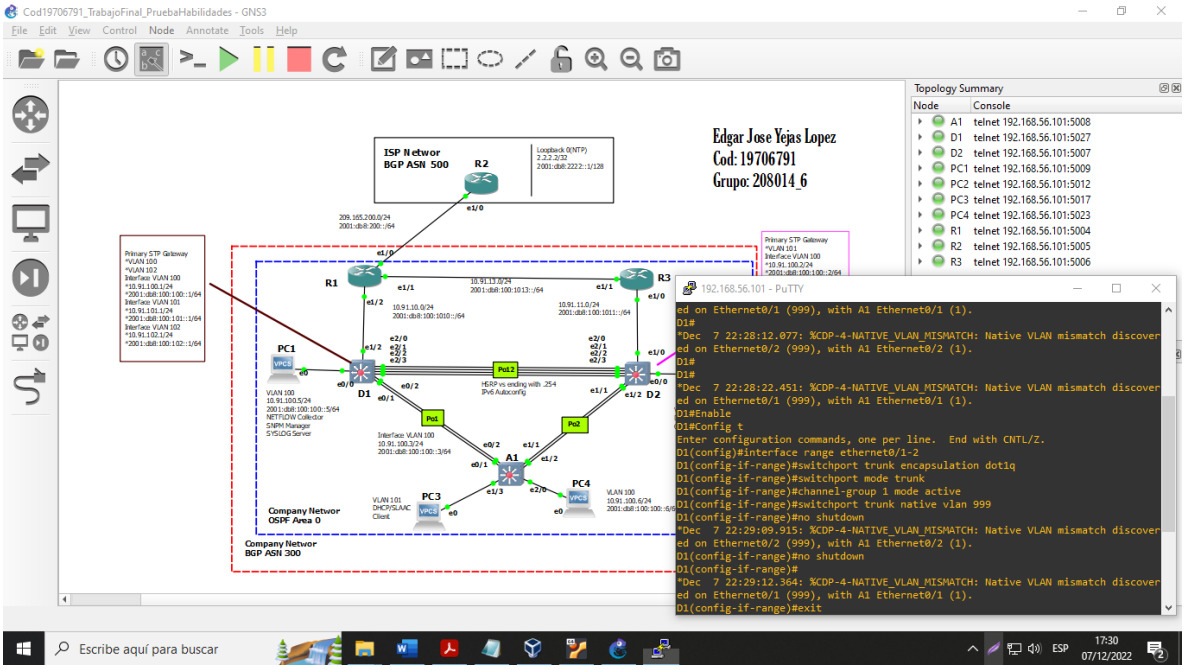
Figura 19. Configuración en D1 a D2 - Port channel 12



Configuración en D1 a D2 - Port channel 1

Enable
Config t
interface range ethernet0/1-2
switchport trunk encapsulation dot1q
switchport mode trunk
channel-group 1 mode active
switchport trunk native vlan 999
no shutdown
exit

Figura 20. Configuración en D1 a D2 - Port channel 1

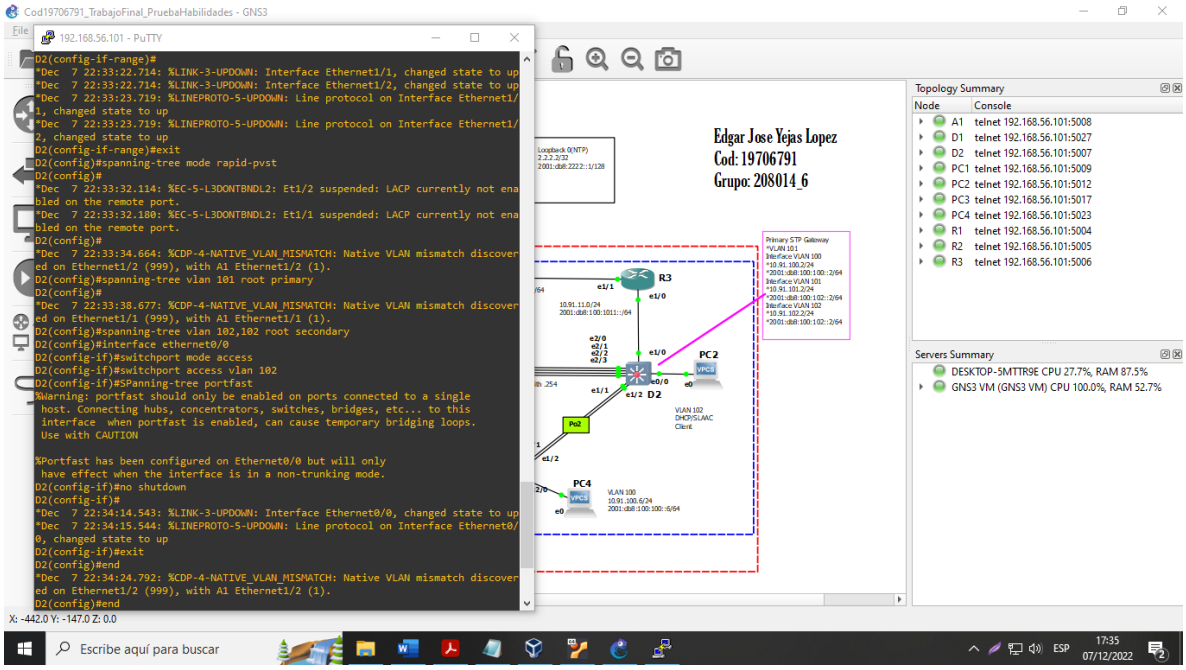


Switch D2

Enable
Config t
interface ethernet1/0
duplex full
interface range ethernet2/0-3
switchport trunk encapsulation dot1q
switchport mode trunk
channel-group 12 mode active
switchport trunk native vlan 999
no shutdown
exit
interface range ethernet1/1-2
switchport trunk encapsulation dot1q
switchport mode trunk
channel-group 2 mode active
switchport trunk native vlan 999
no shutdown
exit

```
spanning-tree mode rapid-pvst
spanning-tree vlan 101 root primary
spanning-tree vlan 102,102 root secondary
interface ethernet0/0
switchport mode access
switchport access vlan 102
SPanning-tree portfast
no shutdown
exit
end
```

Figura 21. A1 a D1 – Port channel 1, y de A1 a D2 – Port channel 2

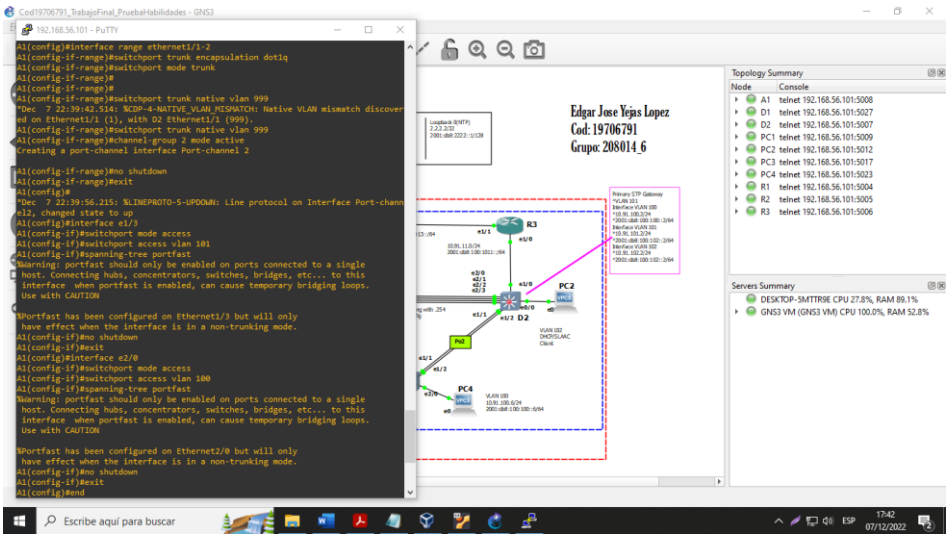


Switch A1

Enable
Config t
spanning-tree mode rapid-pvst
interface range ethernet0/1-2
switchport trunk encapsulation dot1q
switchport mode trunk
switchport trunk native vlan 999
channel-group 1 mode active
no shutdown
exit
interface range ethernet1/1-2
switchport trunk encapsulation dot1q
switchport mode trunk
switchport trunk native vlan 999
channel-group 2 mode active
no shutdown
exit
interface e1/3

switchport mode access
switchport access vlan 101
spanning-tree portfast
no shutdown
exit
interface e2/0
switchport mode access
switchport access vlan 100
spanning-tree portfast
no shutdown
exit
end

Figura 22. A1 de spanning-tree, VLAN, trunk, Port Channel 1 y 2



Con los comandos suministrados anteriormente se pueden configurar correctamente cada dispositivo con los requerimientos de la guía, los cuales se muestran con sus respectivas imágenes, todo ello para configurar todos los switchs, las interfaces troncales IEEE 802.1Q en los enlaces de conmutador de interconexión, se cambió la VLAN nativa en los enlaces troncales, se habilitó el protocolo Rapid Spanning-Tree, se configuró los puentes raíz RSTP apropiados según la información del diagrama de la topología, en todos los switches, se creó la LACP EtherChannels como se muestra en el diagrama de topología, así mismo se configuró los puertos de acceso de host que se conectan a PC1, PC2, PC3 y PC4.

CONFIGURACIONES Y VERIFICACIONES

Figura 23. Configuración PC1

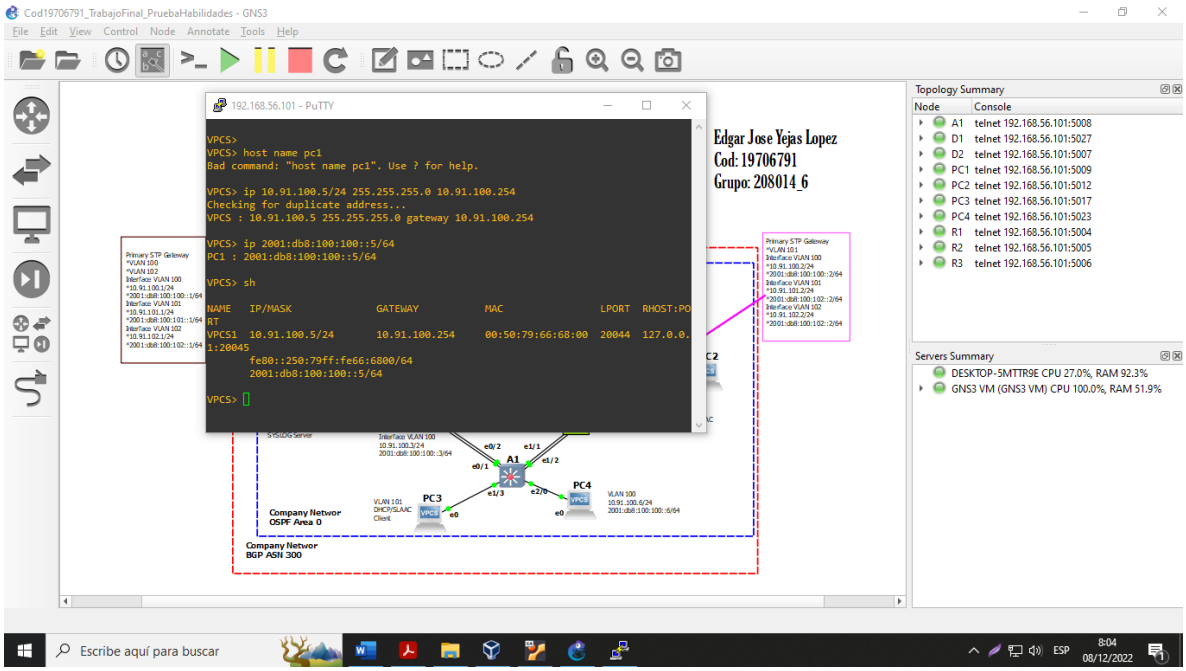


Figura 24. Verificación en D1 spanning-tree, VLAN, trunk, Port Channel

```
D1#show interface trunk

Port        Mode             Encapsulation  Status        Native vlan
Po1         on               802.1q         trunking      999
Po12        on               802.1q         trunking      999

Port        Vlans allowed on trunk
Po1         1-4094
Po12        1-4094

Port        Vlans allowed and active in management domain
Po1         1,100-102,999
Po12        1,100-102,999

Port        Vlans in spanning tree forwarding state and not pruned
Po1         1,100-102,999
Po12        1,100-102,999
D1#
```

Figura 25. Verificación en A1 spanning-tree, VLAN, trunk, Port Channel

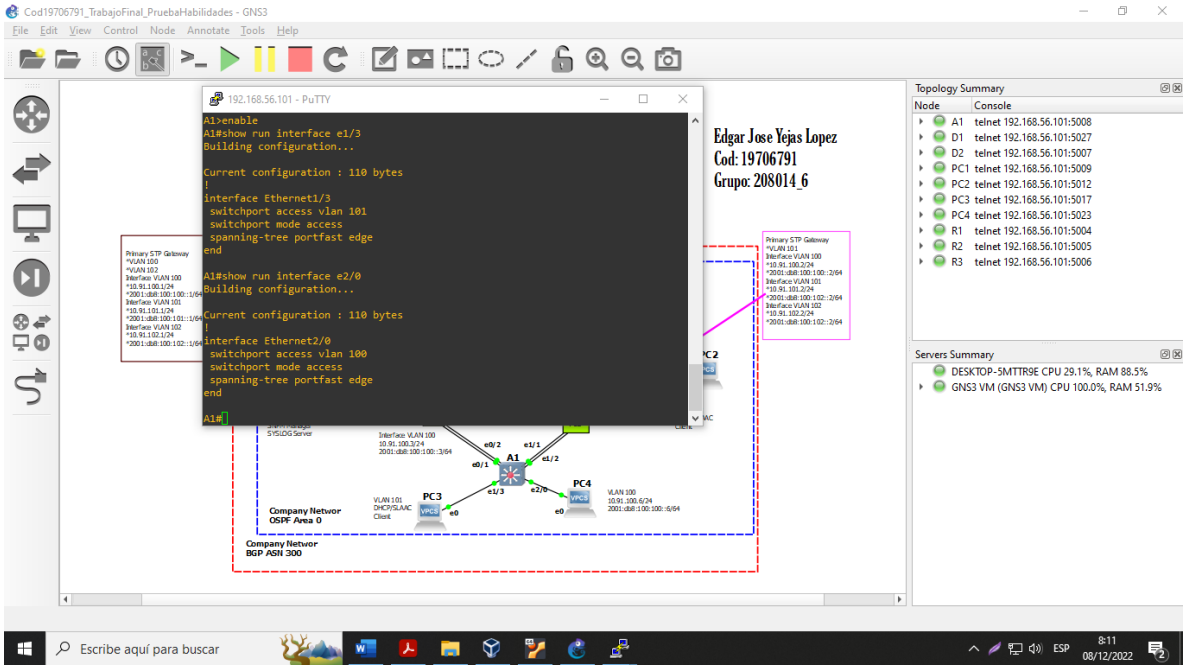


Figura 26. Verificación en A1, D1 y D2 (Spanning-tree)

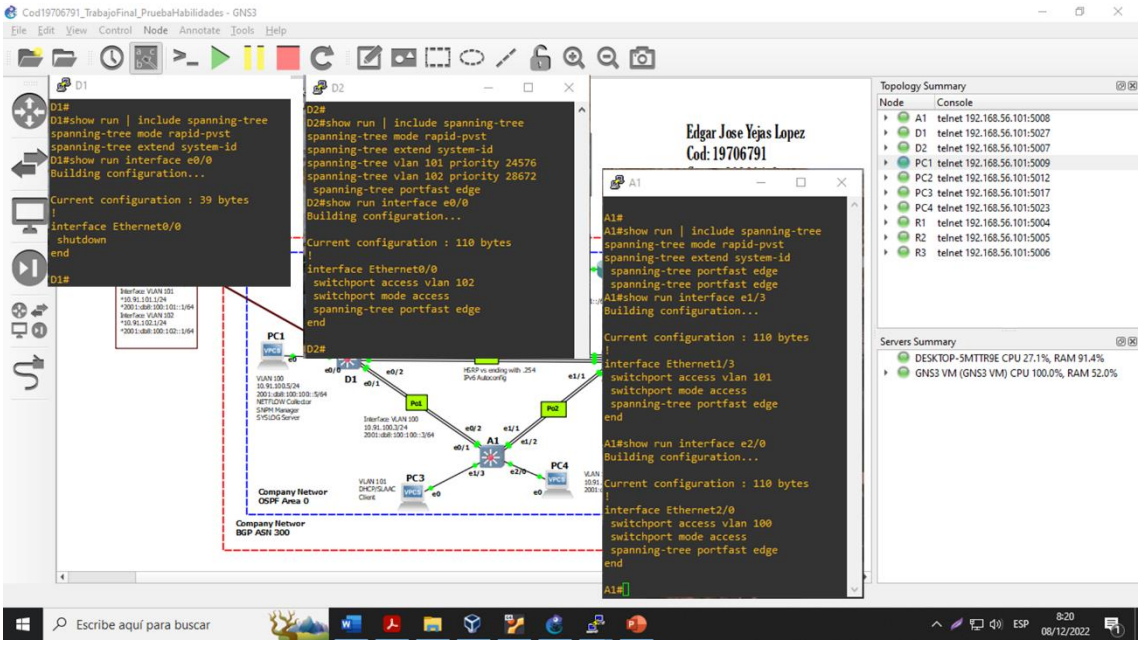
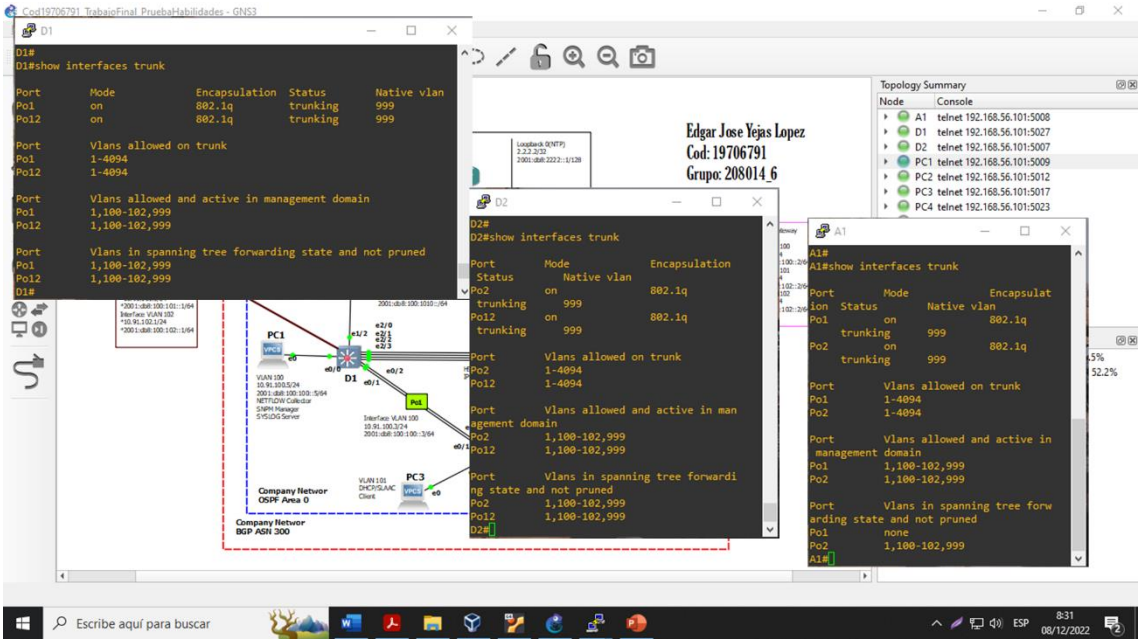


Figura 27. Verificación en A1, D1 y D2 (Interfaces Trunk)



COMANDOS UTILIZADOS EN LA COMPROBACIÓN.

2.1 On all switches, configure IEEE 802.1Q trunk interfaces on interconnecting switch links

interface range ethernet2/0-3
switchport trunk encapsulation dot1q
switchport mode trunk

2.2 On all switches, change the native VLAN on trunk links.

switchport trunk native vlan 999

2.3 On all switches, enable the Rapid Spanning-Tree Protocol.

spanning-tree mode rapid-pvst

2.4 On D1 and D2, configure the appropriate RSTP root bridges based on the information in the topology diagram.

D1

spanning-tree vlan 100,102 root primary

spanning-tree vlan 101 root secondary

D2

spanning-tree vlan 101 root primary
spanning-tree vlan 100,102 root secondary
D2#show run | include spanning-tree
spanning-tree mode rapid-pvst
spanning-tree extend system-id
spanning-tree vlan 100,102 priority 28672
spanning-tree vlan 101 priority 24576
spanning-tree portfast edge

2.5 On all switches, create LACP EtherChannels as shown in the topology diagram.

D1

interface range ethernet2/0-3
channel-group 12 mode active
no shutdown
interface range ethernet0/1-2
channel-group 1 mode active
no shutdown

D2

interface range ethernet2/0-3
channel-group 12 mode active
no shutdown
interface range ethernet1/1-2
channel-group 2 mode active
no shutdown

A1

interface range ethernet0/1-2
channel-group 1 mode active
no shutdown
interface range ethernet1/1-2
channel-group 2 mode active
no shutdown

2.6 On all switches, configure host access ports connecting to PC1, PC2, PC3, and PC4.

D1

```
interface ethernet0/0
switchport mode access
switchport access vlan 100
spanning-tree portfast
no shutdown
```

D2

```
interface ethernet0/0
switchport mode access
switchport access vlan 102
spanning-tree portfast
no shutdown
```

A1

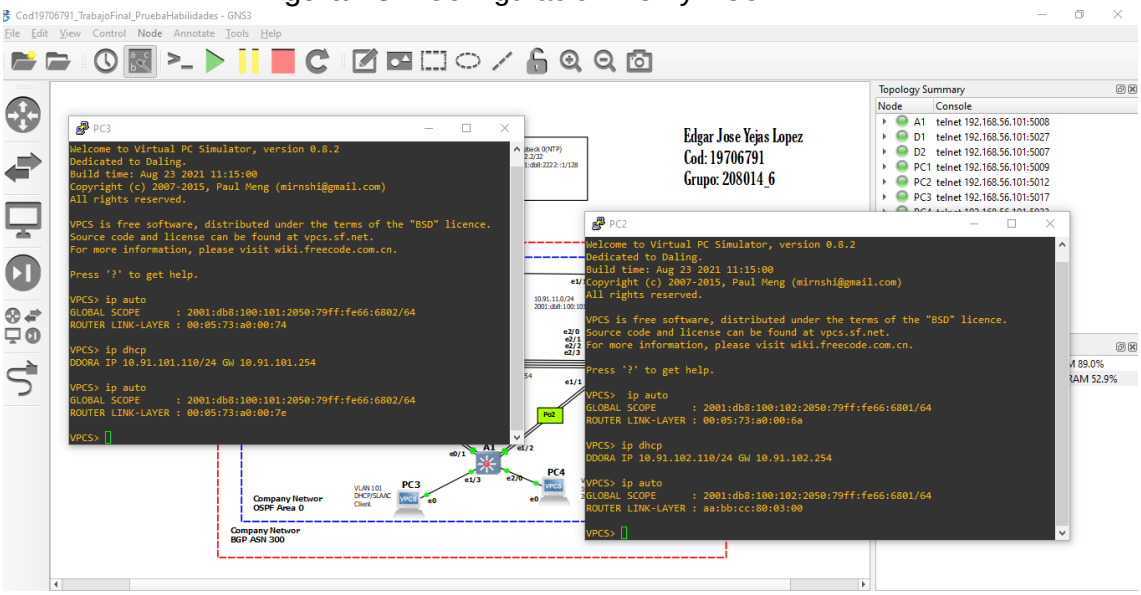
```
interface ethernet2/0
switchport mode access
switchport access vlan 100
spanning-tree portfast
no shutdown
interface ethernet1/3
switchport mode access
switchport access vlan 101
spanning-tree portfast
no shutdown
```

2.7 PC2 and PC3 are DHCP clients and should be receiving valid IPv4 addresses.

```
PC2> ip dhcp
DDORA IP 10.91.102.110/24 GW 10.91.102.254
PC2> ip auto
GLOBAL SCOPE      : 2001:db8:100:102:2050:79ff:fe66:6801/64
ROUTER LINK-LAYER : aa:bb:cc:80:03:00
```

PC3> ip dhcp
DDORA IP 10.91.101.210/24 GW 10.91.101.254
PC3> ip auto
GLOBAL SCOPE : 2001:db8:100:101:2050:79ff:fe66:6802/64
ROUTER LINK-LAYER : 00:05:73:a0:00:7e

Figura 28. Configuración PC2 y PC3



2.8 Verify local LAN connectivity.

PC1> ping 10.91.100.1
PC1> ping 10.91.100.2
PC1> ping 10.91.100.6

PC4> ping 10.91.100.1
PC4> ping 10.91.100.2
PC4> ping 10.91.100.5

3.1 On the “Company Network” (i.e., R1, R3, D1, and D2), configure single-area OSPFv2 in area 0.

Use OSPF Process ID 4 and assign the following router-IDs:

- R1: 0.0.4.1

R1(config)#router ospf 4
R1(config-router)#router-id 0.0.4.1

- R3: 0.0.4.3

  R3(config)#router ospf 4
  R3(config-router)#router-id 0.0.4.3

- D1: 0.0.4.131

  router ospf 4
  router-id 0.0.4.131

- D2: 0.0.4.132

  D2(config)#router ospf 4
  D2(config-router)#router-id 0.0.4.132

On R1, R3, D1, and D2, advertise all directly connected networks / VLANs in Area 0.

R1(config-router)#network 10.91.10.0 0.0.0.255 area 0
R1(config-router)#network 10.91.13.0 0.0.0.255 area 0

R3(config-router)#network 10.91.11.0 0.0.0.255 area 0
R3(config-router)#network 10.91.13.0 0.0.0.255 area 0

D1(config-router)#network 10.91.100.0 0.0.0.255 area 0
D1(config-router)#network 10.91.101.0 0.0.0.255 area 0
D1(config-router)#network 10.91.102.0 0.0.0.255 area 0
D1(config-router)#network 10.91.10.0 0.0.0.255 area 0

D2(config-router)#network 10.91.100.0 0.0.0.255 area 0
D2(config-router)#network 10.91.101.0 0.0.0.255 area 0
D2(config-router)#network 10.91.102.0 0.0.0.255 area 0
D2(config-router)#network 10.91.11.0 0.0.0.255 area 0

- On R1, do not advertise the R1 – R2 network.

  R1(config-router)#default-information originate

- On R1, propagate a default route. Note that the default route will be provided by BGP.

  D1(config-router)#passive-interface default

```
D1(config-router)#no passive-interface e1/2

D2(config-router)#passive-interface default
D2(config-router)#no passive-interface e1/0
```

3.2 On the "Company Network" (i.e., R1, R3, D1, and D2), configure classic single-area OSPFv3 in area 0.

Use OSPF Process ID 6 and assign the following router-IDs:

```
R1(config)#ipv6 router ospf 6
D2(config)#ipv6 router ospf 6
R3(config)#ipv6 router ospf 6
D1(config)#ipv6 router ospf 6
```

- R1: 0.0.6.1

```
R1(config-rtr)#router-id 0.0.6.1
```

- R3: 0.0.6.3

```
R3(config-rtr)#router-id 0.0.6.3
```

- D1: 0.0.6.131

```
D1(config-rtr)#router-id 0.0.6.131
```

- D2: 0.0.6.132

```
D2(config-rtr)#router-id 0.0.6.132
```

On R1, R3, D1, and D2, advertise all directly connected networks / VLANs in Area 0.

```
R1(config)#interface e1/1
R1(config-if)#ipv6 ospf 6 area 0
R1(config-if)#exit
R1(config)#interface e1/2
R1(config-if)#ipv6 ospf 6 area 0

R3(config)#interface e1/1
R3(config-if)#ipv6 ospf 6 area 0
R3(config-if)#exit
R3(config)#interface e1/0
```

```
R3(config-if)#ipv6 ospf 6 area 0

D1(config)#interface e1/2
D1(config-if)#ipv6 ospf 6 area 0
D1(config-if)#exit
D1(config)#interface vlan 100
D1(config-if)#ipv6 ospf 6 area 0
D1(config-if)#exit
D1(config)#interface vlan 101
D1(config-if)#ipv6 ospf 6 area 0
D1(config-if)#exit
D1(config)#interface vlan 102
D1(config-if)#ipv6 ospf 6 area 0

D2(config)#interface e1/0
D2(config-if)#ipv6 ospf 6 area 0
D2(config-if)#exit
D2(config)#interface vlan 100
D2(config-if)#ipv6 ospf 6 area 0
D2(config-if)#exit
D2(config)#interface vlan 101
D2(config-if)#ipv6 ospf 6 area 0
D2(config-if)#exit
D2(config)#interface vlan 102
D2(config-if)#ipv6 ospf 6 area 0
```

Disable OSPFv3 advertisements on:

- D1: All interfaces except E1/2

```
D1(config-router)#passive-interface default
D1(config-router)#no passive-interface e1/2
```

- D2: All interfaces except E1/0

```
D2(config-rtr)#passive-interface default
```

D2(config-rtr)#no passive-interface e1/0

3.3 On R2 in the “ISP Network”, configure MP-BGP.

Configure two default static routes via interface Loopback 0:

- An IPv4 default static route.

  R2(config)#ip route 0.0.0.0 0.0.0.0 loopback 0

- An IPv6 default static route.

  R2(config)#ipv6 route ::/0 loopback 0

Configure R2 in BGP ASN **500** and use the router-id 2.2.2.2.

R2(config)#router bgp 500

R2(config-router)#bgp router-id 2.2.2.2

Configure and enable an IPv4 and IPv6 neighbor relationship with R1 in ASN 300.

R2(config-router)#neighbor 209.165.200.225 remote-as 300

R2(config-router)#neighbor 2001:db8:200::1 remote-as 300

In IPv4 address family, advertise:

R2(config-router)#address-family ipv4

R2(config-router-af)#neighbor 209.165.200.225 activate

R2(config-router-af)#no neighbor 2001:db8:200::1 activate

- The Loopback 0 IPv4 network (/32).

  R2(config-router-af)#network 2.2.2.2 mask 255.255.255.255

- The default route (0.0.0.0/0).

  R2(config-router-af)#network 0.0.0.0

In IPv6 address family, advertise:

R2(config-router)#address-family ipv6
R2(config-router-af)#no neighbor 209.165.200.225 activate
R2(config-router-af)#neighbor 2001:db8:200::1 activate

- The Loopback 0 IPv4 network (/128).

  R2(config-router-af)#network 2001:db8:2222::1/128

- The default route (::/0).

  R2(config-router-af)#network ::/0

3.4 On R1 in the “ISP Network”, configure MP-BGP.

Configure two static summary routes to interface Null 0:

- A summary IPv4 route for 10.91.0.0/8.

R1(config)#ip route 10.91.0.0 255.255.0.0 null0

- A summary IPv6 route for 2001:db8:100::/48.
  R1(config)#ipv6 route 2001:db8:100::/48 null0

Configure R1 in BGP ASN **300** and use the router-id 1.1.1.1.

R1(config)#router bgp 300

R1(config-router)#bgp router-id 1.1.1.1

Configure an IPv4 and IPv6 neighbor relationship with R2 in ASN 500.

R1(config-router)#neighbor 209.165.200.226 remote-as 500

R1(config-router)#neighbor 2001:db8:200::2 remote-as 500

In IPv4 address family:

R1(config-router)#address-family ipv4 unicast

- Disable the IPv6 neighbor relationship.
  R1(config-router-af)#neighbor 209.165.200.226 activate

- Enable the IPv4 neighbor relationship.
  R1(config-router-af)#no neighbor 2001:db8:200::2 activate
- Advertise the 10.91.0.0/8 network.
  R1(config-router-af)#network 10.91.0.0 mask 255.255.0.0

In IPv6 address family:

R1(config-router)#address-family ipv6 unicast

- Disable the IPv4 neighbor relationship.
  R1(config-router-af)#no neighbor 209.165.200.226 activate

- Enable the IPv6 neighbor relationship.
  R1(config-router-af)#neighbor 2001:db8:200::2 activate

- Advertise the 2001:db8:100::/48 network.
  R1(config-router-af)#network 2001:db8:100::/48

Configure First Hop Redundancy

4.1 On D1, create IP SLAs that test the reachability of R1 interface E1/2.

Create two IP SLAs.

- Use SLA number **4** for IPv4.
  ip SLA 4

- Use SLA number **6** for IPv6.
  ip SLA 6

The IP SLAs will test availability of R1 E1/2 interface every 5 seconds.

```
icmp-echo 10.91.10.1
frequency 5
icmp-echo 2001:db8:100:1010::1
frequency 5
```

Schedule the SLA for immediate implementation with no end time.

```
D1(config)#ip sla schedule 4 life forever start-time now
D1(config)#ip sla schedule 6 life forever start-time now
```

D1(config)#ip sla schedule 6 life forever start-time now

Create an IP SLA object for IP SLA 4 and one for IP SLA 6.

- Use track number **4** for IP SLA 4.
  D1(config)#track 4 ip sla 4
- Use track number **6** for IP SLA 6.

  D1(config)#track 6 ip sla 6

The tracked objects should notify D1 if the IP SLA state changes from down to up after 10 seconds, or from up to down after 15 seconds.

```
D1(config-track)#delay down 10 up 15
```

4.2 On D2, create IP SLAs that test the reachability of R3 interface E1/0.

Create two IP SLAs.

- Use SLA number **4** for IPv4.
  ip SLA 4
- Use SLA number **6** for IPv6.
  ip SLA 6

The IP SLAs will test availability of R3 E1/0 interface every 5 seconds.

```
icmp-echo 10.91.11.1
frequency 5
icmp-echo 2001:db8:100:1011::1
frequency 5
```

Schedule the SLA for immediate implementation with no end time.

```
D2(config)#ip sla schedule 4 life forever start-time now
D2(config)#ip sla schedule 6 life forever start-time now
```

D1(config)#ip sla schedule 6 life forever start-time now

Create an IP SLA object for IP SLA 4 and one for IP SLA 6.

- Use track number **4** for IP SLA 4.
  D2(config)#track 4 ip sla 4
- Use track number **6** for IP SLA 6.

  D2(config)#track 6 ip sla 6

The tracked objects should notify D1 if the IP SLA state changes from down to up after 10 seconds, or from up to down after 15 seconds.

D2(config-track)#delay down 10 up 15

4.3 On D1, configure HSRPv2

D1 is the primary router for VLANs 100 and 102; therefore, their priority will also be changed to 150.

D1(config)#interface vlan 100
D1(config-if)#standby 104 priority 150
D1(config)#interface vlan 102
D1(config-if)#standby 124 priority 150

Configure HSRP version 2.

D1(config-if)#standby version 2

Configure IPv4 HSRP group **104** for VLAN 100:

D1(config)#interface vlan 100
D1(config-if)#standby version 2
D1(config-if)#standby 104 ip 10.91.100.254
D1(config-if)#standby 104 priority 150
D1(config-if)#standby 104 preempt
D1(config-if)#standby 104 track 4 decrement 60
D1(config-if)#standby 106 ipv6 autoconfig
D1(config-if)#standby 106 priority 150
D1(config-if)#standby 106 preempt

D1(config-if)#standby 106 track 6 decrement 60

- Assign the virtual IP address **10.91.100.254**.
  D1(config-if)#standby 104 ip 10.91.100.254
- Set the group priority to **150**.
  D1(config-if)#standby 104 priority 150
- Enable preemption.
  D1(config-if)#standby 104 preempt
- Track object 4 and decrement by 60.
  D1(config-if)#standby 104 track 4 decrement 60

```
D1(config-if)#standby 106 track 6 decrement 60
```

Configure IPv4 HSRP group **114** for VLAN 101:

```
D1(config)#interface vlan 101
D1(config-if)#standby version 2
D1(config-if)#standby 114 ip 10.91.101.254
D1(config-if)#standby 114 preempt
D1(config-if)#standby 114 track 4 decrement 60
```

- Assign the virtual IP address **10.91.101.254**.
  ```
  D1(config-if)#standby 114 ip 10.91.101.254
  ```
- Enable preemption.
  ```
  D1(config-if)#standby 114 preempt
  ```
- Track object 4 to decrement by 60.
  ```
  D1(config-if)#standby 114 track 4 decrement 60
  ```

Configure IPv4 HSRP group **124** for VLAN 102:

```
D1(config)#interface vlan 102
D1(config-if)#standby version 2
D1(config-if)#standby 124 ip 10.91.102.254
D1(config-if)#standby 124 priority 150
D1(config-if)#standby 124 preempt
D1(config-if)#standby 124 track 4 decrement 60
```

- Assign the virtual IP address **10.91.102.254**.
  ```
  D1(config-if)#standby 124 ip 10.91.102.254
  ```
- Set the group priority to **150**.
  ```
  D1(config-if)#standby 124 priority 150
  ```
- Enable preemption.
  ```
  D1(config-if)#standby 124 preempt
  ```
- Track object 4 to decrement by 60.
  ```
  D1(config-if)#standby 124 track 4 decrement 60
  ```

Configure IPv6 HSRP group **106** for VLAN 100:

```
D1(config)#interface vlan 100
D1(config-if)#standby 106 ipv6 autoconfig
D1(config-if)#standby 106 priority 150
D1(config-if)#standby 106 preempt
D1(config-if)#standby 106 track 6 decrement 60
```

- Assign the virtual IP address using **ipv6 autoconfig**.
  ```
  D1(config-if)#standby 106 ipv6 autoconfig
  ```
- Set the group priority to **150**.
  ```
  D1(config-if)#standby 106 priority 150
  ```
- Enable preemption.
  ```
  D1(config-if)#standby 106 preempt
  ```

- Track object 6 and decrement by 60.
  D1(config-if)#standby 106 track 6 decrement 60

Configure IPv6 HSRP group **116** for VLAN 101:

```
D1(config)#interface vlan 101
D1(config-if)#standby 116 ipv6 autoconfig
D1(config-if)#standby 116 preempt
D1(config-if)#standby 116 track 6 decrement 60
```

- Assign the virtual IP address using **ipv6 autoconfig**.
  D1(config-if)#standby 116 ipv6 autoconfig

- Enable preemption.
  D1(config-if)#standby 116 preempt

- Track object 6 and decrement by 60.
  D1(config-if)#standby 116 track 6 decrement 60

Configure IPv6 HSRP group **126** for VLAN 102:

```
D1(config-if)#standby 126 ipv6 autoconfig
D1(config-if)#standby 126 priority 150
D1(config-if)#standby 126 preempt
D1(config-if)#standby 126 track 6 decrement 60
```

- Assign the virtual IP address using **ipv6 autoconfig**.
  D1(config-if)#standby 126 ipv6 autoconfig

- Set the group priority to **150**.
  D1(config-if)#standby 126 priority 150

- Enable preemption.
  D1(config-if)#standby 126 preempt

- Track object 6 and decrement by 60.
  D1(config-if)#standby 126 track 6 decrement 60

Figura 29. Verificación protocolo enrutamiento en R1

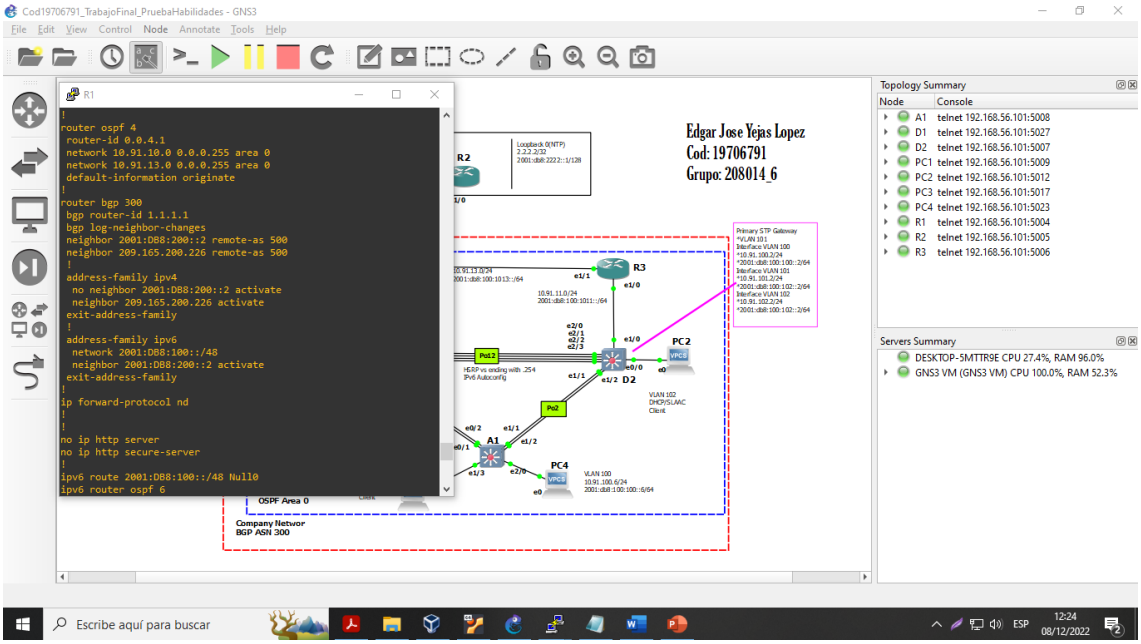


Figura 30. Verificación protocolo enrutamiento en R2

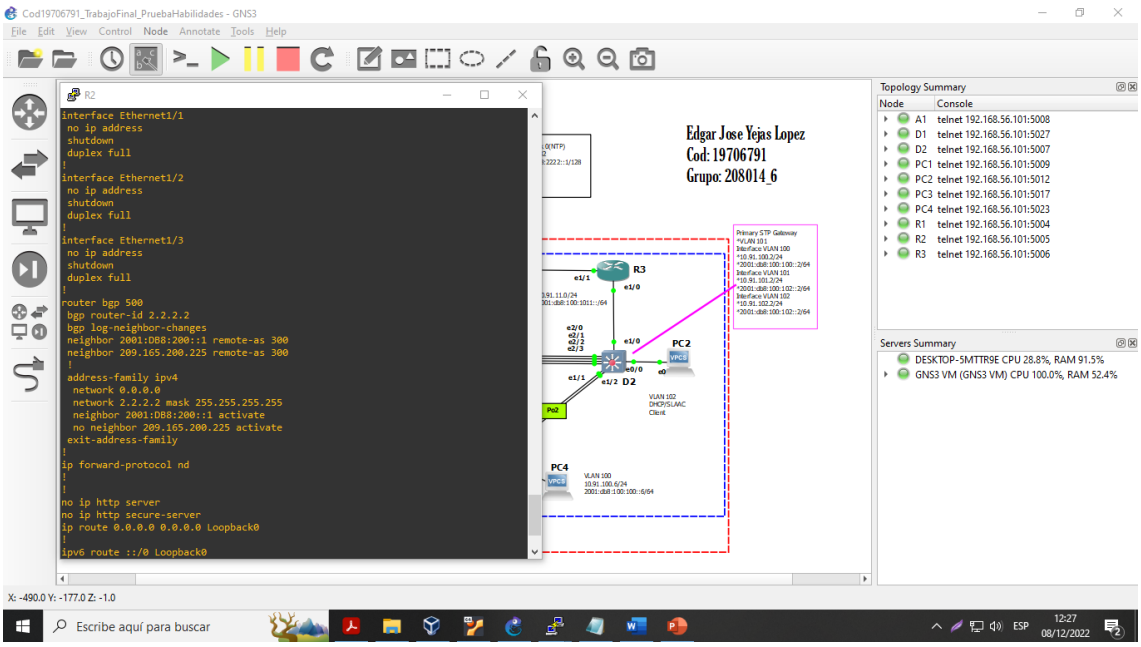
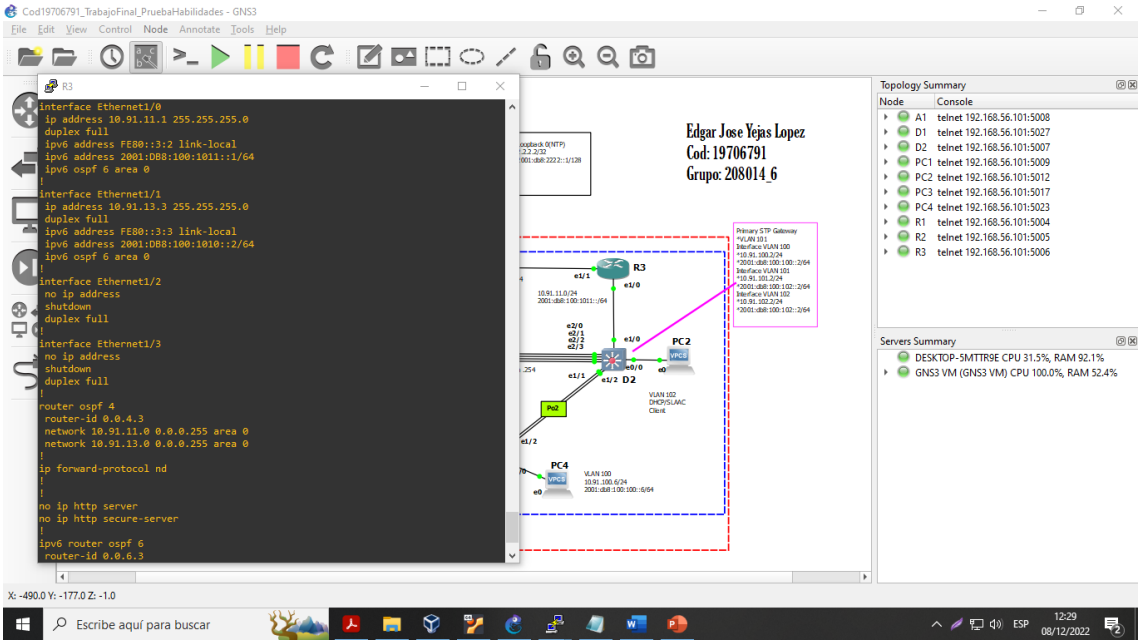


Figura 31. Verificación protocolo enrutamiento en R3



4.4 On D2, configure HSRPv2

D1 is the primary router for VLANs 101; therefore, their priority will also be changed to 150.

```
D2(config)#interface vlan 101
D2(config-if)#standby 114 priority 150
```

Configure HSRP version 2.

```
D2(config-if)#standby version 2
```

Configure IPv4 HSRP group **104** for VLAN 100:

```
D2(config)#interface vlan 100
D2(config-if)#standby version 2
D2(config-if)#standby 104 ip 10.91.100.254
D2(config-if)#standby 104 preempt
D2(config-if)#standby 104 track 4 decrement 60
```

- Assign the virtual IP address **10.91.101.254**.

```
D2(config-if)#standby 104 ip 10.91.101.254
```

- Set the group priority to **150**.

```
D2(config-if)#standby 104 priority 150
```

- Enable preemption.

```
D2(config-if)#standby 104 preempt
```

- Track object 4 and decrement by 60.
  D2(config-if)#standby 104 track 4 decrement 60

Configure IPv4 HSRP group **124** for VLAN 102:

```
D2(config)#interface vlan 102
D2(config-if)#standby version 2
D2(config-if)#standby 124 ip 10.91.102.254
D2(config-if)#standby 124 preempt
D2(config-if)#standby 124 track 4 decrement 60
```

- Assign the virtual IP address **10.91.102.254**.
  D2(config-if)#standby 124 ip 10.91.102.254

- Enable preemption.
  D2(config-if)#standby 124 preempt

- Track object 4 to decrement by 60.
  D2(config-if)#standby 124 track 4 decrement 60

Configure IPv4 HSRP group **106** for VLAN 100:

```
D2(config-if)#standby 106 ipv6 autoconfig
D2(config-if)#standby 106 preempt
D2(config-if)#standby 106 track 6 decrement 60
```

- Assign the virtual IP address using **ipv6 autoconfig**.
  D2(config-if)#standby 106 ipv6 autoconfig
- Set the group priority to **150**.
  D2(config-if)#standby 106 priority 150

- Enable preemption.
  D2(config-if)#standby 106 preempt
- Track object 6 and decrement by 60.
  D2(config-if)#standby 106 track 6 decrement 60

Configure IPv6 HSRP group **116** for VLAN 101:

```
D2(config)#interface vlan 101
D2(config-if)#standby 116 ipv6 autoconfig
D2(config-if)#standby 116 preempt
D2(config-if)#standby 116 track 6 decrement 60
```

- Assign the virtual IP address using **ipv6 autoconfig**.
  D2(config-if)#standby 116 ipv6 autoconfig
- Enable preemption.
  D2(config-if)#standby 116 preempt

- Track object 6 and decrement by 60.
  D2(config-if)#standby 116 track 6 decrement 60

Configure IPv6 HSRP group **126** for VLAN 102:

D2(config-if)#standby 126 ipv6 autoconfig
D2(config-if)#standby 126 priority 150
D2(config-if)#standby 126 preempt
D2(config-if)#standby 126 track 6 decrement 60

- Assign the virtual IP address using **ipv6 autoconfig**.
  D2(config-if)#standby 126 ipv6 autoconfig
- Set the group priority to **150**.
  D2(config-if)#standby 126 priority 150

- Enable preemption.
  D2(config-if)#standby 126 preempt
- Track object 6 and decrement by 60.
  D2(config-if)#standby 126 track 6 decrement 60

Figura 32. Verificación configuración de SLA y HSRPv2 en D1

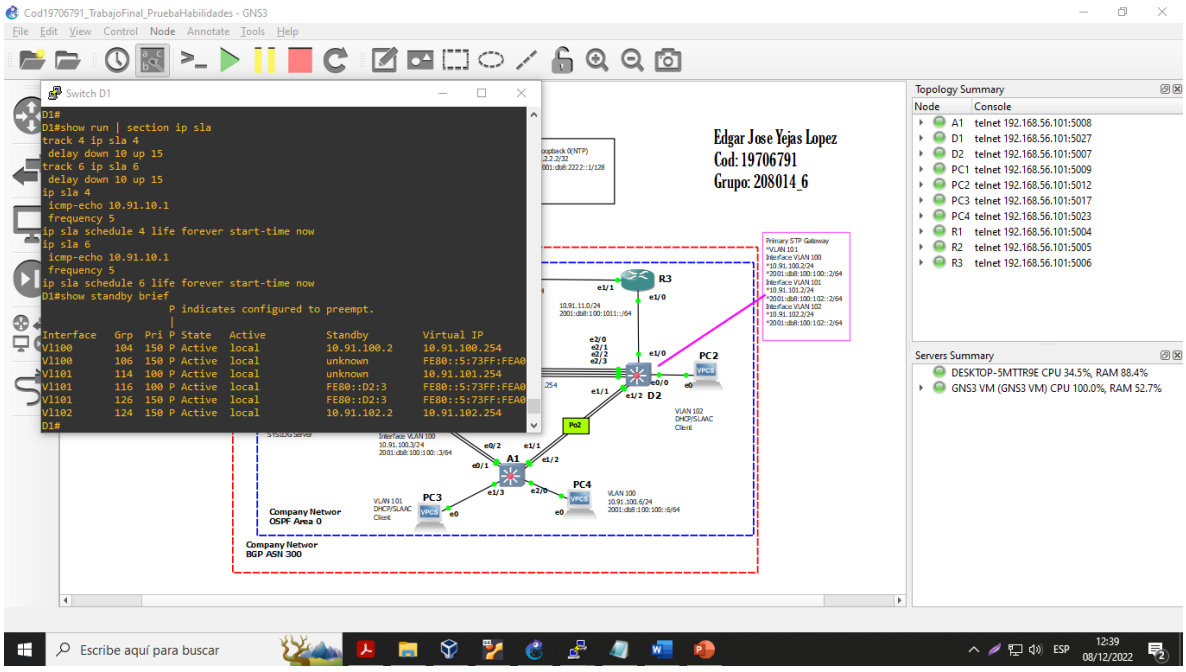
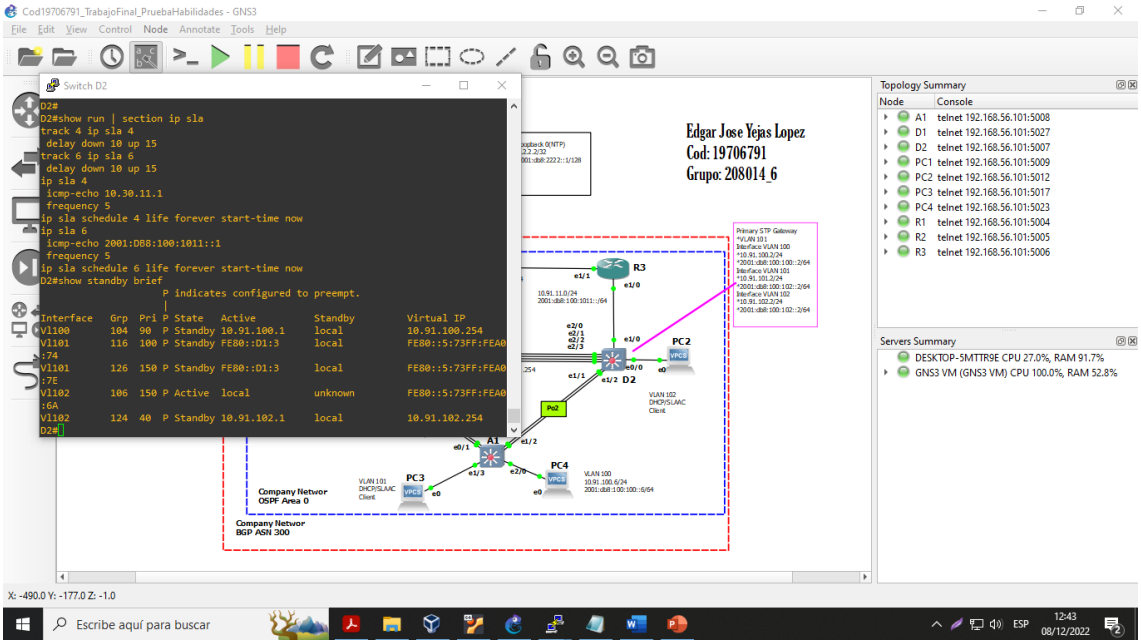


Figura 33. Configuración D1



COMADOS DE VERIFICACIÓN

Figura 34. Ping en PC1

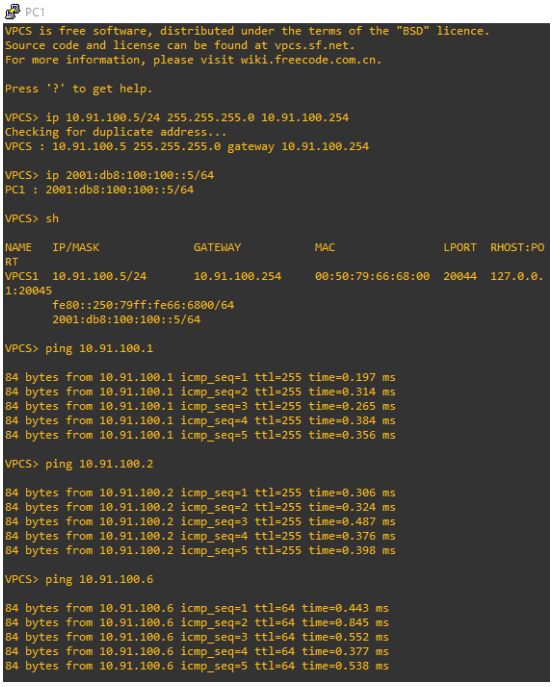


Figura 35. Ping en PC4

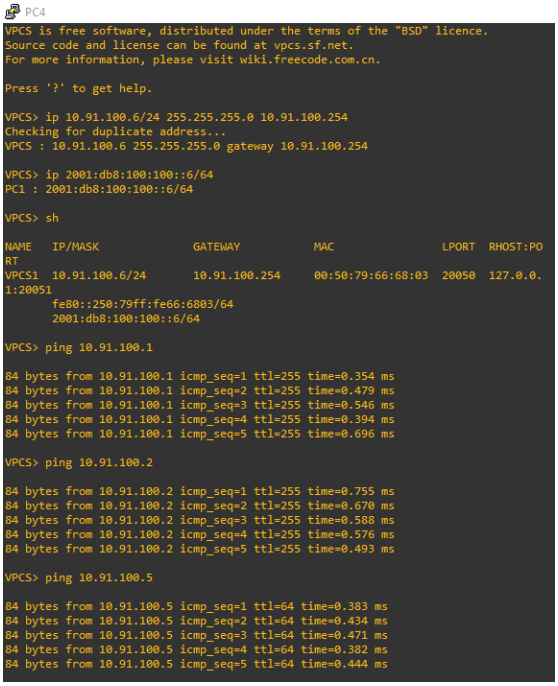
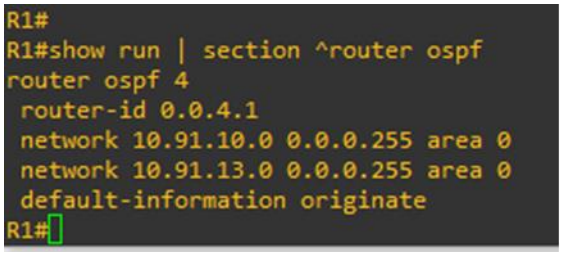


Figura 36. show run | section ^router ospf on R1 y R3



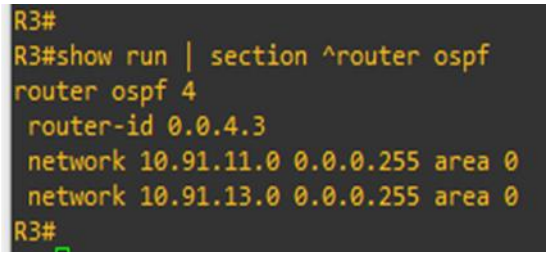


Figura 37. show run | section ^ipv6 route on R1 y R3

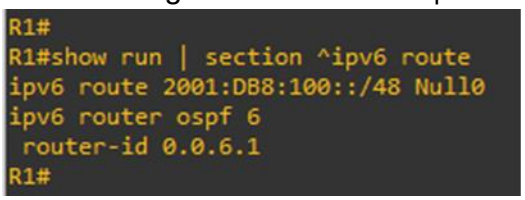
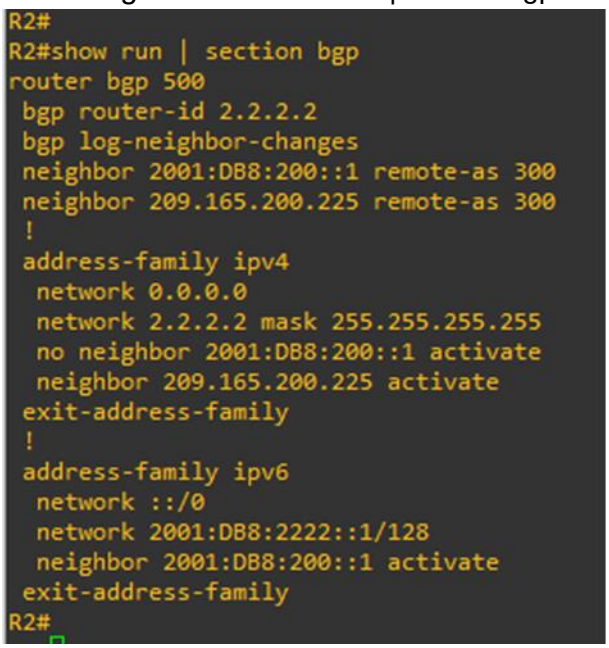


Figura 38. show run | section bgp and show run | include route on R2



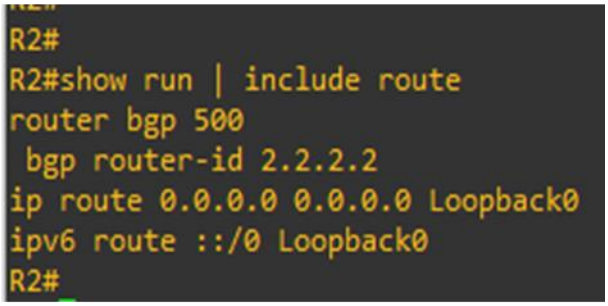


Figura 39. show run | section bgp on R1

```
R1#
R1#show run | section bgp
router bgp 300
 bgp router-id 1.1.1.1
 bgp log-neighbor-changes
 neighbor 2001:DB8:200::2 remote-as 500
 neighbor 209.165.200.226 remote-as 500
 !
 address-family ipv4
  network 10.91.0.0 mask 255.255.0.0
  no neighbor 2001:DB8:200::2 activate
  neighbor 209.165.200.226 activate
 exit-address-family
 !
 address-family ipv6
  network 2001:DB8:100::/48
  neighbor 2001:DB8:200::2 activate
 exit-address-family
R1#
```

Figura 40. show ip route | include O|B on R1

```
R1#
R1#show ip route | include O|B
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
       o - ODR, P - periodic downloaded static route, H - NHRP, l - LISP
B*    0.0.0.0/0 [20/0] via 209.165.200.226, 00:18:54
B        2.2.2.2 [20/0] via 209.165.200.226, 00:18:54
O        10.91.11.0/24 [110/20] via 10.91.13.3, 00:31:17, Ethernet1/1
O        10.91.100.0/24 [110/11] via 10.91.10.2, 01:49:58, Ethernet1/2
O        10.91.101.0/24 [110/11] via 10.91.10.2, 01:49:58, Ethernet1/2
O        10.91.102.0/24 [110/11] via 10.91.10.2, 01:49:58, Ethernet1/2
R1#
```

Figura 41. show ipv6 route command on R1

```
R1#show ipv6 route
IPv6 Routing Table - default - 14 entries
Codes: C - Connected, L - Local, S - Static, U - Per-user Static route
       B - BGP, R - RIP, H - NHRP, I1 - ISIS L1
       I2 - ISIS L2, IA - ISIS interarea, IS - ISIS summary, D - EIGRP
       EX - EIGRP external, ND - ND Default, NDp - ND Prefix, DCE - Destination
       NDr - Redirect, O - OSPF Intra, OI - OSPF Inter, OE1 - OSPF ext 1
       OE2 - OSPF ext 2, ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2, l - LISP
B   ::/0 [20/0]
     via FE80::2:1, Ethernet1/0
S   2001:DB8:100::/48 [1/0]
     via Null0, directly connected
O   2001:DB8:100:100::/64 [110/11]
     via FE80::D1:1, Ethernet1/2
O   2001:DB8:100:101::/64 [110/11]
     via FE80::D1:1, Ethernet1/2
O   2001:DB8:100:102::/64 [110/11]
     via FE80::D1:1, Ethernet1/2
C   2001:DB8:100:1010::/64 [0/0]
     via Ethernet1/2, directly connected
L   2001:DB8:100:1010::1/128 [0/0]
     via Ethernet1/2, receive
O   2001:DB8:100:1011::/64 [110/20]
     via FE80::3:3, Ethernet1/1
C   2001:DB8:100:1013::/64 [0/0]
     via Ethernet1/1, directly connected
L   2001:DB8:100:1013::1/128 [0/0]
     via Ethernet1/1, receive
C   2001:DB8:200::/64 [0/0]
     via Ethernet1/0, directly connected
L   2001:DB8:200::1/128 [0/0]
     via Ethernet1/0, receive
B   2001:DB8:2222::1/128 [20/0]
     via FE80::2:1, Ethernet1/0
L   FF00::/8 [0/0]
     via Null0, receive
R1#
```

Figura 42. show ip route ospf | begin Gateway on R3

```
R3#
R3#show ip route ospf | begin Gateway
Gateway of last resort is 10.91.13.1 to network 0.0.0.0

O*E2  0.0.0.0/0 [110/1] via 10.91.13.1, 00:23:48, Ethernet1/1
      10.0.0.0/8 is variably subnetted, 8 subnets, 2 masks
O        10.91.10.0/24 [110/20] via 10.91.13.1, 00:36:35, Ethernet1/1
O        10.91.100.0/24 [110/11] via 10.91.11.2, 01:54:53, Ethernet1/0
O        10.91.101.0/24 [110/11] via 10.91.11.2, 01:54:53, Ethernet1/0
O        10.91.102.0/24 [110/11] via 10.91.11.2, 01:54:53, Ethernet1/0
R3#
```

show ipv6 route ospf on R3

```
R3#
R3#show ipv6 route ospf
IPv6 Routing Table - default - 9 entries
Codes: C - Connected, L - Local, S - Static, U - Per-user Static route
       B - BGP, R - RIP, H - NHRP, I1 - ISIS L1
       I2 - ISIS L2, IA - ISIS interarea, IS - ISIS summary, D - EIGRP
       EX - EIGRP external, ND - ND Default, NDp - ND Prefix, DCE - Destination
       NDr - Redirect, O - OSPF Intra, OI - OSPF Inter, OE1 - OSPF ext 1
       OE2 - OSPF ext 2, ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2, l - LISP
O   2001:DB8:100:100::/64 [110/11]
     via FE80::D1:1, Ethernet1/0
O   2001:DB8:100:101::/64 [110/11]
     via FE80::D1:1, Ethernet1/0
O   2001:DB8:100:102::/64 [110/11]
     via FE80::D1:1, Ethernet1/0
O   2001:DB8:100:1013::/64 [110/10]
     via Ethernet1/1, directly connected
R3#
```

Figura 43. show run | section ip sla command on D1

```
D1#
D1#show run | section ip sla
track 4 ip sla 4
 delay down 10 up 15
track 6 ip sla 6
 delay down 10 up 15
ip sla 6
 icmp-echo 2001:DB8:100:1010::1
 frequency 5
ip sla schedule 6 life forever start-time now
D1#
```

Figura 44. show standby brief command on D1

```
D1#
D1#show standby brief
                     P indicates configured to preempt.
                     |
Interface   Grp  Pri P State   Active          Standby         Virtual IP
Vl100       104  90  P Standby 10.91.100.2     local           10.91.100.254
Vl100       106  150 P Active  local           unknown         FE80::5:73FF:FEA0
:6A
Vl101       114  40  P Active  local           unknown         10.91.101.254
Vl101       116  100 P Active  local           FE80::D2:3      FE80::5:73FF:FEA0
:74
Vl101       126  150 P Active  local           FE80::D2:3      FE80::5:73FF:FEA0
:7E
Vl102       124  90  P Active  local           10.91.102.2     10.91.102.254
D1#
```

Figura 45. show run | section ip sla command on D2

```
D2#
D2#show run | section ip sla
track 4 ip sla 4
 delay down 10 up 15
track 6 ip sla 6
 delay down 10 up 15
ip sla 6
 icmp-echo 2001:DB8:100:1011::1
 frequency 5
ip sla schedule 6 life forever start-time now
D2#
```

Figura 46. show run | section ^router ospf on D1 and D2

```
D1#
D1#show run | section ^router ospf
router ospf 4
 router-id 0.0.4.131
 passive-interface default
 no passive-interface Ethernet1/2
 network 10.91.10.0 0.0.0.255 area 0
 network 10.91.100.0 0.0.0.255 area 0
 network 10.91.101.0 0.0.0.255 area 0
 network 10.91.102.0 0.0.0.255 area 0
D1#
```

```
D2#
D2#show run | section ^router ospf
router ospf 4
 router-id 0.0.4.132
 passive-interface default
 no passive-interface Ethernet1/0
 network 10.91.11.0 0.0.0.255 area 0
 network 10.91.100.0 0.0.0.255 area 0
 network 10.91.101.0 0.0.0.255 area 0
 network 10.91.102.0 0.0.0.255 area 0
D2#
```

Figura 47. show run | section ^ipv6 route on D1 and D2

```
D1#
D1#show run | section ^ipv6 route
ipv6 router ospf 6
 router-id 0.0.6.131
 passive-interface default
 no passive-interface Ethernet1/2
D1#
```

```
D2#
D2#show run | section ^ipv6 route
ipv6 router ospf 6
 router-id 0.0.6.132
D2#
```

Figura 48. show ipv6 ospf interface brief on R1, R3, D1, and D2

```
R1#
R1#show ipv6 ospf interface brief
Interface    PID   Area            Intf ID    Cost  State Nbrs F/C
Et1/2        6     0               5          10    DR    1/1
Et1/1        6     0               4          10    BDR   1/1
R1#
```

```
R3#
R3#show ipv6 ospf interface brief
Interface    PID   Area            Intf ID    Cost  State Nbrs F/C
Et1/1        6     0               4          10    DR    1/1
Et1/0        6     0               3          10    BDR   1/1
R3#
```

```
D1#
D1#show ipv6 ospf interface brief
Interface    PID   Area            Intf ID    Cost  State Nbrs F/C
Vl102        6     0               24         1     DR    0/0
Vl101        6     0               23         1     DR    0/0
Vl100        6     0               22         1     DR    0/0
Et1/2        6     0               21         10    BDR   1/1
D1#
```

```
D2#
D2#show ipv6 ospf interface brief
Interface    PID   Area            Intf ID    Cost  State Nbrs F/C
Vl102        6     0               24         1     DR    0/0
Vl101        6     0               23         1     DR    0/0
Vl100        6     0               22         1     DR    0/0
Et1/0        6     0               21         10    DR    1/1
D2#
```

CONCLUSIONES

Utilizando el simulador gráfico GNS3 junto con la máquina virtual Oracle VM VirtualBox se pudo implementar un escenario el cual dejó mucho enriquecimiento en el concepto de estructurar redes conmutadas mediante el uso del protocolo STP y la configuración de VLANs, para comprender las características de una infraestructura de red jerárquica convergente.

Se dieron soluciones de red escalables mediante la configuración básica y avanzada de protocolos de enrutamiento para la implementación de servicios IP con calidad de servicio en ambientes de red empresariales LAN y WAN paso a paso.

Se resolvió en su totalidad la actividad práctica propuesta del escenario hipotético, cumpliendo a cabalidad con cada uno de los requerimientos y mostrando tanto los códigos de ejecución como los resultados en los dispositivos configurados.

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