

# **INFORME – PRUEBA DE HABILIDADES PRÁCTICA**

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**INFORME – PRUEBA DE HABILIDADES PRÁCTICA**

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

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NOTA DE ACEPTACIÓN

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## GLOSARIO

**ASN:** Autonomous System Number, se le denomina al grupo de red que es gestionado por algún operador de red por ruteo externo.

**BGP:** Border Gateway Protocol, utilizado para conectar distintos sistemas autónomos principalmente con el canal de internet.

**DHCP:** Dynamic Host Configuration Protocol, funciona en el modelo cliente/servidor y proporciona automáticamente direcciones IP y otra información relacionada como la máscara y el Gateway.

**HSRP:** Host Standby Routing Protocol, asigna a un grupo de redundancia un router activo, otro standby y los demás en estado listen, donde el activo tendrá la IP virtual.

**ISP:** Internet Service Provider, término que identifica las compañías que proveen acceso a internet.

**LACP:** Link Aggregation Control Protocol, característico de la capa 2 une puertos físicos de la red en un único puerto lógico de gran ancho de banda, y crea redundancias.

**MP-BGP:** Multiprotocol -BGP, permite que BGP lleve información de IPv6 y otros protocolos de red múltiple.

**OSPFv2:** Open Shortest Path First, protocolo de enrutamiento dinámico que detecta cambios en la topología, fallas de enlace y converge en una nueva estructura rápidamente, específicamente para IPv4.

**OSPFv3:** Open Shortest Path First, protocolo de enrutamiento dinámico que detecta cambios en la topología, fallas de enlace y converge en una nueva estructura rápidamente, específicamente para IPv6.

**Root bridge:** Punto de referencia dentro de la red que puede soportar más conmutación, todos los switches deben estar conectados hacia él con el mejor coste.

**RSTP:** Rapid Spanning Tree Protocol, aplicable a la capa 2 reduce considerablemente la convergencia de la topología cuando ocurre algún cambio.

**VLAN:** Virtual LAN, método utilizado para crear varias redes lógicas dentro de una solo red física.

## **RESUMEN**

A continuación se desarrolla como opción de grado para la ingeniería en telecomunicaciones y electrónica, aplicando las habilidades prácticas CCNP bajo un escenario planteado, el montaje se realiza en el simulador GNS3 utilizando imágenes IOS de los dispositivos CISCO, esta propuesta de escenario parece simple pero los requisitos de configuración que se piden en la guía son diversos para lograr simular tal y cual es una red a nivel profesional; colocando a prueba las habilidades del estudiante en el conocimiento de las redes de datos, primero se configuran varios protocolos para la conmutación en la capa 2, paralelamente se configuran protocolos de la capa 3 para establecer el enrutamiento entre la propia LAN (red de la empresa) que se comunican entre sí con algunas políticas de seguridad establecidas simulando escenarios a los cuales se va a enfrentar el futuro Ingeniero.

*Palabras clave:* CCNP, Conmutación, Enrutamiento, Redes, Electrónica, CISCO

## **ABSTRACT**

Next, it is developed as a degree option for telecommunications and electronics engineering, applying CCNP practical skills under a proposed scenario, the assembly is carried out in the GNS3 simulator using IOS images of CISCO devices, this scenario proposal seems simple but the configuration requirements that are requested in the guide are diverse in order to simulate such and such a network at a professional level; Testing the skills of the student in the knowledge of data networks, first several protocols are configured for switching in layer 2, parallel layer 3 protocols are configured to establish routing between the LAN itself (company network ) that communicate with each other with some established security policies simulating scenarios that the future Engineer will face.

*Key words:* CCNP, Routing, Swicthing, Networking, Electronics, CISCO

## INTRODUCCIÓN

Tomando como partida el desarrollo y aprendizaje de las grandes tecnologías, las cuales nos facilitan la interacción y la comunicación entre las personas y las empresas; por eso es importante que el futuro ingeniero en Telecomunicaciones entienda estas redes y aprenda a configurar los diferentes protocolos que permiten dicha interconexión; para ello se realiza el siguiente trabajo, donde se plantea un escenario el cual consta de 3 router, 3 switches y 4 PCs simulando las redes a las que se va a ver expuesto en un futuro el ingeniero.

Inicialmente se configura el direccionamiento IP en todos los dispositivos tanto IPv4 e IPv6, luego utilizando 2 switches multicapa como si fueran los CORE de la red encargados de la conmutación cada uno enfatizado en VLAN diferente y con enlaces redundantes, adicional 1 switch de capa 2 utilizado como el acceso a los clientes, en general en la capa 2 se debe trabajar el RSTP Rapid Spanning Tree Protocol y enlaces LACP, a nivel de capa 3 se soluciona la convergencia de la red totalmente,



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	10.53.10.1/24	2001:db8:100:1010::1/64	fe80::1:2
	E1/1	10.53.13.1/24	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	10.53.11.1/24	2001:db8:100:1011::1/64	fe80::3:2
	E1/1	10.53.13.3/24	2001:db8:100:1013::3/64	fe80::3:3
D1	E1/2	10.53.10.2/24	2001:db8:100:1010::2/64	fe80::d1:1
	VLAN 100	10.53.100.1/24	2001:db8:100:100::1/64	fe80::d1:2
	VLAN 101	10.53.101.1/24	2001:db8:100:101::1/64	fe80::d1:3
	VLAN 102	10.53.102.1/24	2001:db8:100:102::1/64	fe80::d1:4
D2	E1/0	10.53.11.2/24	2001:db8:100:1011::2/64	fe80::d2:1
	VLAN 100	10.53.100.2/24	2001:db8:100:100::2/64	fe80::d2:2
	VLAN 101	10.53.101.2/24	2001:db8:100:101::2/64	fe80::d2:3
	VLAN 102	10.53.102.2/24	2001:db8:100:102::2/64	fe80::d2:4
A1	VLAN 100	10.53.100.3/23	2001:db8:100:100::3/64	fe80::a1:1
PC1	NIC	10.53.100.5/24	2001:db8:100:100::5/64	EUI-64
PC2	NIC	DHCP	SLAAC	EUI-64
PC3	NIC	DHCP	SLAAC	EUI-64
PC4	NIC	10.53.100.6/24	2001:db8:100:100::6/64	EUI-64

Tabla 1. Direccionamiento IP

## Paso 2: Configurar los parámetros básicos para cada dispositivo

Se procede a configurar los parámetros básicos de los dispositivos como los nombres, textos de banner motd para cada equipo, específicamente las IP de cada interfaz tanto en IPV4 como en IPV6 de cada uno de los routers, en el caso de los switches la creación de las VLAN con sus nombres, las direcciones IP, y se crea un pool DHCP con sus respectivas exclusiones.

### Router 1:

```
Router#config t //Ingreso a modo configuración global
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#hostname R1 //se nombra el router
```

```

R1(config)#ipv6 unicast-routing //habilita el routing en IPV6
R1(config)#no ip domain-lookup //desactiva la traducción de nombres a dirección
R1(config)#banner motd # R1, ENCOR Skills Assessment # //Mensaje cuando se conecta a
consola
R1(config)#line con 0 //configuración de la línea de consola
R1(config-line)#exec-timeout 0 0
R1(config-line)#logging synchronous
R1(config-line)#exit
R1(config)#inter e1/0 //configuración de la interfaz
R1(config-if)#ip address 209.165.200.225 255.255.255.224
R1(config-if)#ipv6 address fe80::1:1 link-local
R1(config-if)#ipv6 address 2001:db8:200::1/64
R1(config-if)#no shutdown //enciende la interfaz
R1(config-if)#exit
R1(config)#interface e1/2
R1(config-if)#ip address 10.53.10.1 255.255.255.0
R1(config-if)#ipv6 address fe80::1:2 link-local
R1(config-if)#ipv6 address 2001:db8:100:1010::1/64
R1(config-if)#no shutdown
R1(config-if)#exit
R1(config)#interface e1/1
R1(config-if)#ip address 10.53.13.1 255.255.255.0
R1(config-if)#ipv6 address fe80::1:3 link-local
R1(config-if)#ipv6 address 2001:db8:100:1013::1/64
R1(config-if)#no shutdown
R1(config-if)#exit
R1(config)#exit
R1#copy run star //guarda la configuración actual
Destination filename [startup-config]?
Building configuration...
[OK]
R1#

```

## Router 2:

```

Router>enable
Router#config t
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#hostname R2
R2(config)#ipv6 unicast-routing
R2(config)#no ip domain-lookup
R2(config)#banner motd # R2, ENCOR Skills Assessment #
R2(config)#line con 0
R2(config-line)#exec-timeout 0 0
R2(config-line)#logging synchronous
R2(config-line)#exit
R2(config)#interface e1/0
R2(config-if)#ip address 209.165.200.226 255.255.255.224
R2(config-if)#ipv6 address fe80::2:1 link-local
R2(config-if)#ipv6 address 2001:db8:200::2/64
R2(config-if)#no shutdown
R2(config-if)#exit
R2(config)#interface Loopback 0 //se configura la interfaz virtual

```

```
R2(config-if)#ip address 2.2.2.2 255.255.255.255
R2(config-if)#ipv6 address fe80::2:3 link-local
R2(config-if)#ipv6 address 2001:db8:2222::1/128
R2(config-if)#no shutdown
R2(config-if)#exit
R2(config)#exit
R2#copy run star
Destination filename [startup-config]?
Building configuration...
[OK]
```

### Router 3:

```
Router>enable
Router#config t
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#hostname R3
R3(config)#ipv6 unicast-routing
R3(config)#no ip domain-loo
R3(config)#banner motd # R3, ENCOR Skills Assessment #
R3(config)#line con 0
R3(config-line)#exec-timeout 0 0
R3(config-line)#logging synchronous
R3(config-line)#exit
R3(config)#interface e1/0
R3(config-if)#ip address 10.53.11.1 255.255.255.0
R3(config-if)#ipv6 address fe80::3:2 link-local
R3(config-if)#ipv6 address 2001:db8:100:1011::1/64
R3(config-if)#no shutdown
R3(config-if)#exit
R3(config)#interface e1/1
R3(config-if)#ip address 10.53.13.3 255.255.255.0
R3(config-if)#ipv6 address fe80::3:3 link-local
R3(config-if)#ipv6 address 2001:db8:100:1010::2/64
R3(config-if)#no shutdown
R3(config-if)#exit
R3#copy run star
Destination filename [startup-config]?
Building configuration...
[OK]
```

### Switch D1:

```
Switch>enable
Switch#config t
Enter configuration commands, one per line. End with CNTL/Z.
Switch(config)#hostname D1
D1(config)#ip routing
D1(config)#ipv6 unicast-routing
```

```

D1(config)#no ip domain lookup
D1(config)#banner motd # D1, ENCOR Skills Assessment #
D1(config)#line con 0
D1(config-line)#exec-timeout 0 0
D1(config-line)#logging synchronous
D1(config-line)#exit
D1(config)#vlan 100 //se crea la VLAN
D1(config-vlan)#name Management
D1(config-vlan)#exit
D1(config)#vlan 101
D1(config-vlan)#name UserGroupA
D1(config-vlan)#exit
D1(config)#vlan 102
D1(config-vlan)#name UserGroupB
D1(config-vlan)#exit
D1(config)#vlan 999
D1(config-vlan)#name NATIVE
D1(config-vlan)#exit
D1(config)#interface e1/2
D1(config-if)#no switchport //Brinda la capacidad capa 3 al puerto
D1(config-if)#ip address 10.53.10.2 255.255.255.0
D1(config-if)#ipv6 address fe80::d1:1 link-local
D1(config-if)#ipv6 address 2001:db8:100:1010::2/64
D1(config-if)#no shutdown
D1(config-if)#exit
D1(config)#interface vlan 100 //se configuran las IP de la VLAN
D1(config-if)#ip address 10.53.100.1 255.255.255.0
D1(config-if)#ipv6 address fe80::d1:2 link-local
D1(config-if)#ipv6 address 2001:db8:100:100::1/64
D1(config-if)#no shutdown
D1(config-if)#exit
D1(config)#interface vlan 101
D1(config-if)#ip address 10.53.101.1
255.255.255.0
D1(config-if)#ipv6 address fe80::d1:3 link-local
D1(config-if)#ipv6 address 2001:db8:100:101::1/64
D1(config-if)#no shutdown
%LINK-5-CHANGED: Interface Vlan101, changed state to up
D1(config-if)#exit
D1(config)#interface vlan 102
D1(config-if)#ip address 10.53.102.1
255.255.255.0
D1(config-if)#ipv6 address fe80::d1:4 link-local
D1(config-if)#ipv6 address 2001:db8:100:102::1/64
D1(config-if)#no shutdown
D1(config-if)#exit
D1(config)#ip dhcp excluded-address 10.53.101.1 10.0.101.109
D1(config)#ip dhcp excluded-address 10.53.101.141 10.0.101.254
D1(config)#ip dhcp excluded-address 10.53.102.1 10.0.102.109
D1(config)#ip dhcp excluded-address 10.53.102.141
10.0.102.254
D1(config)#ip dhcp pool VLAN-101

```

```
D1(dhcp-config)#network 10.53.101.0 255.255.255.0
D1(dhcp-config)#default-router 10.53.101.254
D1(dhcp-config)#exit
D1(config)#ip dhcp pool VLAN-102
D1(dhcp-config)#network 10.53.102.0 255.255.255.0
D1(dhcp-config)#default-router
10.53.102.254
D1(dhcp-config)#exit
D1(config)#exit
D1#copy run star
Destination filename [startup-config]?
Building configuration...
[OK]
```

## Switch D2:

```
Switch>enable
Switch#config t
Enter configuration commands, one per line. End with CNTL/Z.
Switch(config)#hostname D2
D2(config)#ip routing
D2(config)#ipv6 unicast-routing
D2(config)#no ip domain lookup
D2(config)#banner motd # D2, ENCOR Skills Assessment, Scenario 1 #
D2(config)#line con 0
D2(config-line)#exec-timeout 0 0
D2(config-line)#logging synchronous
D2(config-line)#exit
D2(config)#vlan 100
D2(config-vlan)#name Management
D2(config-vlan)#exit
D2(config)#vlan 101
D2(config-vlan)#name UserGroupA
D2(config-vlan)#exit
D2(config)#vlan 102
D2(config-vlan)#name UserGroupB
D2(config-vlan)#exit
D2(config)#vlan 999
D2(config-vlan)#name NATIVE
D2(config-vlan)#exit
D2(config)#interface e1/0
D2(config-if)#no switchport
D2(config-if)#ip address 10.53.11.2 255.255.255.0
D2(config-if)#ipv6 address fe80::d2:1 link-local
D2(config-if)#ipv6 address 2001:db8:100:1011::2/64
D2(config-if)#no shutdown
D2(config-if)#exit
D2(config)#interface vlan 100
D2(config-if)#ip address 10.53.100.2
255.255.255.0
D2(config-if)#ipv6 address fe80::d2:2 link-local
D2(config-if)#ipv6 address 2001:db8:100:100::2/64
D2(config-if)#no shutdown
```

```

D2(config-if)#exit
D2(config)#interface vlan 101
D2(config-if)#ip address 10.53.101.2
255.255.255.0
D2(config-if)#ipv6 address fe80::d2:3 link-local
D2(config-if)#ipv6 address 2001:db8:100:101::2/64
D2(config-if)#no shutdown
D2(config-if)#exit
D2(config)#interface vlan 102
D2(config-if)#ip address 10.53.102.2
255.255.255.0
D2(config-if)#ipv6 address fe80::d2:4 link-local
D2(config-if)#ipv6 address 2001:db8:100:102::2/64
D2(config-if)#no shutdown
D2(config-if)#exit
D2(config)#ip dhcp excluded-address 10.53.101.1 10.0.101.209
D2(config)#ip dhcp excluded-address 10.53.101.241 10.0.101.254
D2(config)#ip dhcp excluded-address 10.53.102.1 10.0.102.209
D2(config)#ip dhcp excluded-address 10.53.102.241
10.0.102.254
D2(config)#ip dhcp pool VLAN-101
D2(dhcp-config)#network 10.53.101.0 255.255.255.0
D2(dhcp-config)#default-router 53.0.101.254
D2(dhcp-config)#exit
D2(config)#ip dhcp pool VLAN-102
D2(dhcp-config)#network 10.53.102.0 255.255.255.0
D2(dhcp-config)#default-router
10.53.102.254
D2(dhcp-config)#exit
D2(config)#exit
D2#copy run star
Destination filename [startup-config]?
Building configuration...
[OK]

```

### Switch A1:

```

Switch>enable
Switch#config t
Enter configuration commands, one per line. End with CNTL/Z.
Switch(config)#hostname A1
A1(config)#no ip domain lookup
A1(config)#banner motd # A1, ENCOR Skills Assessment #
A1(config)#line con 0
A1(config-line)#exec-timeout 0 0
A1(config-line)#logging synchronous
A1(config-line)#exit
A1(config)#vlan 100
A1(config-vlan)#name Management
A1(config-vlan)#exit
A1(config)#vlan 101
A1(config-vlan)#name UserGroupA
A1(config-vlan)#exit

```

```

A1(config)#vlan 102
A1(config-vlan)#name UserGroupB
A1(config-vlan)#exit
A1(config)#vlan 999
A1(config-vlan)#name NATIVE
A1(config-vlan)#exit
A1(config)#interface vlan 100
A1(config-if)#ip address 10.53.100.3
255.255.255.0
A1(config-if)#ipv6 address fe80::a1:1 link-local
A1(config-if)#ipv6 address 2001:db8:100:100::3/64
A1(config-if)#no shutdown
A1(config-if)#exit

```

### Configuración de los PC:

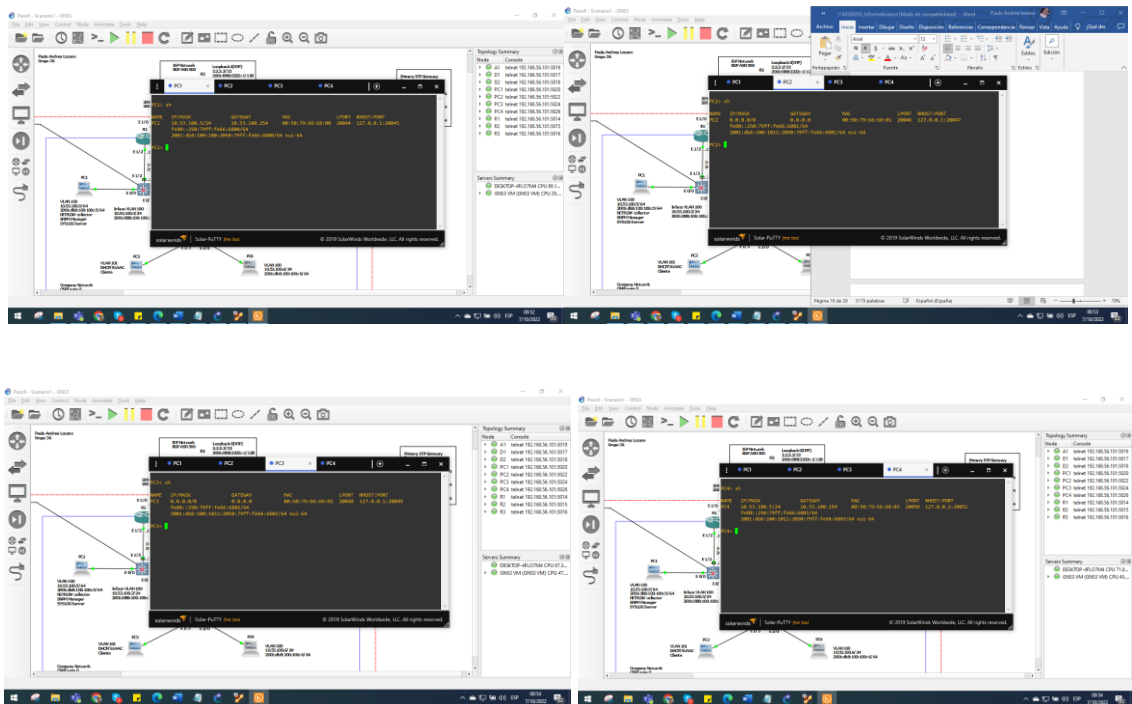


Figura 2. Configuración de IP en los PC

## PARTE 2: CONFIGURAR LA CAPA 2 DE LA RED Y EL SOPORTE DE HOST

### Paso 1: Configurar las interfaces troncales

#### Switch D1:

```
D1(config)# interface range e2/0 - 3, e0/1 - 2//configura un grupo de interfaces
D1(config-if-range)# switchport trunk encapsulation dot1q //establece la encapsulación en el
estándar IEEE 802.1Q
D1(config-if-range)#switchport mode trunk //configura la interfaz troncal
```

#### Switch D2:

```
D2(config)# interface range e2/0 - 3, e1/1 - 2
D2(config-if-range)#switchport trunk encapsulation dot1q
D2(config-if-range)#switchport mode trunk
D2(config-if-range)#exit
```

#### Switch A1:

```
A1(config)#interface range e0/1 - 2
A1(config-if-range)#switchport trunk encapsulation dot1q
A1(config-if-range)#switchport mode trunk
```

### Paso 2: Configurar la VLAN 99 como nativa:

#### Switch D1:

```
D1(config)# interface range e2/0 - 3, e0/1 - 2
D1(config-if-range)#switchport trunk native vlan 999
```

#### Switch D2:

```
D2(config)# interface range e2/0 - 3, e1/1 - 2
D2(config-if-range)#switchport trunk native vlan 999
```

#### Switch A1:

```
A1(config)# interface range e0/1 - 2
A1(config-if-range)#switchport trunk native vlan 999
```



Figura 3. Verificación de los enlaces troncales

### Paso 3: Habilitar protocolo Rapid Spanning-Tree (RSTP).

#### Switch D1:

```
D1(config)#spanning-tree mode rapid-pvst
D1(config)#
```

#### Switch D2:

```
D2(config)#spanning-tree mode rapid-pvst
D2(config)#
```

#### Switch A1:

```
A1(config)#spanning-tree mode rapid-pvst
A1(config)#
```

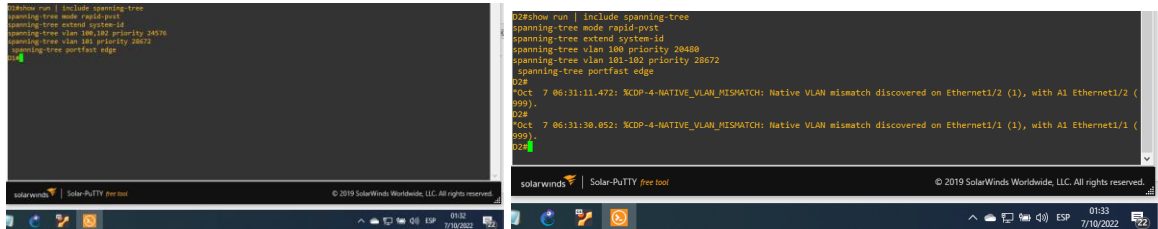
### Paso 4: Configurar los puentes raíz (root bridges)

#### Switch D1:

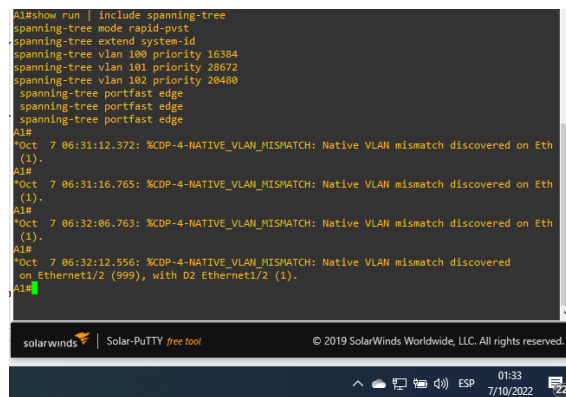
```
D1(config)#spanning-tree vlan 100 root primary
D1(config)#spanning-tree vlan 102 root primary
D1(config)#spanning-tree vlan 101 root secondary
```

## Switch D2:

```
D2(config)#spanning-tree vlan 101 root primary
D2(config)#spanning-tree vlan 100 root secondary
D2(config)#spanning-tree vlan 102 root secondary
```



The image shows two side-by-side screenshots of a SolarWinds Solar-PuTTY terminal window. The left window displays the configuration for Switch D2, including commands for spanning-tree mode, system-id, and root priorities for VLANs 100, 101, and 102. The right window shows the output of a 'show run' command, which includes the same configuration and two error messages: '%CDP-4-NATIVE\_VLAN\_MISMATCH: Native VLAN mismatch discovered on Ethernet1/2 (1), with A1 Ethernet1/2 (999)'. The terminal windows are running on a Windows desktop environment.



The image shows a single screenshot of a SolarWinds Solar-PuTTY terminal window. The terminal displays the configuration for Switch A1, including commands for spanning-tree mode, system-id, and root priorities for VLANs 100, 101, and 102. Below the configuration, there are four error messages: '%CDP-4-NATIVE\_VLAN\_MISMATCH: Native VLAN mismatch discovered on Ethernet1/2 (1), with D2 Ethernet1/2 (999)'. The terminal windows are running on a Windows desktop environment.

Figura 4. Verificación de spanning-tree

## Paso 5: crear los LACP.

### Switch D1:

```
D1(config)# interface range e2/0-3
D1(config-if-range)#channel-protocol lacp
D1(config-if-range)#channel-group 12 mode active
D1(config-if-range)#
Creating a port-channel interface Port-channel 12
D1(config-if-range)#exit
D1(config)#interfac port-channel 12
D1(config-if)#switchport trunk encapsulation dot1q
D1(config-if)#switchport mode trunk
D1(config-if)#switchport trunk native vlan 999
D1(config-if)#switchport trunk allowed vlan 100-102
D1(config-if)#exit
D1(config)# interface range e0/1-2
D1(config-if-range)#channel-protocol lacp
D1(config-if-range)#channel-group 1 mode active
```

```
D1(config-if-range)#  
Creating a port-channel interface Port-channel 1  
D1(config-if-range)#exit  
D1(config)#interfac port-channel 1  
D1(config-if)#switchport trunk encapsulation dot1q  
D1(config-if)#switchport mode trunk  
D1(config-if)#switchport trunk native vlan 999  
D1(config-if)#switchport trunk allowed vlan 100-102  
D1(config-if)#exit  
D1(config)#
```

### Switch D2:

```
D2(config)# interface range e2/0-3  
D2(config-if-range)#channel-protocol lACP  
D2(config-if-range)#channel-group 12 mode active  
D2(config-if-range)#  
Creating a port-channel interface Port-channel 12  
D2(config-if-range)#exit  
D2(config)#interfac port-channel 12  
D2(config-if)#switchport trunk encapsulation dot1q  
D2(config-if)#switchport mode trunk  
D2(config-if)#switchport trunk native vlan 999  
D2(config-if)#switchport trunk allowed vlan 100-102  
D2(config-if)#exit  
D2(config)# interface range e1/1-2  
D2(config-if-range)#channel-protocol lACP  
D2(config-if-range)#channel-group 2 mode active  
D2(config-if-range)#  
Creating a port-channel interface Port-channel 2  
D2(config-if-range)#exit  
D2(config)#interfac port-channel 2  
D2(config-if)#switchport trunk encapsulation dot1q  
D2(config-if)#switchport mode trunk  
D2(config-if)#switchport trunk native vlan 999  
D2(config-if)#switchport trunk allowed vlan 100-102  
D2(config-if)#exit  
D2(config)#
```

### Switch A1:

```
A1(config)# interface range e0/1-2  
A1(config-if-range)#channel-protocol lACP  
A1(config-if-range)#channel-group 1 mode active  
A1(config-if-range)#  
Creating a port-channel interface Port-channel 1  
A1(config-if-range)#exit  
A1(config)#interfac port-channel 1  
A1(config-if)#switchport trunk native vlan 999  
A1(config-if)#switchport trunk allowed vlan 100-102  
A1(config-if)#switchport mode trunk  
A1(config-if)#exit  
A1(config)# interface range e1/1-2
```

```

A1(config-if-range)#channel-protocol lacp
A1(config-if-range)#channel-group 2 mode passive
A1(config-if-range)#
Creating a port-channel interface Port-channel 2
A1(config-if-range)#exit
A1(config)#interfac port-channel 2
A1(config-if)#switchport mode trunk
A1(config-if)#switchport trunk native vlan 999
A1(config-if)#switchport trunk allowed vlan 100-102
A1(config-if)#exit
A1(config)#

```

## Paso 6: Configurar los puertos de acceso a los PC.

### Switch D1:

```

D1(config)# interface e0/0
D1(config-if)#switchport mode access
D1(config-if)#switchport access vlan 100

```

### Switch D2:

```

D2(config)# interface e0/0
D2(config-if)#switchport mode access
D2(config-if)#switchport access vlan 102

```

### Switch A1:

```

A1(config)# interface e1/3
A1(config-if)#switchport mode access
A1(config-if)#switchport access vlan 101
A1(config-if)#exit
A1(config)# interface e2/0
A1(config-if)#switchport mode access
A1(config-if)#switchport access vlan 100
A1(config-if)#exit
A1(config)#

```

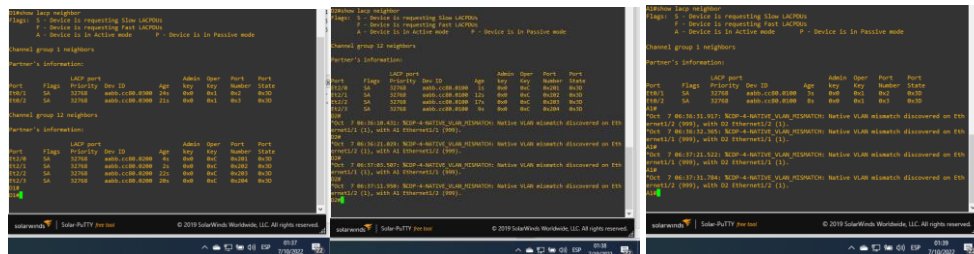


Figura 5. Verificación del LACP

## Paso 7: Verificar los PC en DHCP:

The image shows two screenshots of a SolarWinds Solar-PuTTY terminal window. The top screenshot shows the configuration for PC2, where the IP address is 10.53.102.254. The bottom screenshot shows the configuration for PC3, where the IP address is 10.53.101.254. Both screenshots show the output of the 'ip dhcp' and 'sh' commands, displaying the IP address, gateway, MAC address, and LPORT for each PC.

```
PC2> ip dhcp
DORA IP 10.53.102.110/24 GW 10.53.102.254

PC2> sh

NAME IP/MASK GATEWAY MAC LPORT RHOST:PORT
PC2 10.53.102.110/24 10.53.102.254 00:50:79:66:68:01 20046 127.0.0.1:20047
fe08:1260:79ff:fe66:6801/64
2001:d08:100:1011:2050:79ff:fe66:6801/64 eui-64

PC2>
```

```
PC3> ip dhcp
DORA IP 10.53.101.110/24 GW 10.53.101.254

PC3> sh

NAME IP/MASK GATEWAY MAC LPORT RHOST:PORT
PC3 10.53.101.110/24 10.53.101.254 00:50:79:66:68:02 20048 127.0.0.1:20049
fe08:1260:79ff:fe66:6802/64
2001:d08:100:1011:2050:79ff:fe66:6802/64 eui-64

PC3>
```

Figura 6. IP de los PC en DHCP

## Paso 8: Verificación de la conectividad de la LAN local

PC1 should successfully ping:

- D1: 10.53.100.1
- D2: 10.53.100.2
- PC4: 10.53.100.6

The screenshot shows the output of three ping commands from PC1. The first ping is to 10.53.100.1, the second to 10.53.100.2, and the third to 10.53.100.6. All pings are successful, showing 84 bytes received and various TTL and time values.

```
PC1> ping 10.53.100.1
84 bytes from 10.53.100.1: icmp_seq=1 ttl=255 time=0.985 ms
84 bytes from 10.53.100.1: icmp_seq=2 ttl=255 time=0.722 ms
84 bytes from 10.53.100.1: icmp_seq=3 ttl=255 time=0.539 ms
84 bytes from 10.53.100.1: icmp_seq=4 ttl=255 time=0.689 ms
84 bytes from 10.53.100.1: icmp_seq=5 ttl=255 time=0.766 ms

PC1> ping 10.53.100.2
84 bytes from 10.53.100.2: icmp_seq=1 ttl=255 time=0.333 ms
84 bytes from 10.53.100.2: icmp_seq=2 ttl=255 time=0.725 ms
84 bytes from 10.53.100.2: icmp_seq=3 ttl=255 time=1.044 ms
84 bytes from 10.53.100.2: icmp_seq=4 ttl=255 time=0.991 ms
84 bytes from 10.53.100.2: icmp_seq=5 ttl=255 time=1.416 ms

PC1> ping 10.53.100.6
84 bytes from 10.53.100.6: icmp_seq=1 ttl=64 time=0.803 ms
84 bytes from 10.53.100.6: icmp_seq=2 ttl=64 time=4.883 ms
84 bytes from 10.53.100.6: icmp_seq=3 ttl=64 time=0.958 ms
84 bytes from 10.53.100.6: icmp_seq=4 ttl=64 time=1.831 ms
84 bytes from 10.53.100.6: icmp_seq=5 ttl=64 time=1.204 ms
```

PC2 should successfully ping:

- D1: 10.53.102.1

- D2: 10.53.102.2

```

PC2> ping 10.53.102.1
84 bytes from 10.53.102.1 icmp_seq=1 ttl=255 time=1.296 ms
84 bytes from 10.53.102.1 icmp_seq=2 ttl=255 time=1.230 ms
84 bytes from 10.53.102.1 icmp_seq=3 ttl=255 time=1.032 ms
84 bytes from 10.53.102.1 icmp_seq=4 ttl=255 time=0.741 ms
84 bytes from 10.53.102.1 icmp_seq=5 ttl=255 time=1.659 ms

PC2> ping 10.53.102.2
84 bytes from 10.53.102.2 icmp_seq=1 ttl=255 time=0.739 ms
84 bytes from 10.53.102.2 icmp_seq=2 ttl=255 time=0.578 ms
84 bytes from 10.53.102.2 icmp_seq=3 ttl=255 time=0.511 ms
84 bytes from 10.53.102.2 icmp_seq=4 ttl=255 time=0.528 ms
84 bytes from 10.53.102.2 icmp_seq=5 ttl=255 time=0.862 ms

PC2>

```

**PC3 should successfully ping:**

- D1: 10.53.101.1
- D2: 10.53.101.2

```

PC3> ping 10.53.101.1
84 bytes from 10.53.101.1 icmp_seq=1 ttl=255 time=1.022 ms
84 bytes from 10.53.101.1 icmp_seq=2 ttl=255 time=0.993 ms
84 bytes from 10.53.101.1 icmp_seq=3 ttl=255 time=0.928 ms
84 bytes from 10.53.101.1 icmp_seq=4 ttl=255 time=1.043 ms
84 bytes from 10.53.101.1 icmp_seq=5 ttl=255 time=0.899 ms

PC3> ping 10.53.101.2
84 bytes from 10.53.101.2 icmp_seq=1 ttl=255 time=1.168 ms
84 bytes from 10.53.101.2 icmp_seq=2 ttl=255 time=1.100 ms
84 bytes from 10.53.101.2 icmp_seq=3 ttl=255 time=3.501 ms
84 bytes from 10.53.101.2 icmp_seq=4 ttl=255 time=1.952 ms
84 bytes from 10.53.101.2 icmp_seq=5 ttl=255 time=1.632 ms

PC3>

```

**PC4 should successfully ping:**

- D1: 10.53.100.1
- D2: 10.53.100.2
- PC1: 10.53.100.5

```

PC4> ping 10.53.100.1
84 bytes from 10.53.100.1 icmp_seq=1 ttl=255 time=0.704 ms
84 bytes from 10.53.100.1 icmp_seq=2 ttl=255 time=0.896 ms
84 bytes from 10.53.100.1 icmp_seq=3 ttl=255 time=4.055 ms
84 bytes from 10.53.100.1 icmp_seq=4 ttl=255 time=0.930 ms
84 bytes from 10.53.100.1 icmp_seq=5 ttl=255 time=1.278 ms

PC4> ping 10.53.100.2
84 bytes from 10.53.100.2 icmp_seq=1 ttl=255 time=5.372 ms
84 bytes from 10.53.100.2 icmp_seq=2 ttl=255 time=1.074 ms
84 bytes from 10.53.100.2 icmp_seq=3 ttl=255 time=2.442 ms
84 bytes from 10.53.100.2 icmp_seq=4 ttl=255 time=5.748 ms
84 bytes from 10.53.100.2 icmp_seq=5 ttl=255 time=2.116 ms

PC4> ping 10.53.100.5
84 bytes from 10.53.100.5 icmp_seq=1 ttl=64 time=0.727 ms
84 bytes from 10.53.100.5 icmp_seq=2 ttl=64 time=1.032 ms
84 bytes from 10.53.100.5 icmp_seq=3 ttl=64 time=1.021 ms
84 bytes from 10.53.100.5 icmp_seq=4 ttl=64 time=0.730 ms
84 bytes from 10.53.100.5 icmp_seq=5 ttl=64 time=0.929 ms

PC4>

```

Figura 7. Ping entre los dispositivos de la red local

## PART 3 CONFIGURE ROUTING PROTOCOLS

### Paso 1 Configuración OSPFv2

#### Router R1:

```
R1(config)#router ospf 4
R1(config-router)#router-id 0.0.4.1
R1(config-router)#network 10.53.10.0 0.0.0.255 area 0
R1(config-router)#network 10.53.13.0 0.0.0.255 area 0
R1(config-router)#exit
R1(config)#ip route 0.0.0.0 0.0.0.0 e1/0
R1(config)#router ospf 4
R1(config-router)#default-information originate
```

#### Router R3:

```
R3(config)#router ospf 4
R3(config-router)#router-id 0.0.4.3
R3(config-router)#network 10.53.11.0 0.0.0.255 area 0
R3(config-router)#network 10.53.13.0 0.0.0.255 area 0
```

#### Switch D1:

```
D1(config)#router ospf 4
D1(config-router)#router-id 0.0.4.131
D1(config-router)#network 10.53.10.0 0.0.0.255 area 0
D1(config-router)#network 10.53.100.0 0.0.0.255 area 0
D1(config-router)#network 10.53.101.0 0.0.0.255 area 0
D1(config-router)#network 10.53.102.0 0.0.0.255 area 0
D1(config-router)#passive-interface default
D1(config-router)#no passive-interface e1/2
```

#### Switch D2:

```
D2(config)#router ospf 4
D2(config-router)#router-id 0.0.4.132
D2(config-router)#network 10.53.11.0 0.0.0.255 area 0
D2(config-router)#network 10.53.100.0 0.0.0.255 area 0
D2(config-router)#network 10.53.101.0 0.0.0.255 area 0
D2(config-router)#network 10.53.102.0 0.0.0.255 area 0
D2(config-router)#passive-interface default
D2(config-router)#no passive-interface e1/0
```

## Paso 2: Configuración de OSPFv3

### Router R1:

```
R1(config)#ipv6 router ospf 6
R1(config-rtr)#router-id 0.0.6.1
R1(config-rtr)#exit
R1(config)#interface e1/1
R1(config-if)#ipv6 ospf 6 area 0
R1(config-if)#interface e1/2
R1(config-if)#ipv6 ospf 6 area 0
R1(config-if)#exit
R1(config)#ipv6 router ospf 6
R1(config-rtr)#default-information originate
```

### Router R3:

```
R3(config)#ipv6 router ospf 6
R3(config-rtr)#router-id 0.0.6.3
R3(config-rtr)#exit
R3(config)#interface e1/0
R3(config-if)#ipv6 ospf 6 area 0
R3(config-if)#interface e1/1
R3(config-if)#ipv6 ospf 6 area 0
```

### Switch D1:

```
D1(config)#ipv6 router ospf 6
D1(config-rtr)#router-id 0.0.6.131
D1(config-rtr)#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)#interface vlan 101
D1(config-if)#ipv6 ospf 6 area 0
D1(config-if)#interface vlan 102
D1(config-if)#ipv6 ospf 6 area 0
```

### Switch D2:

```
D2(config)#ipv6 router ospf 6
D2(config-rtr)#router-id 0.0.6.132
D2(config-rtr)#interface e1/0
D2(config-if)#ipv6 ospf 6 area 0
D2(config-if)#interface vlan 100
D2(config-if)#ipv6 ospf 6 area 0
D2(config-if)#interface vlan 101
D2(config-if)#ipv6 ospf 6 area 0
D2(config-if)#interface vlan 102
D2(config-if)#ipv6 ospf 6 area 0
```

### **Paso 3: Configuración MP-BGP en la red ISP R2.**

#### **Router R2:**

```
R2(config)#ip route 0.0.0.0 0.0.0.0 loopback 0
R2(config)#ipv6 route ::/0 loopback 0
R2(config)#router bgp 500
R2(config-router)#bgp router-id 2.2.2.2
R2(config-router)#no bgp default ipv4-unicast
R2(config-router)#neighbor 209.165.200.225 remote-as 300
R2(config-router)#neighbor 2001:db8:200::1 remote-as 300
R2(config-router)#address-family ipv4 unicast
R2(config-router-af)#neighbor 209.165.200.225 activate
R2(config-router-af)#network 2.2.2.2 mask 255.255.255.255
R2(config-router-af)#network 0.0.0.0 mask 0.0.0.0
R2(config-router-af)#exit
R2(config-router)#address-family ipv6 unicast
R2(config-router-af)#neighbor 2001:db8:200::1 activate
R2(config-router-af)#network 2001:db8:2222::1/128
R2(config-router-af)#network ::/0
R2(config-router-af)#exit
```

### **Paso 4: Configuración MP-BGP en la red ISP R1**

#### **Router R1:**

```
R1(config)#ip route 10.0.0.0 255.0.0.0 null 0
R1(config)#ipv6 route 2001:db8:100::/48 null 0
R1(config)#router bgp 300
R1(config-router)#bgp router-id 1.1.1.1
R1(config-router)#no bgp default ipv4-unicast
R1(config-router)#neighbor 209.165.200.226 remote-as 500
R1(config-router)#neighbor 2001:db8:200::2 remote-as 500
R1(config-router)#address-family ipv4 unicast
R1(config-router-af)#neighbor 209.165.200.226 activate
R1(config-router-af)#network 10.0.0.0 mask 255.0.0.0
R1(config-router-af)#exit
R1(config-router)#address-family ipv6 unicast
R1(config-router-af)#neighbor 2001:db8:200::2 activate
R1(config-router-af)#network 2001:db8:100::/48
```

Issue **show run | section ^router ospf** on R1, R3, D1, and D2; output should appear as below. Verify task 3.1 on each device.

### Router R1:

```
R1#show run | section ^router ospf
router ospf 4
router-id 0.0.4.1
network 10.53.10.0 0.0.0.255 area 0
network 10.53.13.0 0.0.0.255 area 0
default-information originate
R1#
```

### Router R3:

```
R3#show run | section ^router ospf
router ospf 4
router-id 0.0.4.3
network 10.53.11.0 0.0.0.255 area 0
network 10.53.13.0 0.0.0.255 area 0
R3#
```

### Switch 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 10.53.10.0 0.0.0.255 area 0
network 10.53.100.0 0.0.0.255 area 0
network 10.53.101.0 0.0.0.255 area 0
network 10.53.102.0 0.0.0.255 area 0
D1#
```

### Switch 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 10.53.11.0 0.0.0.255 area 0
network 10.53.100.0 0.0.0.255 area 0
network 10.53.101.0 0.0.0.255 area 0
network 10.53.102.0 0.0.0.255 area 0
D2#
```

Figura 8. Verificación de show run | section ^router ospf on R1, R3, D1, and D2

Issue **show run | section ^ipv6 router** and **show ipv6 ospf interface brief** on R1, R3, D1, and D2; output should appear as below. Verify task 3.2 on each device.

### Router R1:

```
R1#show run | section ^ipv6 router
ipv6 router ospf 6
router-id 0.0.6.1
default-information originate
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 5 10 BDR 1/1
R1#
```

Router R3:

```
R3#show run | section ^ipv6 router
ipv6 router ospf 6
router-id 0.0.6.3
R3#show ipv6 ospf interface brief
Interface PID Area Intf ID Cost State Nbrs F/C
Et1/1 6 0 5 10 DR 1/1
Et1/0 6 0 4 10 DR 1/1
R3#
```

Switch D1:

```
D1#show run | section ^ipv6 router
ipv6 router ospf 6
router-id 0.0.6.131
D1#show ipv6 ospf interface brief
Interface PID Area Intf ID Cost State Nbrs F/C
V1102 6 0 18 1 DR 1/1
V1101 6 0 17 1 DR 1/1
V1100 6 0 16 1 DR 1/1
Et1/2 6 0 15 10 BDR 1/1
D1#
```

Switch D2:

```
D2#show run | section ^ipv6 router
ipv6 router ospf 6
router-id 0.0.6.132
D2#show ipv6 ospf interface brief
Interface PID Area Intf ID Cost State Nbrs F/C
V1102 6 0 18 1 BDR 1/1
V1101 6 0 17 1 BDR 1/1
V1100 6 0 16 1 BDR 1/1
Et1/0 6 0 15 10 BDR 1/1
D2#
```

Figura 9. Verificación show run | section ^ipv6 router and show ipv6 ospf

Issue **show run | section bgp** and **show run | include route** on R2; output should appear as below. Verify task 3.3.

Router R2:

```
R2#show run | section bgp
router bgp 65521
bgp router-id 2.2.2.2
bgp log neighbor-changes
bgp graceful-restart
neighbor 200.100.200.1 remote-as 65521
neighbor 200.100.200.255 remote-as 65521
!
address-family ipv4
neighbor 2.2.2.2 asak 200.100.200.255
neighbor 200.100.200.255 activate
exit-address-family
!
address-family ipv6
neighbor 100.100.200.255
neighbor 200.100.200.1 activate
exit-address-family
!
!
R2#
```

```
R2#show run | include route
router bgp 65521
bgp router-id 2.2.2.2
ip route 0.0.0.0 0.0.0.0 Loopback0
ipv6 route ::/0 Loopback0
R2#
```

Figura 10. Verificación show run | section bgp and show run | include route on R2

Issue **show run | section bgp** on R1; output should appear as below. Verify task 3.4.

Router R1:

```
R1#show run | section bgp
router bgp 300
  bgp router-id 1.1.1.1
  bgp log-neighbor-changes
  no bgp default ipv4-unicast
  neighbor 2001:DB8:200::2 remote-as 500
  neighbor 209.165.200.226 remote-as 500
}
address-family ipv4
  network 10.0.0.0
  network 10.53.0.0 mask 255.255.0.0
  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 11. Verificación show run | section bgp on R1

Issue **show ip route | include O|B** on R1; output should appear as below. Verify that OSPF and BGP for IPv4 are working properly.

Router 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, I - ISIS
2.2.2.2 [20/0] via 209.165.200.226, 00:18:51
O
10.53.11.0/24 [110/20] via 10.53.13.3, 00:16:39, Ethernet1/1
O
10.53.100.0/24 [110/11] via 10.53.10.2, 00:09:15, Ethernet1/2
O
10.53.101.0/24 [110/11] via 10.53.10.2, 00:09:15, Ethernet1/2
O
10.53.102.0/24 [110/11] via 10.53.10.2, 00:09:15, Ethernet1/2
R1#
```

Figura 12. Verificación show ip route | include O|B on R1

Issue **show ipv6 route command** on R1; should appear as below. Verify that OSPFv3 for IPv6 is working properly.

Router R1:

```
R1#show ip route
IPv6 Routing Table - default - 14 entries
Codes: C - Connected, S - Static, D - Dynamic, R - Per-user Static route
D - BGP, HA - Home Agent, M - Mobile Router, E - EIGRP
E1 - EIGRP Summary, E2 - EIGRP External, IA - OSPF Inter Area
N1 - OSPF NSSA External Type 1, N2 - OSPF NSSA External Type 2
O - OSPFv3, ODR - OSPFv3 Over Demand Route, H - NHRP, I - ISIS
N1 - OSPF NSSA ext 1, N2 - OSPF NSSA ext 2, I - ISIS
O:
:::/8 [1/0]
  via Ethernet1/0, directly connected
:::100::/64 [1/0]
  via Null0, directly connected
:::100:100::/64 [110/11]
  via Ethernet1/2, receive
:::100:100:100::/64 [110/11]
  via Ethernet1/2, receive
:::100:100:100:100::/64 [110/11]
  via Ethernet1/2, receive
:::100:100:100:100:100::/64 [110/11]
  via Ethernet1/2, receive
:::100:100:100:100:100:100::/64 [110/11]
  via Ethernet1/2, receive
:::100:100:100:100:100:100:100::/64 [110/11]
  via Ethernet1/2, receive
:::100:100:100:100:100:100:100:100::/64 [110/11]
  via Ethernet1/2, receive
:::100:100:100:100:100:100:100:100:100::/64 [110/11]
  via Ethernet1/2, receive
:::100:100:100:100:100:100:100:100:100:100::/64 [110/11]
  via Ethernet1/2, receive
:::100:100:100:100:100:100:100:100:100:100:100::/64 [110/11]
  via Ethernet1/2, receive
:::100:100:100:100:100:100:100:100:100:100:100:100::/64 [110/11]
  via Ethernet1/2, receive
:::100:100:100:100:100:100:100:100:100:100:100:100:100::/64 [110/11]
  via Ethernet1/2, receive
R1#
```

Figura 13. Verificación show ipv6 route command on R1



```

D1#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
i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
ia - IS-IS inter area, * - candidate default, U - per-user static route
o - ODR, P - periodic downloaded static route, H - NHRP, I - LISP
a - application route
+ - replicated route, % - next hop override

Gateway of last resort is 10.53.10.1 to network 0.0.0.0

O*E2 0.0.0.0/0 [110/1] via 10.53.10.1, 00:12:40, Ethernet1/2
L 10.0.0.0/8 is variably subnetted, 10 subnets, 2 masks
C 10.53.10.0/24 is directly connected, Ethernet1/2
L 10.53.10.2/32 is directly connected, Ethernet1/2
L 10.53.11.0/24 [110/30] via 10.53.10.1, 00:12:40, Ethernet1/2
L 10.53.13.0/24 [110/20] via 10.53.10.1, 00:12:40, Ethernet1/2
C 10.53.100.0/24 is directly connected, Vlan100
C 10.53.100.1/32 is directly connected, Vlan100
C 10.53.101.0/24 is directly connected, Vlan101
L 10.53.101.1/32 is directly connected, Vlan101
C 10.53.102.0/24 is directly connected, Vlan102
L 10.53.102.1/32 is directly connected, Vlan102
D1#

D2#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
i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
ia - IS-IS inter area, * - candidate default, U - per-user static route
o - ODR, P - periodic downloaded static route, H - NHRP, I - LISP
a - application route
+ - replicated route, % - next hop override

Gateway of last resort is 10.53.11.1 to network 0.0.0.0

O*E2 0.0.0.0/0 [110/1] via 10.53.11.1, 00:09:51, Ethernet1/0
L 10.0.0.0/8 is variably subnetted, 10 subnets, 2 masks
C 10.53.10.0/24 [110/30] via 10.53.11.1, 00:09:51, Ethernet1/0
C 10.53.11.0/24 is directly connected, Ethernet1/0
L 10.53.11.2/32 is directly connected, Ethernet1/0
L 10.53.13.0/24 [110/20] via 10.53.11.1, 00:09:51, Ethernet1/0
C 10.53.100.0/24 is directly connected, Vlan100
C 10.53.100.2/32 is directly connected, Vlan100
C 10.53.101.0/24 is directly connected, Vlan101
L 10.53.101.2/32 is directly connected, Vlan101
C 10.53.102.0/24 is directly connected, Vlan102
L 10.53.102.2/32 is directly connected, Vlan102
D2#

```

Figura 16. Verificación de la tabla de ruta IPv4

## Paso 5: Verificación del MP-BGP con Ping

- Ping D1 y D2 hacia Loopback 0

```

D1#ping 2.2.2.2
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2.2.2.2, timeout is 2 seconds:
!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 20/30/48 ms
D1#

D2#ping 2.2.2.2
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2.2.2.2, timeout is 2 seconds:
!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 32/46/57 ms
D2#

```

Figura 17. Verificación de Ping D1 y D2 hacia Loopback 0

## PART 4 CONFIGURE FIRST HOP REDUNDANCY

**Paso 1: En D1, cree IP SLAs que prueben la accesibilidad de la interfaz R1 G1/0**

### Switch D1:

```
D1(config)#
D1(config)#ip sla 4
D1(config-ip-sla)#icmp-echo 10.53.10.1 source-ip 10.53.10.2
D1(config-ip-sla-echo)#frequency 5
D1(config-ip-sla-echo)#exit
D1(config)#ip sla schedule 4 start-time now life forever
D1(config)#track 4 ip sla 4 reachability
D1(config-track)#delay up 10 down 15
D1(config-track)#exit
D1(config)#ip sla 6
D1(config-ip-sla)#icmp-echo 2001:db8:100:1010::1
D1(config-ip-sla-echo)#frequency 5
D1(config-ip-sla-echo)#exit
D1(config)#ip sla schedule 6 start-time now life forever
D1(config)#track 6 ip sla 6 reachability
D1(config-track)#delay up 10 down 15
D1(config-track)#exit
```

**Paso 2: En D2, cree IP SLAs que prueben la accesibilidad de la interfaz R3 G1/0.**

### Switch D2:

```
D2(config)#ip sla 4
D2(config-ip-sla)#icmp-echo 10.53.11.1 source-interface
e6/0D2(config-ip-sla-echo)#frequency 5
D2(config-ip-sla-echo)#exit
D2(config)#ip sla schedule 4 start-time now life forever
D2(config)#track 4 ip sla 4 reachability
D2(config-track)#delay up 10 down 15
D2(config-track)#exit
D2(config)#ip sla 6
D2(config-ip-sla)#icmp-echo 2001:db8:100:1011::1
D2(config-ip-sla-echo)#frequency 5
D2(config-ip-sla-echo)#exit
D2(config)#ip sla schedule 6 start-time now life forever
D2(config)#track 6 ip sla 6 reachability
D2(config-track)#delay up 10 down 15
D2(config-track)#exit
```

### **Paso 3: En D1 configure HSRPv2.**

#### **Switch D1:**

```
D1(config)#interface vlan 100
D1(config-if)#standby version 2
D1(config-if)#standby 104 ip 10.53.100.254
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
D1(config-if)#exit
D1(config)#interface vlan 101
D1(config-if)#standby version 2
D1(config-if)#standby 114 ip 10.53.101.254
D1(config-if)#standby 114 preempt
D1(config-if)#standby 114 track 4 decrement 60
D1(config-if)#standby 116 ipv6 autoconfig
D1(config-if)#standby 116 preempt
D1(config-if)#standby 116 track 6 decrement 60
D1(config-if)#exit
D1(config)#interface vlan 102
D1(config-if)#standby version 2
D1(config-if)#standby 124 ip 10.53.102.254
D1(config-if)#standby 124 priority 150
D1(config-if)#standby 124 preempt
D1(config-if)#standby 124 track 4 decrement 60
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
D1(config-if)#exit
```

### **Paso 4: En D2 configure HSRPv2.**

#### **Switch D2:**

```
D2(config)#interface vlan 100
D2(config-if)#standby version 2
D2(config-if)#standby 104 ip 10.53.100.254
D2(config-if)#standby 104 preempt
D2(config-if)#standby 104 track 4 decrement 60
D2(config-if)#standby 106 ipv6 autoconfig
D2(config-if)#standby 106 preempt
D2(config-if)#standby 106 track 6 decrement 60
D2(config-if)#exit
D2(config)#interface vlan 101
```

```

D2(config-if)#standby version 2
D2(config-if)#standby 114 ip 10.53.101.254
D2(config-if)#standby 114 priority 150
D2(config-if)#standby 114 preempt
D2(config-if)#standby 114 track 4 decrement 60
D2(config-if)#standby 116 ipv6 autoconfig
D2(config-if)#standby 116 priority 150
D2(config-if)#standby 116 preempt
D2(config-if)#standby 116 track 6 decrement 60
D2(config-if)#exit
D2(config)#interface vlan 102
D2(config-if)#standby version 2
D2(config-if)#standby 124 ip 10.53.102.254
D2(config-if)#standby 124 preempt
D2(config-if)#standby 124 track 4 decrement 60
D2(config-if)#standby 126 ipv6 autoconfig
D2(config-if)#standby 126 preempt
D2(config-if)#standby 126 track 6 decrement 60
D2(config-if)#exit

```

Issue the **show run | section ip sla** command on D1; output should appear as below. Verify task 4.1 and bullet 3 of task 4.3 for Switch D1.  
**Switch D1:**

```

D1#show run | section ip sla
track 4 ip sla 4 reachability
delay down 15 up 10
track 6 ip sla 6 reachability
delay down 15 up 10
ip sla 4
icmp-echo 10.53.10.1 source-ip 10.53.10.2
frequency 5
ip sla schedule 4 life forever start-time now
ip sla 6
icmp-echo 2001::DB8:100:1010::1
frequency 5
ip sla schedule 6 life forever start-time now
D1#

```

Figura 18. Verificación de show run | section ip sla

Issue the **show standby brief** command on D1; output should appear as below. Verify task 4.3.  
**Switch D1:**

```

D1#show standby brief
          P indicates configured to preempt.
Interface Grp Pri P State Active Standby Virtual IP
Vl100     104 150 P Active local 10.53.100.2 10.53.100.254
Vl100     106 150 P Active local FE80::D2:2 FE80::5:73FF:FEA0:6
Vl101     114 100 P Standby 10.53.101.2 local 10.53.101.254
Vl101     116 100 P Standby FE80::D2:3 local FE80::5:73FF:FEA0:7
Vl102     124 150 P Active local 10.53.102.2 10.53.102.254
Vl102     126 150 P Active local FE80::D2:4 FE80::5:73FF:FEA0:7
D1#

```

## Switch D2:

```
D2#show standby brief
                P indicates configured to preempt.
Interface  Grp  Pri P State  Active      Standby      Virtual IP
Vl100     104 100 P Standby 10.53.100.1 local        10.53.100.254
Vl100     106 100 P Standby FE80::D1:2 local        FE80::5:73FF:FEA0:6A
Vl101     114 150 P Active  local      10.53.101.1  10.53.101.254
Vl101     116 150 P Active  local      FE80::D1:3   FE80::5:73FF:FEA0:74
Vl102     124 100 P Standby 10.53.102.1 local        10.53.102.254
Vl102     126 100 P Standby FE80::D1:4 local        FE80::5:73FF:FEA0:7E
D2#
```

Figura 19. Verificación de show standby brief command on D1

Issue the **show run | section ip sla** command on D2; output should appear as below. Verify task 4.2 and bullet 3 of task 4.3 for Switch D2.

## Switch D2:

```
D2#show run | section ip sla
track 4 ip sla 4 reachability
delay down 15 up 10
track 6 ip sla 6 reachability
delay down 15 up 10
ip sla 4
icmp-echo 10.53.11.1 source-interface Ethernet1/0
frequency 5
ip sla schedule 4 life forever start-time now
ip sla 6
icmp-echo 2001:DB8:100:1011::1
frequency 5
ip sla schedule 6 life forever start-time now
D2#
```

Figura 20. Verificación de show run | section ip sla command on D2

## Verificación del Standby Switch D1:

```
D1#show run | section standby
standby version 2
standby 104 ip 10.53.100.254
standby 104 priority 150
standby 104 preempt
standby 104 track 4 decrement 60
standby 106 ipv6 autoconfig
standby 106 priority 150
standby 106 preempt
standby 106 track 6 decrement 60
standby version 2
standby 114 ip 10.53.101.254
standby 114 preempt
standby 114 track 4 decrement 60
standby 116 ipv6 autoconfig
standby 116 preempt
standby 116 track 6 decrement 60
standby version 2
standby 124 ip 10.53.102.254
standby 124 priority 150
standby 124 preempt
standby 124 track 4 decrement 60
standby 126 ipv6 autoconfig
standby 126 priority 150
standby 126 preempt
standby 126 track 6 decrement 60
D1#
```

## Switch D2:

```
D2#show run | section standby
standby version 2
standby 104 ip 10.53.100.254
standby 104 preempt
standby 104 track 4 decrement 60
standby 106 ipv6 autoconfig
standby 106 preempt
standby 106 track 6 decrement 60
standby version 2
standby 114 ip 10.53.101.254
standby 114 priority 150
standby 114 preempt
standby 114 track 4 decrement 60
standby 116 ipv6 autoconfig
standby 116 priority 150
standby 116 preempt
standby 116 track 6 decrement 60
standby version 2
standby 124 ip 10.53.102.254
standby 124 preempt
standby 124 track 4 decrement 60
standby 126 ipv6 autoconfig
standby 126 preempt
standby 126 track 6 decrement 60
D2#
```

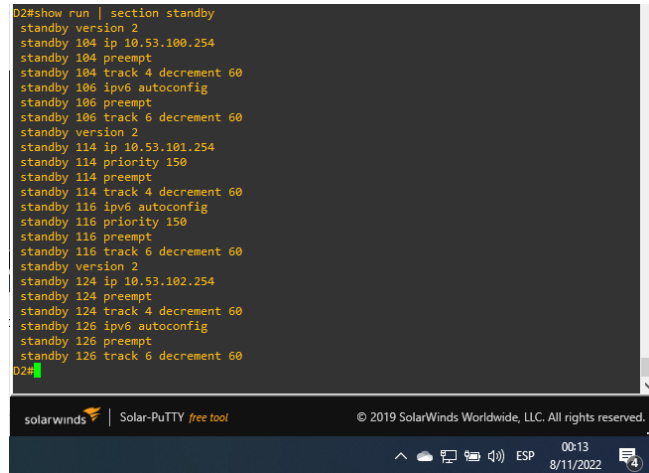


Figura 21. Verificación de Verificación del Standby

## CONCLUSIONES

Se puede notar como se utiliza la combinación de técnicas y protocolos como: Redundancia de enlaces, Spanning tree y LACP para sacar el mejor provecho a la conexión en capa 2; donde el primero permite dar tolerancia a las fallas y protección contra la inoperatividad, el segundo asegura que solo exista una ruta lógica y evita bucles en estas redundancias, finalmente el LACP combina las redundancias físicas en un solo enlace lógico de alta velocidad; una combinación poderosa pero que se debe realizar con cuidado y en orden para no crear errores premeditados en la red.

Se puede evidenciar que los protocolos de enrutamiento utilizados en el escenario OSPF y BGP son los más comunes que se pueden encontrar en un entorno real, muchas organizaciones utilizan el OSPF para enrutar como protocolo interno porque permite que se conozca toda la red a través de la tabla de enrutamiento de cada router evitando loops, también actualizan automáticamente las tables con cualquier cambio en la topología; el BGP para interconectar sistemas autónomos porque es normal que no todas las organizaciones utilicen el mismo protocolo de enrutamiento interno como lo es el ISP adicional sobre la importancia de las redundancias a nivel de capa 3 también se utilizan para evitar que los dispositivos locales queden fuera de red por algún fallo en el Gateway, utilizando SLAs para monitorear continuamente las interfaces del Gateway y el protocolo HSRP para tener un router activo con la interfaz virtual y el otro de reserva.

## BIBLIOGRAFÍA

- BITACORDABYTE. (18 de Julio de 2017). *Configurar DHCP en router CISCO*. Obtenido de <https://bitacorabyte.wordpress.com/2017/07/18/configurar-dhcp-en-router-cisco/>
- CISCO. (26 de Octubre de 2005). *How to Configure SNMP Community Strings*. Obtenido de <https://www.cisco.com/c/en/us/support/docs/ip/simple-network-management-protocol-snmp/7282-12.html>
- CISCO. (11 de Junio de 2020). *RSTP: Configuración*. Obtenido de <https://ccnadesdecero.com/curso/rstp-configuracion/>
- Eugenio, G. (24 de Agosto de 2020). *Como configurar IP SLA tracking*. Obtenido de <https://estudiaredes.com/cisco/como-configurar-ip-sla-tracking/>
- Fernández Sánchez, A. (s.f.). *¿Cómo configurar NTP en Cisco?* Obtenido de <https://network-tic.com/como-configurar-ntp-en-cisco/>
- NetworkLessons. (s.f.). *Multiprotocol BGP (MP-BGP) Configuration*. Obtenido de <https://networklessons.com/bgp/multiprotocol-bgp-mp-bgp-configuration>
- Rosales, D. (2015). *AAA en Routers & Switches Cisco*. Obtenido de <https://delfirosales.blogspot.com/2014/04/aaa-en-routers-switches-cisco.html>