

Diplomado de Profundización en Redes de Nueva Generación

Configuración del Servicio de IPTV

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Introducción

En el siguiente trabajo se abordarán las temáticas principales sobre la configuración e identificación del Servicio de Iptv, a través de la investigación de los conceptos vigentes, los cuales son la base dentro de una arquitectura de red para realizar un streaming. De igual forma se identifican los protocolos y funciones de la capa de red, mediante el uso de los principios de direccionamiento IP, enmarcados dentro de los estándares.

Al reconocer las capas, protocolos, funciones y ventajas de la arquitectura NGN utilizada en la interconexión de redes, mediante la comparación con las redes tradicionales y el uso de protocolos involucrados. Se espera llegar a realizar una configuración de servicios multimedia para un escenario de NGN a nivel de simulación, aplicando los conceptos de arquitectura funcional y definiendo políticas de Calidad de Servicio (QoS, Quality of Service), Ospf, Mpls y Idp.

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Resumen

En el presente trabajo se explica el funcionamiento de los mecanismos QoS, por medio de diagramas de bloque y de flujo.

También se dan a conocer los pasos requeridos para configurar los mecanismos de la calidad de Servicio (QoS) y generar porcentajes sobre el ancho de banda total en el sistema.

Se realiza el diseño de la topología y la configuración de los componentes como routers y switches para crear un servicio Iptv, entre el servidor fuentes y los clientes, dentro de la máquina virtual.

Se implementa servicios multimedia de una red NGN simulada, usando tecnología Multicast, programa GNS3, windows xp en máquinas virtuales como virtualbox y el reproductor de multimedia VLC realizando la transmisión de una película desde un equipo Source a un equipo cliente.

Palabras claves: Multicast, NGN, IPTV, GNS3, QoS

Abstract

In the present work the operation of the QoS mechanisms is explained, by means of block and flow diagrams.

The steps required to configure the Quality of Service (QoS) mechanisms and generate percentages of the total bandwidth in the system are also disclosed.

The design of the topology and the configuration of the components such as routers and switches are carried out to create an IPTV service, between the source server and the clients, within the virtual machine.

Multimedia services of a simulated NGN network are implemented, using Multicast technology, GNS3 program, windows xp in virtual machines such as virtualbox and the VLC media player, transmitting a movie from a Source computer to a client computer.

Keywords: Multicast, NGN, IPTV, GNS3, QoS

Diagrama de Bloque de Calidad de Servicio (QoS)

1. Seleccionar dos mecanismos de QoS y describir el proceso que realiza cada uno mediante un diagrama de bloques.

Mecanismos de QoS

- Custom Queuing (CQ)

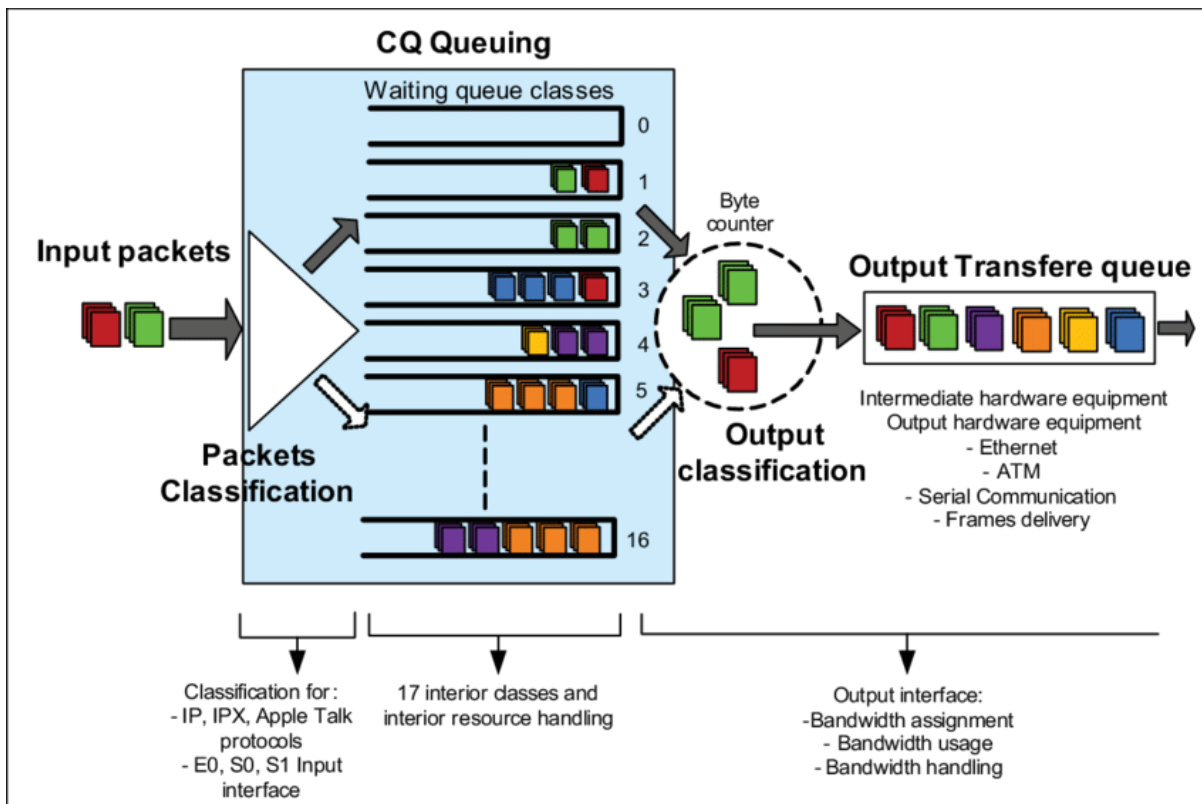


Figura No. 1. La cola personalizada (CQ) atiende 17 colas internas de manera circular. Amor

Chowdhury (2011).

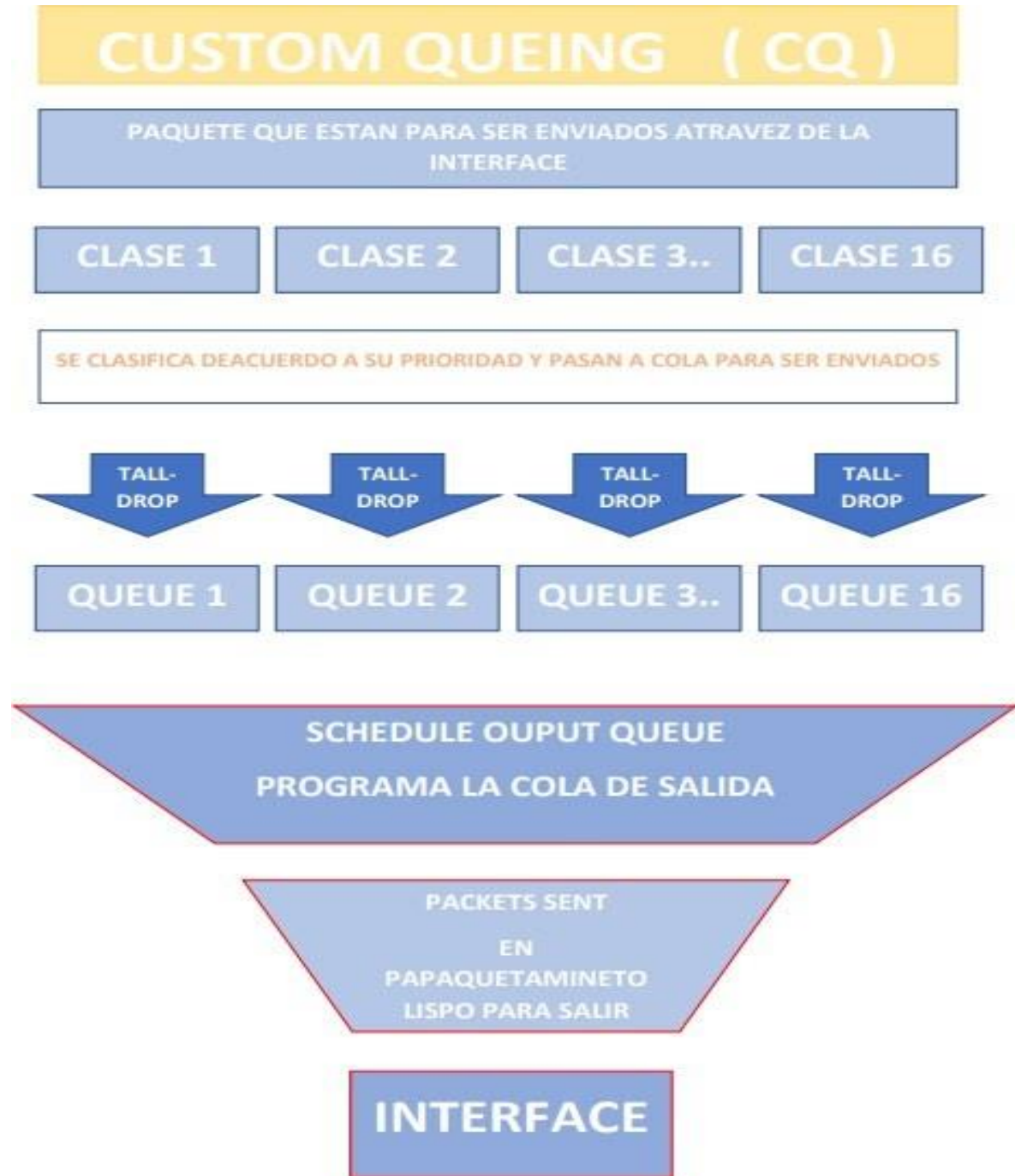


Figura No. 2. Diagrama de bloques. Configuración Servicio IPTV (2021).

2. Documente los pasos requeridos para definir un plan de QoS que incluya los siguientes Porcentajes sobre el ancho de banda total (separar tráficos mediante definición de clases):

- 10% del ancho de banda total para tráfico web
- 15% para tráfico de voz
- 20% para tráfico de streaming de video.

Realizamos el diseño de la red

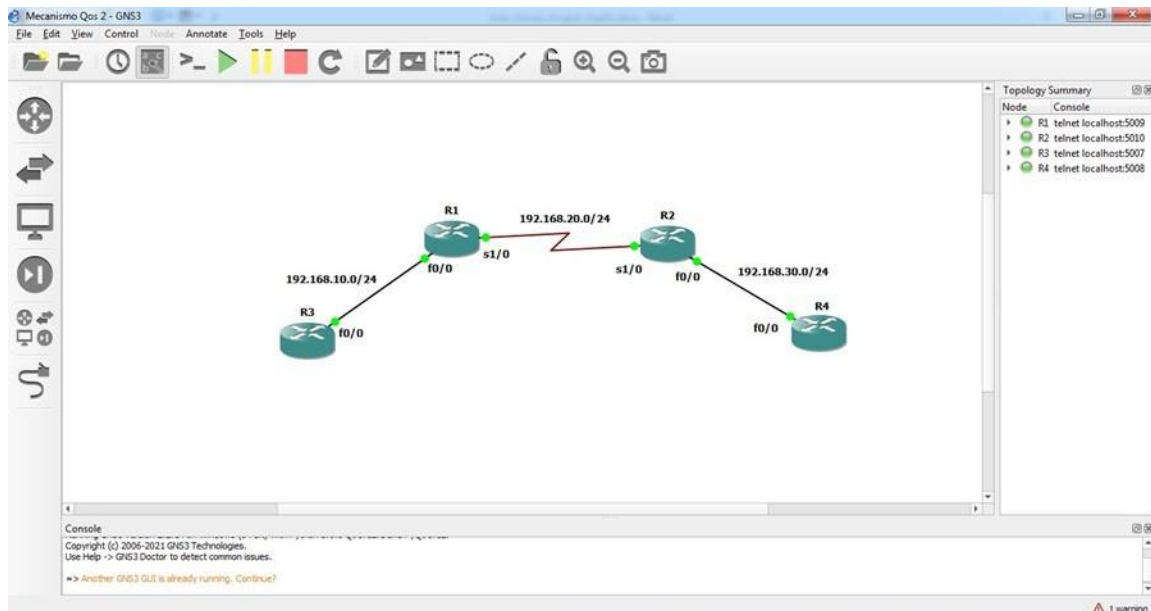


Figura No. 3. Topología de red

Luego ingresamos a la configuración general de cada uno de los router de la consola y configuramos la calidad de servicio, con los siguientes comandos.

```
#config t
```

```
#policy-map QoS1
```

```
#class VOIP
```

```
#priority percent 15
```

```
#class WEB
```

```
#bandwidth percent 10
```

```
#class IPTV
```

```
#bandwidth percent 20
```

```
#class PING
```

```
#bandwidth percent 2
```

```
#class class-default
```

```
#fair-queue
```

Mecanismo LLQ en el Router R2

La herramienta de encolamiento de baja latencia Low Latency Queueing LLQ lleva la disciplina de servicio de colas encolamiento de prioridad estricta (Strict Priority Queueing) a CBWFQ. Strict priority Queueing permite que el tráfico sensible al retardo como el tráfico de voz sea desencolado y enviado antes que paquetes de otras colas, dándole al tráfico sensible al retardo un tratamiento preferente sobre otros tipos de tráfico.

LLQ proporciona Strict Priority Queueing a CBWFQ reduciendo la varianza del retardo jitter en las conversaciones de voz. Cuando se activa LLQ se emplea una única cola de prioridad estricta (Strict Priority Queue) dentro de CBWFQ a nivel de clase, permitiendo llevar el tráfico perteneciente a una clase a una CBWFQ Strict Priority Queue. Dentro de una policy map se pueden configurar más de una clase para que usen LLQ, pero todo el tráfico de esas clases será encolado dentro de la misma Strict Priority Queue.

Cuando se configura LLQ mediante el comando `priority` para una clase, toma un ancho de banda como argumento que es el ancho de banda máximo en kilobits por segundo (kbps). Este parámetro garantiza un ancho de banda para la clase `priority`, pero también acota el flujo de paquetes de esa clase.

Ingresamos a la consola de cada uno de los router e ingresamos a la configuración general.

Usamos el comando priority para activar LLQ.

El comando priority define las acciones que se pueden aplicar dentro de una correspondencia de políticas de la Interfaz de línea de comando de calidad de servicio modular (MQC), que se aplica a una interfaz, subinterfaz o circuito virtual (VC) mediante el comando service-policy.

Específicamente, estos comandos proporcionan una garantía de ancho de banda a los paquetes que coinciden con los criterios de una clase de tráfico.

```
R2(config)#
R2(config)#access-list 100 permit udp any any range 16384 32000
R2(config)#access-list 101 permit tcp any any eq www
R2(config)#access-list 101 permit tcp any any eq 443
R2(config)#access-list 102 permit udp any any eq 5004
R2(config)#access-list 103 permit icmp any any
R2(config)#
```

Figura No. 4. Configuración del access-list

```
R2(config-cmap)#exit
R2(config)#
R2(config)#class-map VOZ
R2(config-cmap)#match access-group 101
R2(config-cmap)#exit
R2(config)#class-map WEB
R2(config-cmap)#match access-group 102
R2(config-cmap)#exit
R2(config)#class-map VIDEO
R2(config-cmap)#match access-group 103
R2(config-cmap)#exit
R2(config)#
R2(config)#policy-map QoS3
R2(config-pmap)#class VOZ
R2(config-pmap-c)#priority percent 15
R2(config-pmap-c)#exit
^
Invalid input detected at '^' marker.
R2(config-pmap-c)#priority percent 15
R2(config-pmap-c)#exit
R2(config-pmap-c)#class WEB
R2(config-pmap-c)#priority percent 10
R2(config-pmap-c)#exit
R2(config-pmap-c)#class VIDEO
R2(config-pmap-c)#priority percent 20
R2(config-pmap-c)#exit
R2(config-pmap)#
*Mar 1 00:27:54.315: %OSPF-5-ADJCHG: Process 10, Nbr 1.1.1.1 on Serial1/0 from LOADING to FULL, Loading Done
R2(config-pmap)#
*Mar 1 00:28:05.131: %OSPF-5-ADJCHG: Process 10, Nbr 1.1.1.1 on Serial1/0 from LOADING to FULL, Loading Done
R2(config-pmap)#
*Mar 1 00:28:14.463: %OSPF-5-ADJCHG: Process 10, Nbr 1.1.1.1 on Serial1/0 from LOADING to FULL, Loading Done
R2(config-pmap)#
*Mar 1 00:28:24.887: %OSPF-5-ADJCHG: Process 10, Nbr 1.1.1.1 on Serial1/0 from LOADING to FULL, Loading Done
R2(config-pmap)#
```

Figura No. 5. Configuración comando priority

Verificamos la Configuración

se verifica si los porcentajes sobre el ancho de banda quedaron:

- 10% del ancho de banda total para tráfico web
- 15% para tráfico de voz
- 20% para tráfico de streaming de video.

```

R2
ip tcp synwait-time 5

class-map match-all VOIP
class-map match-all VOZ
match access-group 101
class-map match-all WEB
match access-group 102
class-map match-all VIDEO
match access-group 103

policy-map QoS3
class VOZ
priority percent 15
class WEB
priority percent 10
class VIDEO
priority percent 20

interface Loopback0
ip address 2.2.2.2 255.255.255.255
ip ospf 10 area 0

interface FastEthernet0/0
ip address 192.168.30.2 255.255.255.0
ip ospf 10 area 0
duplex auto
speed auto

interface Serial0/0
no ip address
shutdown

```

Figura No. 6. Verificación de la Configuración

```

R2#show class-map
Class Map match-any class-default (id 0)
  Match any

Class Map match-all VOZ (id 2)
  Match access-group 101

Class Map match-all WEB (id 3)
  Match access-group 102

Class Map match-all VIDEO (id 4)
  Match access-group 103

R2#sh policy-map
Policy Map QoS3
Class VOZ
  Strict Priority
  Bandwidth 15 (%)
Class WEB
  Strict Priority
  Bandwidth 10 (%)
Class VIDEO
  Strict Priority
  Bandwidth 20 (%)

```

Figura No. 7. Verificación de parámetros en el Router 2

Configuración del Servicio de IPTV

3. Mediante el emulador GNS3 y el uso de máquinas virtuales, a partir del análisis del servicio de IPTV desarrollado en la Fase 10, implemente IPTV Multicast entre las sedes del escenario de red descrito en la Fase 1, el cual permitirá transferir contenidos multimedia entre dos sedes.

Documente los pasos en un informe

- Configuración de dispositivos y servidor TVIP
- Habilitación de protocolos de enrutamiento, Multicast, RTP, etc.
- Configuración de cliente de video VLC
- Pruebas funcionales.

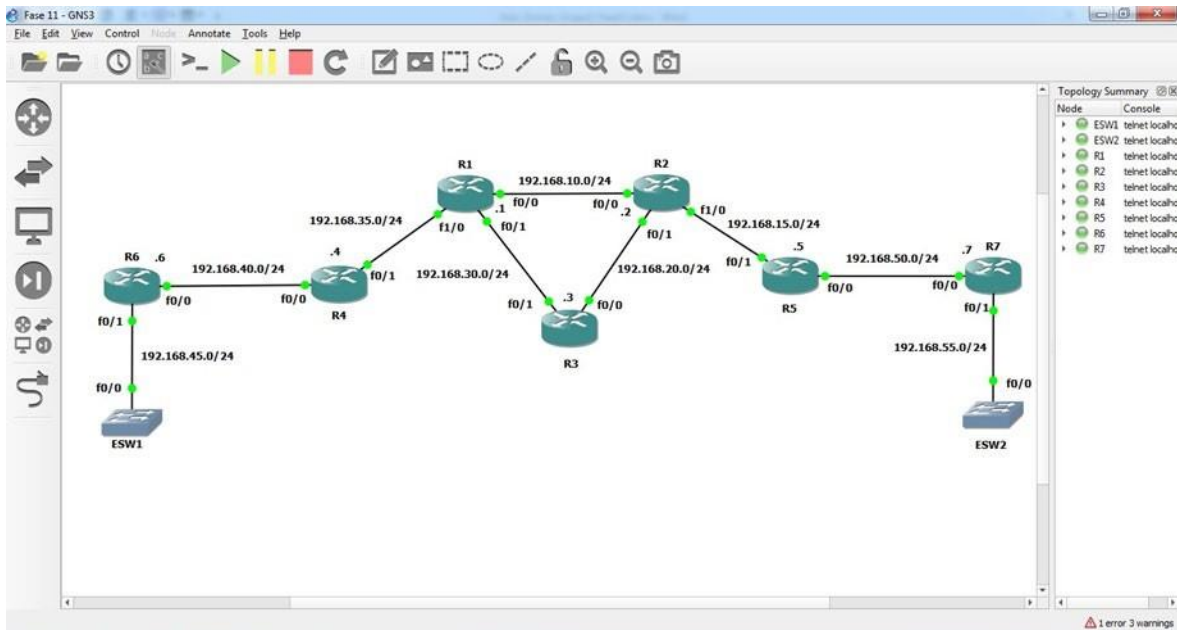


Figura No. 8. Topología de red IPTV

Diseño de la red en la Fase

R1

Interface	1.1.1.1			
loopback 0				
		255.255.255.255		
Interface f0/0	192.168.10.1			
		255.255.255.0		
Interface f0/1	192.168.30.1			
		255.255.255.0		
Interface f1/0	192.168.35.1			
		255.255.255.0		

```

R1#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R1(config)#int loopback 0
R1(config-if)#ip add
*May 13 14:43:10.263: %LINEPROTO-5-UPDOWN: Line protocol on Interface loopback0, changed state
to up
R1(config-if)#ip add 1.1.1.1 255.255.255.255
R1(config-if)#exit
R1(config)#int f0/0
R1(config-if)#ip add 192.168.10.1 255.255.255.0
R1(config-if)#no shut
R1(config-if)#exit
R1(config)#int f0/1
*May 13 14:43:30.195: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to up
*May 13 14:43:39.195: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed
state to up
R1(config)#int f0/1
R1(config-if)#ip add 192.168.30.1 255.255.255.0
R1(config-if)#no shut
R1(config-if)#exit
*May 13 14:44:37.543: %LINK-3-UPDOWN: Interface FastEthernet0/1, changed state to up
*May 13 14:44:38.543: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed
state to up
R1(config)#int f1/0
R1(config-if)#ip add 192.168.35.1 255.255.255.0
R1(config-if)#no shut
R1(config-if)#exit
R1(config)#
*May 13 14:45:22.655: %LINK-3-UPDOWN: Interface FastEthernet1/0, changed state to up
*May 13 14:45:23.655: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet1/0, changed
state to up
R1(config)#router ospf 10
R1(config-router)#router-id 1.1.1.1
R1(config-router)#network 192.168.10.0 0.0.0.255 area 0
R1(config-router)#network 192.168.30.0 0.0.0.255 area 0
R1(config-router)#network 192.168.35.0 0.0.0.255 area 0
R1(config-router)#network 1.1.1.1 0.0.0.0 area 0
R1(config-router)#exit
R1(config)#
*May 13 14:49:10.279: %OSPF-5-ADJCHG: Process 10, Nbr 2.2.2.2 on FastEthernet0/0 from LOADING t
o FULL, Loading Done

```

Figura No.9. Interfaces R1

R2

Interface 2.2.2.2

loopback 0

 255.255.255.255

Interface f0/0 192.168.10.2

 255.255.255.0

Interface f0/1 192.168.20.2

 255.255.255.0

Interface f1/0 192.168.15.2

 255.255.255.0

```

R2#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R2(config)#int loopback 0
R2(config-if)#ip add 2.2.2.2 255.255.255.255
R2(config-if)#exit
R2(config)#int f0/0
R2(config-if)#ip add 192.168.10.2 255.255.255.0
R2(config-if)#exit
R2(config)#int f0/1
R2(config-if)#ip add 192.168.20.2 255.255.255.0
R2(config-if)#exit
R2(config)#int f1/0
R2(config-if)#ip add 192.168.15.2 255.255.255.0
R2(config-if)#exit
R2(config)#int range f0/0 - 1, f1/0
R2(config-if-range)#no shut
R2(config-if-range)#
May 13 14:48:26.583: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to up
May 13 14:48:26.699: %LINK-3-UPDOWN: Interface FastEthernet0/1, changed state to up
May 13 14:48:26.739: %LINK-3-UPDOWN: Interface FastEthernet1/0, changed state to up
May 13 14:48:27.583: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed
state to up
R2(config-if-range)#
May 13 14:48:27.699: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed
state to up
May 13 14:48:27.739: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet1/0, changed
state to up
R2(config-if-range)#exit
R2(config)#router ospf 10
R2(config-router)#router-id 2.2.2.2
R2(config-router)#network 192.168.10.0 0.0.0.255 area 0
R2(config-router)#network 192.168.20.0 0.0.0.255 area 0
May 13 14:48:18.811: %OSPF-5-ADJCHG: Process 10, Nbr 1.1.1.1 on FastEthernet0/0 from LOADING t
o FULL, Loading Done
R2(config-router)#network 192.168.15.0 0.0.0.255 area 0
R2(config-router)#network 192.168.20.0 0.0.0.255 area 0
R2(config-router)#network 2.2.2.2 0.0.0.0 area 0
R2(config-router)#exit
R2(config)#
May 13 14:53:07.207: %OSPF-5-ADJCHG: Process 10, Nbr 3.3.3.3 on FastEthernet0/1 from LOADING t

```

Figura No.10. Interfaces R2

R3

Interface 3.3.3.3

loopback 0
255.255.255.255

Interface f0/0 192.168.20.3
255.255.255.0

Interface f0/1 192.168.30.3
255.255.255.0

```

R3#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R3(config)#int lo0
R3(config-if)#ip add 3.3.3.3 255.255.255.255
R3(config-if)#exit
R3(config)#int f0/0
R3(config-if)#ip add 192.168.20.3 255.255.255.0
R3(config-if)#exit
R3(config)#int f0/1
R3(config-if)#ip add 192.168.30.3 255.255.255.0
R3(config-if)#exit
R3(config)#int range f0/0 - 1
R3(config-if-range)#no shut
R3(config-if-range)#exit
R3(config)#
May 13 14:52:02.719: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to up
May 13 14:52:02.827: %LINK-3-UPDOWN: Interface FastEthernet0/1, changed state to up
May 13 14:52:03.719: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed
state to up
R3(config)#
May 13 14:52:03.827: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed
state to up
R3(config)#router ospf 10
R3(config-router)#router-id 3.3.3.3
R3(config-router)#network 192.168.20.0 0.0.0.255 area 0
R3(config-router)#network 192.168.30.0 0.0.0.255 area 0
R3(config-router)#network 3.3.3.3
May 13 14:53:06.627: %OSPF-5-ADJCHG: Process 10, Nbr 1.1.1.1 on FastEthernet0/1 from LOADING to FULL, Loadin
g Done
May 13 14:53:06.631: %OSPF-5-ADJCHG: Process 10, Nbr 2.2.2.2 on FastEthernet0/0 from LOADING to FULL, Loadin
g Done
R3(config-router)#network 3.3.3.3 0.0.0.0 area 0
R3(config-router)#exit
R3(config)#do wr
Warning: Attempting to overwrite an NVRAM configuration previously written
by a different version of the system image.
Overwrite the previous NVRAM configuration?[confirm]
Building configuration...
[OK]
R3(config)#

```

Figura No.11. Interfaces R3

R4

Interface 4.4.4.4

loopback 0

 255.255.255.255

Interface f0/0 192.168.40.4

 255.255.255.0

Interface f0/1 192.168.30.3

 255.255.255.0

```

R4#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R4(config)#int lo0
R4(config-if)#ip add 4.4.4.4 255.255.255.255
R4(config-if)#exit
R4(config)#int f0/0
R4(config-if)#ip add 192.168.40.4 255.255.255.0
R4(config-if)#exit
R4(config)#int f0/1
R4(config-if)#ip add 192.168.30.4 255.255.255.0
R4(config-if)#exit
R4(config)#int range f0/0 - 1
R4(config-if-range)#no shut
R4(config-if-range)#exit
R4(config)#
*May 13 14:56:23.095: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to up
*May 13 14:56:23.839: %LINK-3-UPDOWN: Interface FastEthernet0/1, changed state to up
*May 13 14:56:24.695: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
R4(config)#
*May 13 14:56:24.839: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to up
R4(config)#router ospf 10
R4(config-router)#router-id 4.4.4.4
R4(config-router)#network 192.168.40.0 0.0.0.255 area 0
R4(config-router)#network 192.168.30.0 0.0.0.255 area 0
R4(config-router)#network 4.4.4.4 0.0.0.0 area 0
R4(config-router)#exit
R4(config)#
*May 13 14:57:05.631: %OSPF-5-ADJCHG: Process 10, Nbr 1.1.1.1 on FastEthernet0/1 from LOADING to FULL, Loading Done
R4(config)#
*May 13 15:01:37.955: %OSPF-5-ADJCHG: Process 10, Nbr 6.6.6.6 on FastEthernet0/0 from LOADING to FULL, Loading Done
R4(config)#do wr
Warning: Attempting to overwrite an NVRAM configuration previously written
by a different version of the system image.
Overwrite the previous NVRAM configuration?[confirm]
Building configuration...
[OK]
R4(config)#
R4(config)#

```

Figura No.12. Interfaces R4

R5

Interface 5.5.5.5

loopback 0

255.255.255.255

Interface f0/0 192.168.50.5

255.255.255.0

Interface f0/1 192.168.15.5

255.255.255.0

```

R5#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R5(config)#int lo0
R5(config-if)#
*May 13 14:57:30.299: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback0, changed state to up
R5(config-if)#ip add 5.5.5.5 255.255.255.255
R5(config-if)#exit
R5(config)#int f0/0
R5(config-if)#ip add 192.168.50.5 255.255.255.0
R5(config-if)#exit
R5(config)#int f0/1
R5(config-if)#ip add 192.168.15.5 255.255.255.0
R5(config-if)#exit
R5(config)#int range f0/0 - 1
R5(config-if-range)#no shut
R5(config-if-range)#exit
R5(config)#
*May 13 14:58:30.151: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to up
*May 13 14:58:30.291: %LINK-3-UPDOWN: Interface FastEthernet0/1, changed state to up
*May 13 14:58:31.151: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
R5(config)#
*May 13 14:58:31.291: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to up
R5(config)#router ospf 10
R5(config-router)#router-id 5.5.5.5
R5(config-router)#network 192.168.50.0 0.0.0.255 area 0
R5(config-router)#network 192.168.15.0 0.0.0.255 area 0
R5(config-router)#network 5.5.5.0 0.0.0.0 area 0
R5(config-router)#
*May 13 14:59:03.619: %OSPF-5-ADJCHG: Process 10, Nbr 2.2.2.2 on FastEthernet0/1 from LOADING to FULL, Loading Done
R5(config-router)#exit
R5(config)#
*May 13 15:04:47.323: %OSPF-5-ADJCHG: Process 10, Nbr 7.7.7.7 on FastEthernet0/0 from LOADING to FULL, Loading Done
R5(config)#do wr
Warning: Attempting to overwrite an NVRAM configuration previously written
by a different version of the system image.
Overwrite the previous NVRAM configuration?[confirm]
Building configuration...
[OK]
R5(config)#

```

Figura No.13. Interfaces R5

R6

Interface 6.6.6.6

loopback 0

255.255.255.255

Interface f0/0 192.168.40.6

255.255.255.0

Interface f0/1 192.168.45.6

255.255.255.0

```

R6#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R6(config)#int lo0
R6(config-if)#
*May 13 14:59:31.375: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback0, changed state to up
R6(config-if)#ip add 6.6.6.6 255.255.255.255
R6(config-if)#exit
R6(config)#int f0/0
R6(config-if)#ip add 192.168.40.6 255.255.255.0
R6(config-if)#exit
R6(config)#int f0/1
R6(config-if)#ip add 192.168.45.6 255.255.255.0
R6(config-if)#exit
R6(config)#int range f0/0 - 1
R6(config-if-range)#no shut
R6(config-if-range)#exit
R6(config)#
*May 13 15:00:51.907: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to up
*May 13 15:00:52.019: %LINK-3-UPDOWN: Interface FastEthernet0/1, changed state to up
*May 13 15:00:52.907: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
R6(config)#
*May 13 15:00:53.019: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to up
R6(config)#router ospf 10
R6(config-router)#router-id 6.6.6.6
R6(config-router)#network 192.168.40.0 0.0.0.255 area 0
^
% Invalid input detected at '^' marker.
R6(config-router)#network 192.168.40.0 0.0.0.255 area 0
R6(config-router)#network 192.168.45.0 0.0.0.255 area 0
R6(config-router)#network
*May 13 15:01:37.635: %OSPF-5-ADJCHG: Process 10, Nbr 4.4.4.4 on FastEthernet0/0 from LOADING to FULL, Loading Done
R6(config-router)#network 6.6.6.6 0.0.0.0 area 0
R6(config-router)#exit
R6(config)#do wr
Warning: Attempting to overwrite an NVRAM configuration previously written
by a different version of the system image.
Overwrite the previous NVRAM configuration?[confirm]
Building configuration...
[OK]
R6(config)#

```

Figura No.14. Interfaces R6

R7

Interface 7.7.7.7

loopback 0

255.255.255.255

Interface f0/0 192.168.50.7

255.255.255.0

Interface f0/1 192.168.55.7

255.255.255.0

```

R7#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R7(config)#int lo0
R7(config-if)#
**May 13 15:02:26.567: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback0, changed state to up
R7(config-if)#ip add 7.7.7.7 255.255.255.255
R7(config-if)#exit
R7(config)#int f0/0
R7(config-if)#ip add 192.168.50.7 255.255.255.0
R7(config-if)#exit
R7(config)#int f0/1
R7(config-if)#ip add 192.168.55.7 255.255.255.0
R7(config-if)#exit
R7(config)#int range f0/0 - 1
R7(config-if-range)#no shut
R7(config-if-range)#exit
R7(config)#
**May 13 15:03:30.471: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to up
**May 13 15:03:30.583: %LINK-3-UPDOWN: Interface FastEthernet0/1, changed state to up
**May 13 15:03:31.471: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
R7(config)#
**May 13 15:03:31.583: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to up
R7(config)#router ospf 10
R7(config-router)#router-id 7.7.7.7
R7(config-router)#network 192.168.50.0 0.0.0.255 area 0
R7(config-router)#network 192.168.55.0 0.0.0.255 area 0
R7(config-router)#network 7.7.7.7
**May 13 15:04:47.627: %OSPF-5-ADJCHG: Process 10, Nbr 5.5.5.5 on FastEthernet0/0 from LOADING to FULL, Loading Done
R7(config-router)#network 7.7.7.7 0.0.0.0 area 0
R7(config-router)#exit
R7(config)#do wr
Warning: Attempting to overwrite an NVRAM configuration previously written
by a different version of the system image.
Overwrite the previous NVRAM configuration?(confirm)
Building configuration...
[OK]
R7(config)#

```

Figura No.15. Interfaces R7

ESW1

Interface 192.168.45.7
f0/0
255.255.255.0

```
ESW1#conf t
Enter configuration commands, one per line. End with CNTL/Z.
ESW1(config)#int f0/0
ESW1(config-if)#ip add 192.168.45.7 255.255.255.0
ESW1(config-if)#no shut
ESW1(config-if)#exit
ESW1(config)#
*Mar 1 00:36:22.079: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to up
*Mar 1 00:36:23.079: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
ESW1(config)#
```

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Figura No.16. Configuracion del Switche 1

ESW2

Interface 192.168.55.8
f0/0
255.255.255.0

```
ESW2#conf t
Enter configuration commands, one per line. End with CNTL/Z.
ESW2(config)#int f0/0
ESW2(config-if)#ip add 192.168.55.8 255.255.255.0
ESW2(config-if)#no shut
ESW2(config-if)#exit
ESW2(config)#
*Mar 1 00:36:50.799: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to up
*Mar 1 00:36:51.799: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
ESW2(config)#
```

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Figura No.17. Configuracion del Switche 2

Configuración red MPLS

Aquí Habilitamos el IP CEF, Habilitamos el protocolo LDP para el intercambio de etiquetas, luego utilizamos una interface Loopback como router-id para LDP y utilizar la Loopback como identificador del router y por último habilitamos MPLS en cada interface.

Ingresamos a la consola de cada uno de los router e ingresamos a la configuración general.

```
#config t
```

```
#mpls ip
```

```
#ip CEF
```

```
#mpls label protocol LDP
```

```
#mpls ldp router-id loopback 0
```

```
#do sh mpls int
```

```
#router ospf 10
```

```
#mpls ldp autoconfig área 0
```

```
#exit
```

```

R1#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R1(config)#mpl ip
R1(config)#ip cef
R1(config)#mpls label protocol ldp
R1(config)#mpls ldp router-id loopback 0
R1(config)#do sh mpls int
no MPLS apps enabled or MPLS not enabled on any interfaces

R1(config)#router ospf 10
R1(config-router)#mpls ldp autoconfig area 0
R1(config-router)#exit
*May 13 15:16:59.891: %PARSE_RC-3-PRC_INVALID_BLOCK_PTR:
*May 13 15:16:59.947: %PARSE_RC-3-PRC_INVALID_BLOCK_PTR:
*May 13 15:16:59.971: %PARSE_RC-3-PRC_INVALID_BLOCK_PTR:
R1(config-router)#do sh mpls int
Interface      IP          Tunnel  BGP  Static  Operational
FastEthernet0/0  Yes (ldp)  No     No  No     Yes
FastEthernet0/1  Yes (ldp)  No     No  No     Yes
FastEthernet1/0  Yes (ldp)  No     No  No     Yes
R1(config-router)#
*May 13 15:19:04.343: %LDP-5-NBRCHG: LDP Neighbor 2.2.2.2:0 (1) is UP
R1(config-router)#
*May 13 15:19:26.439: %LDP-5-NBRCHG: LDP Neighbor 3.3.3.3:0 (2) is UP
R1(config-router)#
*May 13 15:19:40.823: %LDP-5-NBRCHG: LDP Neighbor 4.4.4.4:0 (3) is UP
R1(config-router)#

```

*Figura No.18. Configuración y
habilitación mpls ip y cef (Router 1).*

```

R2#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R2(config)#mpl ip
R2(config)#ip cef
R2(config)#mpls label protocol ldp
R2(config)#mpls ldp router-id loopback 0
R2(config)#do sh mpls int
no MPLS apps enabled or MPLS not enabled on any interfaces

R2(config)#router ospf 10
R2(config-router)#mpls ldp autoconfig area 0
R2(config-router)#do sh mpls int
Interface      IP          Tunnel  BGP  Static  Operational
FastEthernet0/0  Yes (ldp)  No     No  No     Yes
FastEthernet0/1  Yes (ldp)  No     No  No     Yes
FastEthernet1/0  Yes (ldp)  No     No  No     Yes
R2(config-router)#exit
*May 13 15:19:02.475: %PARSE_RC-3-PRC_INVALID_BLOCK_PTR:
*May 13 15:19:02.527: %PARSE_RC-3-PRC_INVALID_BLOCK_PTR:
*May 13 15:19:02.551: %PARSE_RC-3-PRC_INVALID_BLOCK_PTR:
R2(config-router)#exit
R2(config)#
*May 13 15:19:04.327: %LDP-5-NBRCHG: LDP Neighbor 1.1.1.1:0 (1) is UP
R2(config)#
*May 13 15:19:26.431: %LDP-5-NBRCHG: LDP Neighbor 3.3.3.3:0 (2) is UP
R2(config)#
*May 13 15:19:51.855: %LDP-5-NBRCHG: LDP Neighbor 5.5.5.5:0 (3) is UP
R2(config)#

```

*Figura No.19. Configuración y
habilitación mpls ip y cef (Router 2).*

```

R3#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R3(config)#mpl ip
R3(config)#ip cef
R3(config)#mpls label protocol ldp
R3(config)#mpls ldp router-id loopback 0
R3(config)#do sh mpls int
no MPLS apps enabled or MPLS not enabled on any interfaces

R3(config)#router ospf 10
R3(config-router)#mpls ldp autoconfig area 0
R3(config-router)#do sh mpls int
Interface      IP          Tunnel  BGP  Static  Operational
FastEthernet0/0  Yes (ldp)  No     No  No     Yes
FastEthernet0/1  Yes (ldp)  No     No  No     Yes
R3(config-router)#exit
*May 13 15:19:21.451: %PARSE_RC-3-PRC_INVALID_BLOCK_PTR:
*May 13 15:19:21.503: %PARSE_RC-3-PRC_INVALID_BLOCK_PTR:
*May 13 15:19:22.475: %LDP-5-NBRCHG: LDP Neighbor 1.1.1.1:0 (1) is UP
*May 13 15:19:22.487: %LDP-5-NBRCHG: LDP Neighbor 2.2.2.2:0 (2) is UP
R3(config-router)#exit
R3(config)#

```

*Figura No.20. Configuración y
habilitación mpls ip y cef (Router 3).*

```

R4#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R4(config)#mpl ip
R4(config)#ip cef
R4(config)#mpls label protocol ldp
R4(config)#mpls ldp router-id loopback 0
R4(config)#do sh mpls int
no MPLS apps enabled or MPLS not enabled on any interfaces

R4(config)#router ospf 10
R4(config-router)#mpls ldp autoconfig area 0
R4(config-router)#do sh mpls int
Interface      IP          Tunnel  BGP  Static  Operational
FastEthernet0/0  Yes (ldp)  No     No  No     Yes
FastEthernet0/1  Yes (ldp)  No     No  No     Yes
R4(config-router)#exit
*May 13 15:19:36.251: %PARSE_RC-3-PRC_INVALID_BLOCK_PTR:
*May 13 15:19:36.307: %PARSE_RC-3-PRC_INVALID_BLOCK_PTR:
R4(config-router)#exit
R4(config)#
*May 13 15:19:37.215: %LDP-5-NBRCHG: LDP Neighbor 1.1.1.1:0 (1) is UP
R4(config)#
*May 13 15:19:57.567: %LDP-5-NBRCHG: LDP Neighbor 6.6.6.6:0 (2) is UP
R4(config)#

```

*Figura No.21. Configuración y
habilitación mpls ip y cef (Router 4).*

```

R5#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R5(config)#mpl ip
R5(config)#ip cef
R5(config)#mpl label protocol ldp
R5(config)#mpl ldp router-id loopback 0
R5(config)#do sh mpls int
no MPLS apps enabled or MPLS not enabled on any interfaces

R5(config)#router ospf 10
R5(config-router)#mpl ldp autoconfig area 0
R5(config-router)#do sh mpls int
Interface      IP          Tunnel  BGP  Static Operational
FastEthernet0/0  Yes (ldp)  No     No   No   Yes
FastEthernet0/1  Yes (ldp)  No     No   No   Yes
R5(config-router)#exite
*May 13 15:19:46.415: %PARSE_RC-3-PRC_INVALID_BLOCK_PTR:
*May 13 15:19:46.463: %PARSE_RC-3-PRC_INVALID_BLOCK_PTR:
R5(config-router)#exit
R5(config)#
*May 13 15:19:48.663: %LDP-5-NBRCHG: LDP Neighbor 2.2.2.2:0 (1) is UP
R5(config)#
*May 13 15:20:05.879: %LDP-5-NBRCHG: LDP Neighbor 7.7.7.7:0 (2) is UP
R5(config)#

```

Figura No.22. Configuración y habilitación mpls ip y cef (Router 5).

```

R6#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R6(config)#mpl ip
R6(config)#ip cef
R6(config)#mpl label protocol ldp
R6(config)#mpl ldp router-id loopback 0
R6(config)#do sh mpls int
no MPLS apps enabled or MPLS not enabled on any interfaces

R6(config)#router ospf 10
R6(config-router)#mpl ldp autoconfig area 0
R6(config-router)#do sh mpls int
Interface      IP          Tunnel  BGP  Static Operational
FastEthernet0/0  Yes (ldp)  No     No   No   Yes
FastEthernet0/1  Yes (ldp)  No     No   No   Yes
R6(config-router)#exit
*May 13 15:19:55.199: %PARSE_RC-3-PRC_INVALID_BLOCK_PTR:
*May 13 15:19:55.247: %PARSE_RC-3-PRC_INVALID_BLOCK_PTR:
R6(config-router)#exit
R6(config)#
*May 13 15:19:57.111: %LDP-5-NBRCHG: LDP Neighbor 4.4.4.4:0 (1) is UP
R6(config)#

```

Figura No.23. Configuración y habilitación mpls ip y cef (Router 6).

```

R7#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R7(config)#mpl ip
R7(config)#ip cef
R7(config)#mpl label protocol ldp
R7(config)#mpl ldp router-id loopback 0
R7(config)#do sh mpls int
no MPLS apps enabled or MPLS not enabled on any interfaces

R7(config)#router ospf 10
R7(config-router)#mpl ldp autoconfig area 0
R7(config-router)#do sh mpls int
Interface      IP          Tunnel  BGP  Static Operational
FastEthernet0/0  Yes (ldp)  No     No   No   Yes
FastEthernet0/1  Yes (ldp)  No     No   No   Yes
R7(config-router)#exit
R7(config)#
*May 13 15:20:01.267: %PARSE_RC-3-PRC_INVALID_BLOCK_PTR:
*May 13 15:20:01.311: %PARSE_RC-3-PRC_INVALID_BLOCK_PTR:
*May 13 15:20:02.287: %LDP-5-NBRCHG: LDP Neighbor 5.5.5.5:0 (1) is UP
R7(config)#

```

Figura No.24. Configuración y habilitación mpls ip y cef (Router 7).

Configuración del router R1, siendo este el emisor del servicio Multicast an implementar

```
R1(config)#ip multicast-routing
R1(config)#ip pim rp-address 1.1.1.1
R1(config)#do sh ip int br
Interface                IP-Address      OK? Method Status      Protocol
FastEthernet0/0          192.168.10.1    YES manual up           up
FastEthernet0/1          192.168.30.1    YES manual up           up
FastEthernet1/0          192.168.35.1    YES manual up           up
Loopback0                 1.1.1.1         YES manual up           up
Tunnel0                   unassigned      YES unset  up           down
Tunnel1                   1.1.1.1         YES unset  up           up
R1(config)#int range f0/0 - 1
*May 13 15:28:44.975: %LINEPROTO-5-UPDOWN: Line protocol on Interface Tunnel0, changed state to down
*May 13 15:28:45.047: %LINEPROTO-5-UPDOWN: Line protocol on Interface Tunnel1, changed state to up
R1(config)#int range f0/0 - 1, f1/0
R1(config-if-range)#ip pim sparse-mode
R1(config-if-range)#exit
R1(config)#
*May 13 15:29:19.899: %LINEPROTO-5-UPDOWN: Line protocol on Interface Tunnel0, changed state to up
R1(config)#
*May 13 15:29:21.711: %PIM-5-DRCHG: DR change from neighbor 0.0.0.0 to 192.168.10.1 on interface FastEthernet0/0
*May 13 15:29:21.715: %PIM-5-DRCHG: DR change from neighbor 0.0.0.0 to 192.168.30.1 on interface FastEthernet0/1
*May 13 15:29:21.719: %PIM-5-DRCHG: DR change from neighbor 0.0.0.0 to 192.168.35.1 on interface FastEthernet1/0
R1(config)#in lo0
R1(config-if)#ip pim sparse-mode
R1(config-if)#exit
R1(config)#
*May 13 15:29:35.663: %PIM-5-DRCHG: DR change from neighbor 0.0.0.0 to 1.1.1.1 on interface Loopback0
R1(config)#
*May 13 15:30:22.111: %PIM-5-NBRCHG: neighbor 192.168.10.2 UP on interface FastEthernet0/0
*May 13 15:30:22.179: %PIM-5-DRCHG: DR change from neighbor 192.168.10.1 to 192.168.10.2 on interface FastEthernet0/0
R1(config)#
*May 13 15:31:06.659: %PIM-5-NBRCHG: neighbor 192.168.30.3 UP on interface FastEthernet0/1
*May 13 15:31:06.755: %PIM-5-DRCHG: DR change from neighbor 192.168.30.1 to 192.168.30.3 on interface FastEthernet0/1
R1(config)#
*May 13 15:31:50.579: %PIM-5-NBRCHG: neighbor 192.168.35.4 UP on interface FastEthernet1/0
*May 13 15:31:50.675: %PIM-5-DRCHG: DR change from neighbor 192.168.35.1 to 192.168.35.4 on interface FastEthernet1/0
R1(config)#
```

Figura No.25. Configuración multicast en Router 1

```
R2(config)#ip multicast-routing
R2(config)#ip pim rp-address 1.1.1.1
R2(config)#do sh ip int br
Interface                IP-Address      OK? Method Status      Protocol
FastEthernet0/0          192.168.10.2    YES manual up           up
FastEthernet0/1          192.168.20.2    YES manual up           up
FastEthernet1/0          192.168.15.2    YES manual up           up
Loopback0                 2.2.2.2         YES manual up           up
Tunnel0                   unassigned      YES unset  up           down
R2(config)#int range f0/0 - 1
*May 13 15:29:54.175: %LINEPROTO-5-UPDOWN: Line protocol on Interface Tunnel0, changed state to down
R2(config)#int range f0/0 - 1, f1/0
R2(config-if-range)#ip pim sparse-mode
R2(config-if-range)#
*May 13 15:30:21.931: %LINEPROTO-5-UPDOWN: Line protocol on Interface Tunnel0, changed state to up
*May 13 15:30:22.163: %PIM-5-NBRCHG: neighbor 192.168.10.1 UP on interface FastEthernet0/0
R2(config-if-range)#
*May 13 15:30:23.863: %PIM-5-DRCHG: DR change from neighbor 0.0.0.0 to 192.168.10.2 on interface FastEthernet0/0
*May 13 15:30:23.867: %PIM-5-DRCHG: DR change from neighbor 0.0.0.0 to 192.168.20.2 on interface FastEthernet0/1
*May 13 15:30:23.867: %PIM-5-DRCHG: DR change from neighbor 0.0.0.0 to 192.168.15.2 on interface FastEthernet1/0
R2(config-if-range)#int lo0
R2(config-if)#int lo0
R2(config-if)#ip pim sparse-mode
R2(config-if)#exit
R2(config)#
*May 13 15:30:35.763: %PIM-5-DRCHG: DR change from neighbor 0.0.0.0 to 2.2.2.2 on interface Loopback0
R2(config)#
*May 13 15:31:06.151: %PIM-5-NBRCHG: neighbor 192.168.20.3 UP on interface FastEthernet0/1
*May 13 15:31:06.243: %PIM-5-DRCHG: DR change from neighbor 192.168.20.2 to 192.168.20.3 on interface FastEthernet0/1
R2(config)#
*May 13 15:32:26.139: %PIM-5-NBRCHG: neighbor 192.168.15.5 UP on interface FastEthernet1/0
*May 13 15:32:26.139: %PIM-5-DRCHG: DR change from neighbor 192.168.15.2 to 192.168.15.5 on interface FastEthernet1/0
R2(config)#
```

Figura No.26. Configuración multicast en Router 2

Configuración en el router R3 implementando el servicio Multicast

```

R3(config)#ip multicast-routing
R3(config)#ip pim rp-address 1.1.1.1
R3(config)#do sh ip int br
Interface                IP-Address      OK? Method Status      Protocol
FastEthernet0/0          192.168.20.3   YES manual up           up
FastEthernet0/1          192.168.30.3   YES manual up           up
FastEthernet1/0          unassigned     YES unset  administratively down down
Loopback0                 3.3.3.3        YES manual up           up
Tunnel0                   unassigned     YES unset up           down
R3(config)#int range f0/0 - 1
*May 13 15:30:49.867: %LINEPROTO-5-UPDOWN: Line protocol on Interface Tunnel0, changed state to down
R3(config)#int range f0/0 - 1, f1/0
R3(config-if-range)#ip pim sparse-mode
R3(config-if-range)#exit
R3(config)#in lo0
R3(config-if)#
*May 13 15:31:04.575: %LINEPROTO-5-UPDOWN: Line protocol on Interface Tunnel0, changed state to up
*May 13 15:31:04.895: %PIM-5-NBRCHG: neighbor 192.168.20.2 UP on interface FastEthernet0/0
*May 13 15:31:05.131: %PIM-5-NBRCHG: neighbor 192.168.30.1 UP on interface FastEthernet0/1
R3(config-if)#in lo0
*May 13 15:31:06.387: %PIM-5-DRCHG: DR change from neighbor 0.0.0.0 to 192.168.20.3 on interface FastEthernet0/0
*May 13 15:31:06.395: %PIM-5-DRCHG: DR change from neighbor 0.0.0.0 to 192.168.30.3 on interface FastEthernet0/1
R3(config-if)#ip pim sparse-mode
R3(config-if)#
*May 13 15:31:16.335: %PIM-5-DRCHG: DR change from neighbor 0.0.0.0 to 3.3.3.3 on interface Loopback0
R3(config-if)#

```

Figura No.27. Configuración multicast en Router 3

```

R4(config)#ip multicast-routing
R4(config)#ip pim rp-address 1.1.1.1
R4(config)#do sh ip int br
Interface                IP-Address      OK? Method Status      Protocol
FastEthernet0/0          192.168.40.4   YES manual up           up
FastEthernet0/1          192.168.35.4   YES manual up           up
FastEthernet1/0          unassigned     YES unset  administratively down down
Loopback0                 4.4.4.4        YES manual up           up
Tunnel0                   unassigned     YES unset up           down
R4(config)#int range f0/0 - 1
*May 13 15:31:24.751: %LINEPROTO-5-UPDOWN: Line protocol on Interface Tunnel0, changed state to down
R4(config)#int range f0/0 - 1, f1/0
R4(config-if-range)#ip pim sparse-mode
R4(config-if-range)#exit
R4(config)#
*May 13 15:31:47.831: %LINEPROTO-5-UPDOWN: Line protocol on Interface Tunnel0, changed state to up
*May 13 15:31:48.147: %PIM-5-NBRCHG: neighbor 192.168.35.1 UP on interface FastEthernet0/1
R4(config)#
*May 13 15:31:49.595: %PIM-5-DRCHG: DR change from neighbor 0.0.0.0 to 192.168.40.4 on interface FastEthernet0/0
*May 13 15:31:49.603: %PIM-5-DRCHG: DR change from neighbor 0.0.0.0 to 192.168.35.4 on interface FastEthernet0/1
R4(config)#int lo0
R4(config-if)#ip pim sparse-mode
R4(config-if)#exit
R4(config)#
*May 13 15:32:02.543: %PIM-5-DRCHG: DR change from neighbor 0.0.0.0 to 4.4.4.4 on interface Loopback0
R4(config)#
*May 13 15:32:58.103: %PIM-5-NBRCHG: neighbor 192.168.40.6 UP on interface FastEthernet0/0
*May 13 15:32:58.227: %PIM-5-DRCHG: DR change from neighbor 192.168.40.4 to 192.168.40.6 on interface FastEthernet0/0
R4(config)#

```

Figura No.28. Configuración multicast en Router 4

Configuración en el router R5 implementando el servicio Multicast

```

R5(config)#ip multicast-routing
R5(config)#ip pim rp-address 1.1.1.1
R5(config)#do sh ip int br
Interface                IP-Address      OK? Method Status        Protocol
FastEthernet0/0          192.168.50.5    YES manual up             up
FastEthernet0/1          192.168.15.5    YES manual up             up
FastEthernet1/0          unassigned      YES unset  administratively down down
Loopback0                 5.5.5.5         YES manual up             up
Tunnel0                  unassigned      YES unset  up             down
R5(config)#int range f0/0 - 1
*May 13 15:32:09.211: %LINEPROTO-5-UPDOWN: Line protocol on Interface Tunnel0, changed state to down
R5(config)#int range f0/0 - 1, f1/0
R5(config-if-range)#ip pim sparse-mode
R5(config-if-range)#exit
R5(config)#
*May 13 15:32:22.471: %LINEPROTO-5-UPDOWN: Line protocol on Interface Tunnel0, changed state to up
*May 13 15:32:22.807: %PIM-5-NBRCHG: neighbor 192.168.15.2 UP on interface FastEthernet0/1
R5(config)#
*May 13 15:32:24.267: %PIM-5-DRCHG: DR change from neighbor 0.0.0.0 to 192.168.50.5 on interface FastEthernet0/0
*May 13 15:32:24.275: %PIM-5-DRCHG: DR change from neighbor 0.0.0.0 to 192.168.15.5 on interface FastEthernet0/1
R5(config)#int lo0
R5(config-if)#ip pim sparse-mode
R5(config-if)#exit
R5(config)#
*May 13 15:32:35.219: %PIM-5-DRCHG: DR change from neighbor 0.0.0.0 to 5.5.5.5 on interface Loopback0
R5(config)#
*May 13 15:33:33.683: %PIM-5-NBRCHG: neighbor 192.168.50.7 UP on interface FastEthernet0/0
*May 13 15:33:33.875: %PIM-5-DRCHG: DR change from neighbor 192.168.50.5 to 192.168.50.7 on interface FastEthernet0/0
R5(config)#

```

Figura No.29. Configuración multicast en Router 5

Configuración en el router R6 implementando el servicio Multicast

```

R6(config)#ip multicast-routing
R6(config)#ip pim rp-address 1.1.1.1
R6(config)#do sh ip int br
Interface                IP-Address      OK? Method Status        Protocol
FastEthernet0/0          192.168.40.6    YES manual up             up
FastEthernet0/1          192.168.45.6    YES manual up             up
FastEthernet1/0          unassigned      YES unset  administratively down down
Loopback0                 6.6.6.6         YES manual up             up
Tunnel0                  unassigned      YES unset  up             down
R6(config)#int range f0/0 - 1
*May 13 15:32:41.751: %LINEPROTO-5-UPDOWN: Line protocol on Interface Tunnel0, changed state to down
R6(config)#int range f0/0 - 1, f1/0
R6(config-if-range)#ip pim sparse-mode
R6(config-if-range)#exit
R6(config)#
*May 13 15:32:56.467: %LINEPROTO-5-UPDOWN: Line protocol on Interface Tunnel0, changed state to up
*May 13 15:32:56.735: %PIM-5-NBRCHG: neighbor 192.168.40.4 UP on interface FastEthernet0/0
R6(config)#
*May 13 15:32:58.271: %PIM-5-DRCHG: DR change from neighbor 0.0.0.0 to 192.168.40.6 on interface FastEthernet0/0
*May 13 15:32:58.275: %PIM-5-DRCHG: DR change from neighbor 0.0.0.0 to 192.168.45.6 on interface FastEthernet0/1
R6(config)#int lo0
R6(config-if)#ip pim sparse-mode
R6(config-if)#exit
R6(config)#
*May 13 15:33:07.223: %PIM-5-DRCHG: DR change from neighbor 0.0.0.0 to 6.6.6.6 on interface Loopback0
R6(config)#

```

Figura No.30. Configuración multicast en Router 6

Configuración en el router R7 implementando el servicio Multicast

```

R7(config)#ip multicast-routing
R7(config)#ip pim rp-address 1.1.1.1
R7(config)#do sh ip int br
Interface                IP-Address      OK? Method Status          Protocol
FastEthernet0/0          192.168.50.7    YES manual up                up
FastEthernet0/1          192.168.55.7    YES manual up                up
FastEthernet1/0          unassigned      YES unset  administratively down down
Loopback0                 7.7.7.7         YES manual up                up
Tunnel0                   unassigned      YES unset up                 down
R7(config)#int range f0/0 - 1
*May 13 15:33:20.787: %LINEPROTO-5-UPDOWN: Line protocol on Interface Tunnel0, changed state to down
R7(config)#int range f0/0 - 1, f1/0
R7(config-if-range)#ip pim sparse-mode
R7(config-if-range)#exit
R7(config)#
*May 13 15:33:31.739: %LINEPROTO-5-UPDOWN: Line protocol on Interface Tunnel0, changed state to up
*May 13 15:33:32.003: %PIM-5-NBRCHG: neighbor 192.168.50.5 UP on interface FastEthernet0/0
R7(config)#
*May 13 15:33:33.555: %PIM-5-DRCHG: DR change from neighbor 0.0.0.0 to 192.168.50.7 on interface FastEthernet0/0
*May 13 15:33:33.559: %PIM-5-DRCHG: DR change from neighbor 0.0.0.0 to 192.168.55.7 on interface FastEthernet0/1
R7(config)#int lo0
R7(config-if)#ip pim sparse-mode
R7(config-if)#exit
R7(config)#
*May 13 15:33:45.503: %PIM-5-DRCHG: DR change from neighbor 0.0.0.0 to 7.7.7.7 on interface Loopback0
R7(config)#

```

Figura No.31. Configuración multicast en Router 7

Verificación de las configuraciones realizadas

Se verifica las configuraciones realizadas correspondientes al servicio Multicast.

```

R1#ping 192.168.50.7
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.50.7, timeout is 2 seconds:
!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 488/726/1020 ms
R1#ping 192.168.40.6
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.40.6, timeout is 2 seconds:
!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 228/438/596 ms
R1#

```

Figura No.32. Se verifica la configuración del Router 1

```

R6#ping 192.168.50.7
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.50.7, timeout is 2 seconds:
!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1096/1524/1932 ms
R6#

```

Figura No.33. Se verifica la configuracion del Router 6

```

R7#ping 192.168.45.7
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.45.7, timeout is 2 seconds:
.!!!!
Success rate is 80 percent (4/5), round-trip min/avg/max = 1528/1728/1888 ms
R7#ping 192.168.45.6
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.45.6, timeout is 2 seconds:
!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1008/1512/1916 ms
R7#

```

Figura No.34. Se verifica la configuracion del Router 7

```

ESW2#ping 192.168.45.7
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.45.7, timeout is 2 seconds:
!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1488/1701/1788 ms
ESW2#ping 192.168.45.6
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.45.6, timeout is 2 seconds:
.!!!!
Success rate is 80 percent (4/5), round-trip min/avg/max = 1300/1548/1992 ms
ESW2#

```

Figura No.35. Se verifica la configuracion del Switch 2

Configuramos router con las redes global

Ingresamos a la consola de cada uno de los router e ingresamos a la configuración general.

#Config t

#Router ospf 3

#Router-id número id

#Network numero id 0.0.0.0 area 0

#Network red de nube 0.0.0.3 area 0

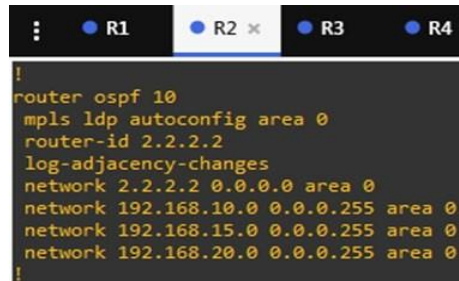
#Network red local 0.0.0.3 area 0

#Ip pim rp-address 1.1.1.1



```
⋮ ● R1 ● R2 ● R3
shutdown
duplex full
!
router ospf 10
router-id 7.7.7.7
network 7.7.7.7 0.0.0.0 area 0
network 192.168.50.0 0.0.0.255 area 0
network 192.168.55.0 0.0.0.255 area 0
mpls ldp autoconfig area 0
!
```

Figura No.36. Configuración de área (Router 7)



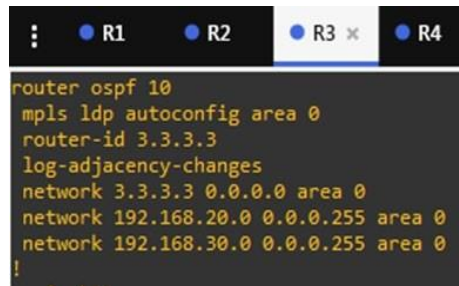
```
⋮ ● R1 ● R2 × ● R3 ● R4
!
router ospf 10
mpls ldp autoconfig area 0
router-id 2.2.2.2
log-adjacency-changes
network 2.2.2.2 0.0.0.0 area 0
network 192.168.10.0 0.0.0.255 area 0
network 192.168.15.0 0.0.0.255 area 0
network 192.168.20.0 0.0.0.255 area 0
!
```

Figura No.37. Configuración de área (Router 2)



```
⋮ ● R1 ● R2 ● R3
shutdown
duplex full
!
router ospf 10
router-id 6.6.6.6
network 6.6.6.6 0.0.0.0 area 0
network 192.168.40.0 0.0.0.255 area 0
network 192.168.45.0 0.0.0.255 area 0
mpls ldp autoconfig area 0
!
```

Figura No.38. Configuración de área (Router 6)



```
⋮ ● R1 ● R2 ● R3 × ● R4
router ospf 10
mpls ldp autoconfig area 0
router-id 3.3.3.3
log-adjacency-changes
network 3.3.3.3 0.0.0.0 area 0
network 192.168.20.0 0.0.0.255 area 0
network 192.168.30.0 0.0.0.255 area 0
!
```

Figura No.39. Configuración de área (Router 3)

```
⋮ ● R1 × ● R2 ● R3 ● R4
!
router ospf 10
mpls ldp autoconfig area 0
router-id 1.1.1.1
log-adjacency-changes
network 1.1.1.1 0.0.0.0 area 0
network 192.168.10.0 0.0.0.255 area 0
network 192.168.30.0 0.0.0.255 area 0
network 192.168.35.0 0.0.0.255 area 0
!
```

```
⋮ ● R1 ● R2 ● R3 ● R4 ×
router ospf 10
mpls ldp autoconfig area 0
router-id 4.4.4.4
log-adjacency-changes
network 4.4.4.4 0.0.0.0 area 0
network 192.168.35.0 0.0.0.255 area 0
network 192.168.40.0 0.0.0.255 area 0
!
```

Figura No.40. Configuración de área (Router1) Figura No.41. Configuración de área (Router 4)

Comunicación con los vecinos

Comunicación con los vecinos

#Show ip ospf neighbor

```
R1#sh ip ospf neig
Neighbor ID    Pri  State           Dead Time   Address      Interface
3.3.3.3        1    FULL/BDR        00:00:36   192.168.30.3 FastEthernet0/1
2.2.2.2        1    FULL/BDR        00:00:38   192.168.10.2 FastEthernet0/0
R1#
```

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Figura No.42. Configuración entre vecinos (Router 1)

```
R2#sh ip ospf neig
Neighbor ID    Pri  State           Dead Time   Address      Interface
3.3.3.3        1    FULL/BDR        00:00:36   192.168.20.3 FastEthernet0/1
5.5.5.5        1    FULL/BDR        00:00:38   192.168.15.5 FastEthernet1/0
1.1.1.1        1    FULL/DR         00:00:30   192.168.10.1 FastEthernet0/0
R2#
```

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Figura No.43. Configuración entre vecinos (Router 2)

Tablas de enrutamiento

Tablas de enrutamiento

Show ip route

```
R1#sh ip mroute
IP Multicast Routing Table
Flags: D - Dense, S - Sparse, B - Bidir Group, s - SSM Group, C - Connected,
L - Local, P - Pruned, R - RP-bit set, F - Register flag,
T - SPT-bit set, J - Join SPT, M - MSDP created entry, E - Extranet,
X - Proxy Join Timer Running, A - Candidate for MSDP Advertisement,
U - URD, I - Received Source Specific Host Report,
Z - Multicast Tunnel, z - MDT-data group sender,
Y - Joined MDT-data group, y - Sending to MDT-data group,
G - Received BGP C-Mroute, g - Sent BGP C-Mroute,
Q - Received BGP S-A Route, q - Sent BGP S-A Route,
V - RD & Vector, v - Vector
Outgoing interface flags: H - Hardware switched, A - Assert winner
Timers: Uptime/Expires
Interface state: Interface, Next-Hop or VCD, State/Mode

(*, 224.0.1.40), 00:39:34/00:03:26, RP 1.1.1.1, flags: SJCL
Incoming interface: Null, RPF nbr 0.0.0.0
Outgoing interface list:
FastEthernet1/0, Forward/Sparse, 00:37:00/00:02:46
FastEthernet0/1, Forward/Sparse, 00:37:43/00:03:04
FastEthernet0/0, Forward/Sparse, 00:39:31/00:03:26

R1#
```

Figura No.44. Tablas de enrutamiento (Router 1)

```
R3#sh ip mroute
IP Multicast Routing Table
Flags: D - Dense, S - Sparse, B - Bidir Group, s - SSM Group, C - Connected,
L - Local, P - Pruned, R - RP-bit set, F - Register flag,
T - SPT-bit set, J - Join SPT, M - MSDP created entry, E - Extranet,
U - URD, I - Received Source Specific Host Report,
Z - Multicast Tunnel, z - MDT-data group sender,
Y - Joined MDT-data group, y - Sending to MDT-data group,
G - Received BGP C-Mroute, g - Sent BGP C-Mroute,
Q - Received BGP S-A Route, q - Sent BGP S-A Route,
V - RD & Vector, v - Vector
Outgoing interface flags: H - Hardware switched, A - Assert winner
Timers: Uptime/Expires
Interface state: Interface, Next-Hop or VCD, State/Mode

(*, 224.0.1.40), 00:38:01/00:02:18, RP 1.1.1.1, flags: SJCL
Incoming interface: FastEthernet0/1, RPF nbr 192.168.30.1
Outgoing interface list:
FastEthernet0/0, Forward/Sparse, 00:37:58/00:02:18

R3#
```

Figura No.45. Tablas de enrutamiento (Router 3)

```

R5#sh ip mroute
IP Multicast Routing Table
Flags: D - Dense, S - Sparse, B - Bidir Group, s - SSM Group, C - Connected,
L - Local, P - Pruned, R - RP-bit set, F - Register flag,
T - SPT-bit set, J - Join SPT, M - MSDP created entry, E - Extranet,
X - Proxy Join Timer Running, A - Candidate for MSDP Advertisement,
U - URD, I - Received Source Specific Host Report,
Z - Multicast Tunnel, z - MDT-data group sender,
Y - Joined MDT-data group, y - Sending to MDT-data group,
G - Received BGP C-Mroute, g - Sent BGP C-Mroute,
Q - Received BGP S-A Route, q - Sent BGP S-A Route,
V - RD & Vector, v - Vector
Outgoing interface flags: H - Hardware switched, A - Assert winner
Timers: Uptime/Expires
Interface state: Interface, Next-Hop or VCD, State/Mode

(*, 224.0.1.40), 00:36:51/00:03:14, RP 1.1.1.1, flags: SJCL
Incoming interface: FastEthernet0/1, RPF nbr 192.168.15.2
Outgoing interface list:
FastEthernet0/0, Forward/Sparse, 00:36:49/00:03:14

R5#

```

Figura No.46. Tablas de enrutamiento (Router 5)

```

R7#sh ip mroute
IP Multicast Routing Table
Flags: D - Dense, S - Sparse, B - Bidir Group, s - SSM Group, C - Connected,
L - Local, P - Pruned, R - RP-bit set, F - Register flag,
T - SPT-bit set, J - Join SPT, M - MSDP created entry, E - Extranet,
X - Proxy Join Timer Running, A - Candidate for MSDP Advertisement,
U - URD, I - Received Source Specific Host Report,
Z - Multicast Tunnel, z - MDT-data group sender,
Y - Joined MDT-data group, y - Sending to MDT-data group,
G - Received BGP C-Mroute, g - Sent BGP C-Mroute,
Q - Received BGP S-A Route, q - Sent BGP S-A Route,
V - RD & Vector, v - Vector
Outgoing interface flags: H - Hardware switched, A - Assert winner
Timers: Uptime/Expires
Interface state: Interface, Next-Hop or VCD, State/Mode

(*, 224.0.1.40), 00:35:54/00:02:57, RP 1.1.1.1, flags: SJPL
Incoming interface: FastEthernet0/0, RPF nbr 192.168.50.5
Outgoing interface list: Null

R7#

```

Figura No.47. Tablas de enrutamiento (Router 7)

Programa para simulación GNS3 y máquinas virtuales VirtualBox

Para la simulación utilizamos los programas GNS3 Y para las máquinas virtuales Virtualbox.

Programa virtualbox

En el programa virtualbox creamos 2 máquinas para simular un servidor que va a transmitir y un receptor que va a recibir la señal, ambas máquinas virtuales tienen como sistema operativo Windows xp. Se va a transmitir un video de una máquina virtual a otra por medio de la topología en gns3.

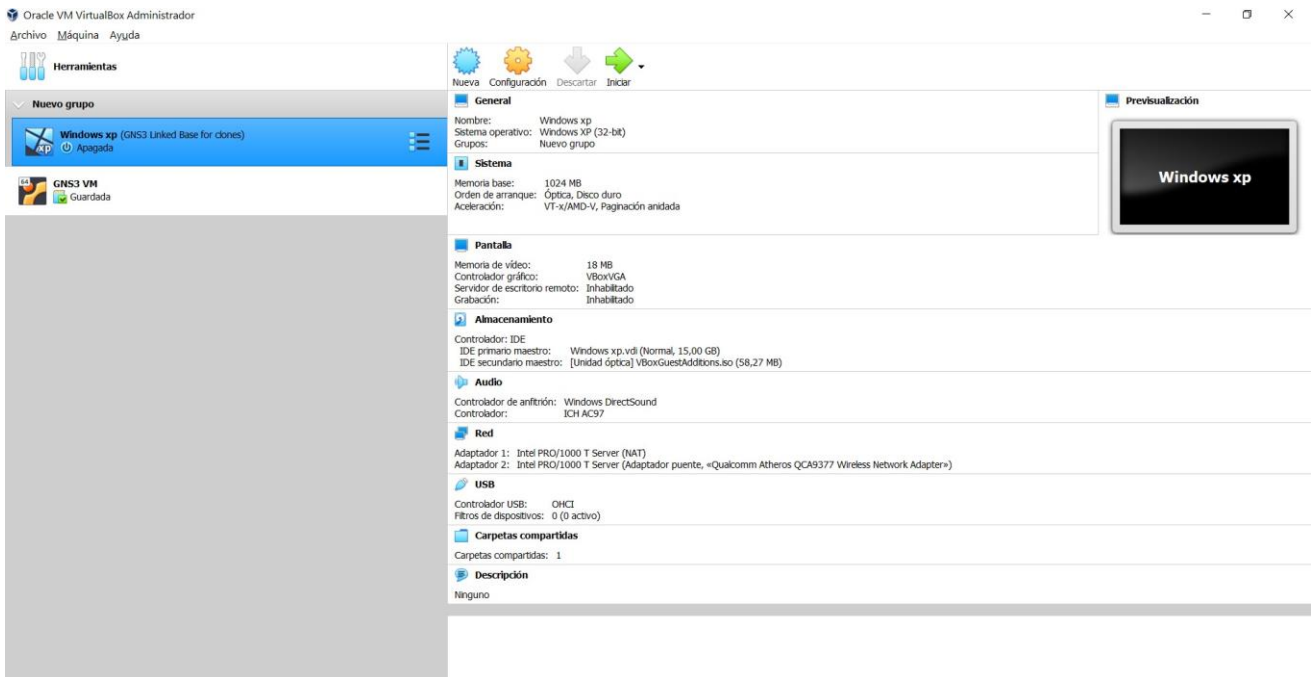


Figura No.48. Oracle VM VirtualBox administrador

Programa GNS3

En nuestro programa GNS3 ingresamos las máquinas para poder enlazarlas y proceder al ensayo

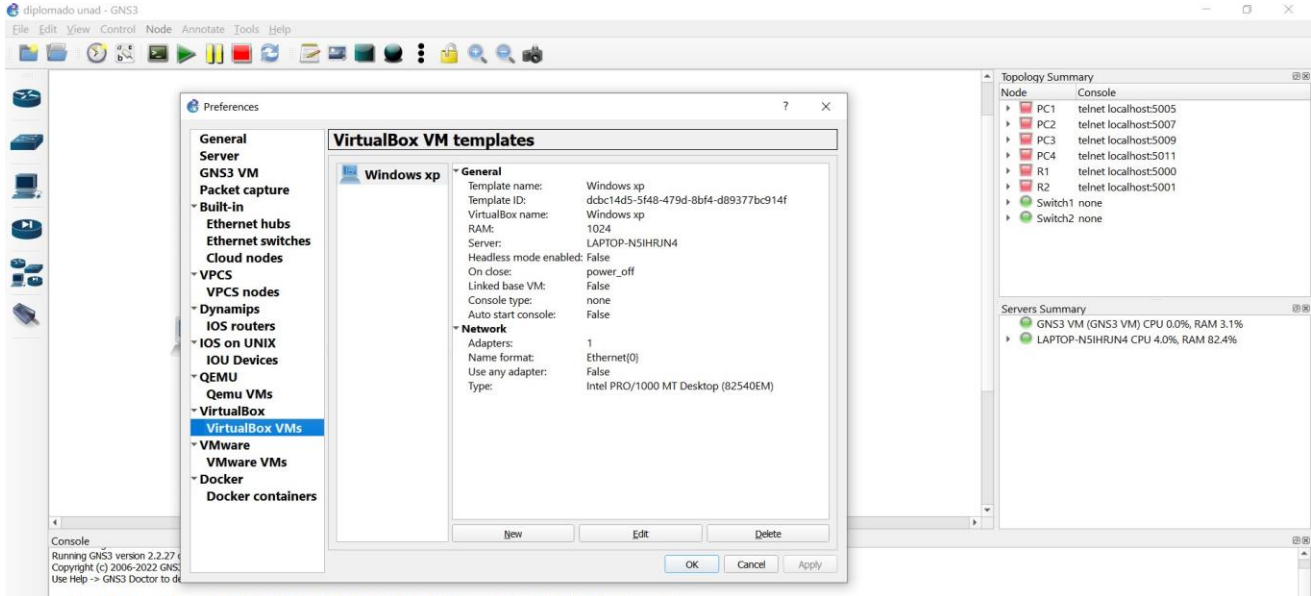


Figura No.49. Práctica fase 11 – GNS3

Configuración del VLC

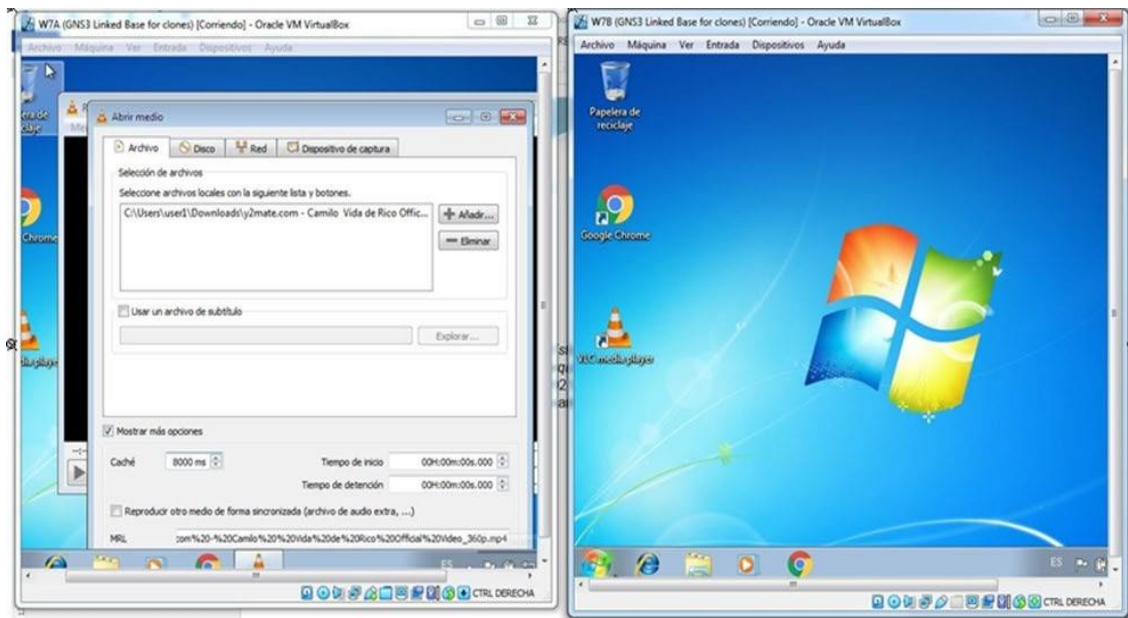


Figura No. 50. VLC, Abrir medio, selección de archivos

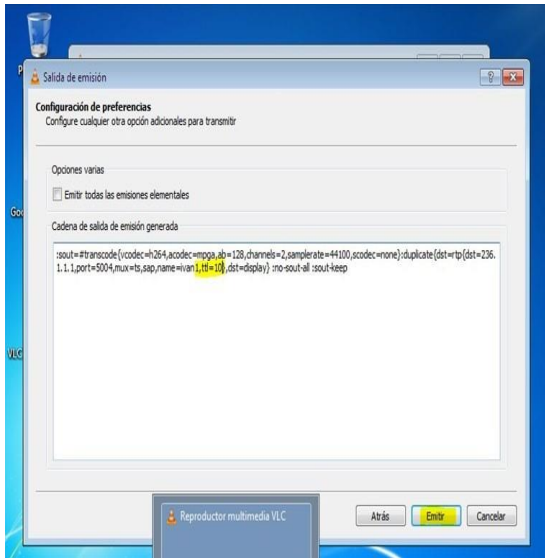


Figura No. 51. VLC, Configuración de preferencias

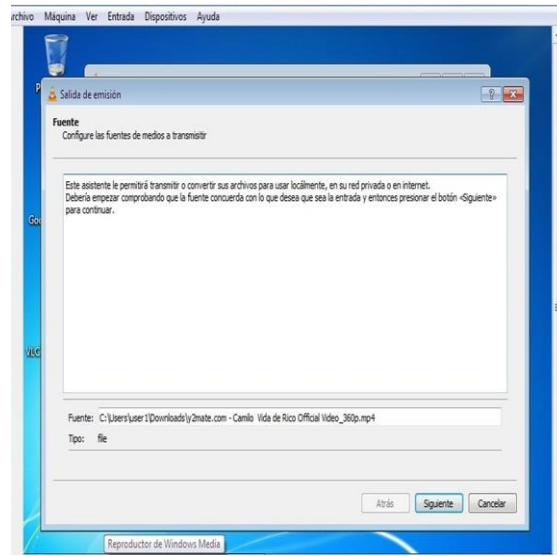


Figura No. 52. VLC, Configuración de medio a transmitir

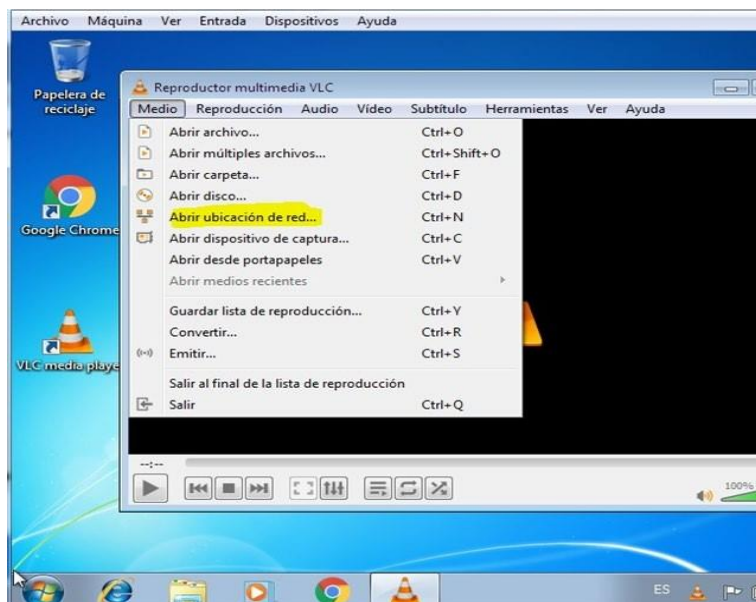


Figura No. 53. Reproductor multimedia VLC.

Nota: a la hora de la simulación se bloquea el pc, debido a que las máquinas virtuales consumen el 100 por ciento de la memoria ram del pc.

Conclusiones

Se ha podido identificar plenamente el concepto e importancia de una red IP dentro de una arquitectura NGN, aplicando los diferentes protocolos de interconexión de redes. De igual manera en estas redes se establecieron varios mecanismos QoS logrando su funcionamiento dentro de la red, ya sea para marcar paquetes con el mecanismo Classification y Marking, tener prioridades en cola con el mecanismo Priority (PQ). También se comprendió la funcionalidad correspondiente al mecanismo LLQ para realizar el plan de QoS sobre el ancho de banda sobre la separación de tráfico mediante la definición de clases.

Para finalizar la práctica se implementó un servicio multimedia a través del simulador GNS3 y el uso de máquinas virtuales, en el que se realizó una configuración básica correspondiente al diseño de red realizado en la Fase 1 y en él se implementó IPTV Multicast entre las diferentes sedes (routers) del escenario el cual como producto final se espera que con este IPTV Multicast transferir contenidos multimedia entre dos sedes (routers).

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