Implemente EVPN de Capa 3 sobre SR MPLS [Ospf / iBGP] [PE-CE es OSPF] en Nexus 9300

Contenido

Introducción

Este documento describe cómo implementar/configurar el switching de etiquetas multiprotocolo (MPLS) EVPN sobre routing de segmentos (SR) de capa 3 en productos Nexus 9300 con el protocolo PE-CE como OSPF (Open Shortest Path First).

Prerequisites

Requirements

Cisco recomienda que tenga conocimiento sobre estos temas:

- Border Gateway Protocol (BGP)
- Abrir primero la ruta más corta (OSPF)
- L3VPN
- EVPN
- Routing de segmentos (SR)

Componentes Utilizados

La información que contiene este documento se basa en las siguientes versiones de software y hardware.

- Hardware SPINE - 93360YC-FX2 ejecutándose con 9.3.(3)
- Hardware LEAF - 93240YC-FX2 ejecutándose con 9.3.(3)
- CLIENTE: 93216TC-FX2 (host-1), Catalyst-3750 (host-2)

The information in this document was created from the devices in a specific lab environment. All of

the devices used in this document started with a cleared (default) configuration. If your network is live, make sure that you understand the potential impact of any command.

Antecedentes

MPLS L3VPN Recap

Una VPN es:

- Una red basada en IP que ofrece servicios de red privada a través de una infraestructura pública.
- Un conjunto de sitios que pueden comunicarse entre sí de forma privada a través de Internet u otras redes públicas o privadas.

Las VPN convencionales se crean mediante la configuración de una malla completa de túneles o circuitos virtuales permanentes (PVC) a todos los sitios de una VPN. Este tipo de VPN no es fácil de mantener o ampliar, ya que para agregar un nuevo sitio es necesario cambiar cada dispositivo de borde en la VPN.

Las VPN basadas en MPLS se crean en la Capa 3 y se basan en el modelo de peer. El modelo de peer permite al proveedor de servicios y al cliente intercambiar información de ruteo de Capa 3. El proveedor de servicios transmite los datos entre las instalaciones del cliente sin la participación del cliente.

Las VPN MPLS son más fáciles de administrar y ampliar que las VPN convencionales. Cuando se agrega un nuevo sitio a una VPN MPLS, sólo se debe actualizar el router de borde del proveedor de servicios que proporciona servicios al sitio del cliente.

Estos son los componentes de MPLS VPN:

- Router del proveedor (P): router en el núcleo de la red del proveedor. Los routers PE ejecutan el switching MPLS y no adjuntan etiquetas VPN a los paquetes enrutados. Las etiquetas VPN se utilizan para dirigir los paquetes de datos a la red privada correcta o al router de borde del cliente.

- Router PE: router que asocia la etiqueta VPN a los paquetes entrantes según la interfaz o subinterfaz en la que se reciben, y también conecta las etiquetas de núcleo MPLS. Un router PE se conecta directamente a un router CE.

- Router (C) del cliente: router en el proveedor de servicios de Internet (ISP) o en la red empresarial.

- Router de borde del cliente (CE): router de borde en la red del ISP que se conecta al router PE de la red. Un router CE debe interactuar con un router PE.

Descripción General de EVPN con L3VPN (MPLS SR)

Las implementaciones de Data Center (DC) han adoptado VXLAN EVPN (o) MPLS EVPN por sus ventajas, como el aprendizaje del plano de control EVPN, la multiempresa, la movilidad fluida, la

redundancia y las incorporaciones POD más sencillas. De forma similar, el CORE es una red MPLS L3VPN basada en el protocolo de distribución de etiquetas (LDP) o una transición de la capa subyacente tradicional basada en LDP de L3VPN MPLS a una solución más sofisticada como el routing de segmentos (SR).

El routing de segmentos se adopta por sus ventajas como:

- Planos de control de MPLS e IGP unificados
- Métodos de ingeniería de tráfico más sencillos
- Configuración más sencilla
- adopción de SDN
- EVPN (RFC 7432) es una solución basada en MPLS de BGP que se ha utilizado para los servicios Ethernet de última generación en una red de Data Center virtualizada.
- EVPN utiliza varios bloques de creación como RD, RT y VRF de las tecnologías MPLS que existen.
- La EVPN L3 sobre SR que se introdujo en la versión NXOS 7.0(3)I6(1) utiliza la ruta EVPN Tipo 5 con encapsulación MPLS.
- La EVPN L3 sobre SR ofrece varios arrendatarios, escalabilidad y alto rendimiento para servicios de Data Center evolucionados.

Nota: En DC, el plano de datos puede ser VXLAN o MPLS.

VPN MPLS L3 tradicional
Bloques de generación principales: RD, RT y VRF
Capa subyacente para transporte: IGP, LDP y RSVP-TE
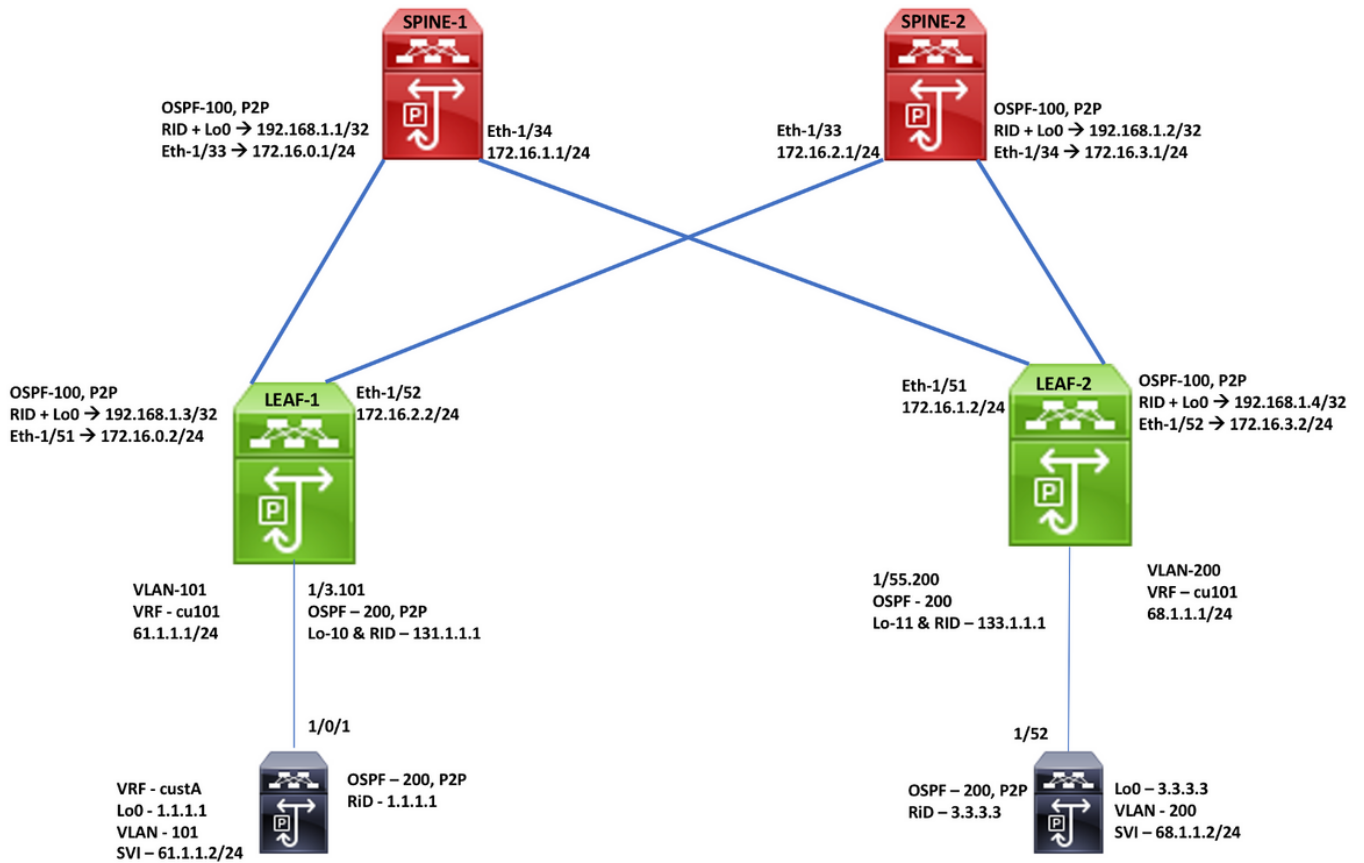Capa de superposición para servicio: VPNv4 y VPNv6

VPN L3 MPLS sobre SR
Bloques de generación principales: RD, RT y VRF
Capa subyacente para transporte: IGP/BGP-LU y SR-TE
Capa de superposición para servicio: EVPN

Diagrama de la red

SPINE-1

OSPF-100, P2P
RID + Lo0 → 192.168.1.1/32
Eth-1/33 → 172.16.0.1/24

Eth-1/34
172.16.1.1/24

SPINE-2

Eth-1/33
172.16.2.1/24

OSPF-100, P2P
RID + Lo0 → 192.168.1.2/32
Eth-1/34 → 172.16.3.1/24

LEAF-1

OSPF-100, P2P
RID + Lo0 → 192.168.1.3/32
Eth-1/51 → 172.16.0.2/24

Eth-1/52
172.16.2.2/24

Eth-1/51
172.16.1.2/24

LEAF-2

OSPF-100, P2P
RID + Lo0 → 192.168.1.4/32
Eth-1/52 → 172.16.3.2/24

VLAN-101
VRF - cu101
61.1.1.1/24

1/3.101
OSPF – 200, P2P
Lo-10 & RID – 131.1.1.1

1/55.200
OSPF - 200
Lo-11 & RID – 133.1.1.1

VLAN-200
VRF – cu101
68.1.1.1/24

1/0/1

1/52

VRF - custA
Lo0 - 1.1.1.1
VLAN - 101
SVI – 61.1.1.2/24

OSPF – 200, P2P
RiD - 1.1.1.1

OSPF – 200, P2P
RiD – 3.3.3.3

Lo0 – 3.3.3.3
VLAN - 200
SVI – 68.1.1.2/24

Configuración

SPINE-1 Configuration		
Enabling Features, Label-Range, Route-map, Label-Index	**OSPF Configuration**	**BGP/EVPN Configuration**
feature-set mpls	interface Ethernet1/33	router bgp 65001
feature ospf	ip address 172.16.0.1/24	router-id 192.168.1.1
feature bgp	ip ospf network point-to-point	address-family ipv4 unicast
feature mpls segment-routing	ip router ospf 100 area 0.0.0.0	network 192.168.1.1/32 route-map label-index-spine1
feature mpls evpn	mpls ip forwarding	allocate-label all
feature interface-vlan	no shutdown	address-family ipv4 labeled-unicast
feature mpls oam		address-family l2vpn evpn
	interface Ethernet1/34	template peer EVPN
	ip address 172.16.1.1/24	remote-as 65001
	ip ospf network point-to-point	update-source loopback0
mpls label range 5000 450000	ip router ospf 100 area 0.0.0.0	address-family l2vpn evpn
segment-routing	mpls ip forwarding	send-community extended
mpls	no shutdown	route-reflector-client
global-block 16000 25000		encapsulation mpls
connected-prefix-sid-map		template peer Labeled-unicast
address-family ipv4		remote-as 65001
192.168.1.1/32 index 211	interface loopback0	address-family ipv4 labeled-unicast
	ip address 192.168.1.1/32	send-community extended
	ip router ospf 100 area 0.0.0.0	route-reflector-client
		next-hop-self
route-map label-index-spine1 permit 10		soft-reconfiguration inbound always
set label-index 211	router ospf 100	neighbor 172.16.0.2
	segment-routing mpls	inherit peer Labeled-unicast
	router-id 192.168.1.1	neighbor 172.16.1.2
		inherit peer Labeled-unicast
		neighbor 192.168.1.3
		inherit peer EVPN
		neighbor 192.168.1.4
		inherit peer EVPN

SPINE-2 Configuration

Enabling Features, Label-Range, Route-map, Label-Index	OSPF Configuration	BGP/EVPN Configuration
feature-set mpls	interface Ethernet1/33	router bgp 65001
feature ospf	ip address 172.16.2.1/24	router-id 192.168.1.2
feature bgp	ip ospf network point-to-point	address-family ipv4 unicast
feature mpls segment-routing	ip router ospf 100 area 0.0.0.0	network 192.168.1.2/32 route-map label-index-spine2
feature mpls evpn	mpls ip forwarding	allocate-label all
feature interface-vlan	no shutdown	address-family ipv4 labeled-unicast
feature mpls oam		address-family l2vpn evpn
		template peer EVPN
mpls label range 5000 450000	interface Ethernet1/34	remote-as 65001
	ip address 172.16.3.1/24	update-source loopback0
segment-routing	ip ospf network point-to-point	address-family l2vpn evpn
mpls	ip router ospf 100 area 0.0.0.0	send-community extended
global-block 16000 25000	mpls ip forwarding	route-reflector-client
connected-prefix-sid-map	no shutdown	encapsulation mpls
address-family ipv4		template peer Labeled-unicast
192.168.1.2/32 index 221		remote-as 65001
	interface loopback0	address-family ipv4 labeled-unicast
	ip address 192.168.1.2/32	send-community extended
route-map label-index-spine2 permit 10	ip router ospf 100 area 0.0.0.0	route-reflector-client
set label-index 221		next-hop-self
		soft-reconfiguration inbound always
		neighbor 172.16.2.2
	router ospf 100	inherit peer Labeled-unicast
	segment-routing mpls	neighbor 172.16.3.2
	router-id 192.168.1.2	inherit peer Labeled-unicast
		neighbor 192.168.1.3
		inherit peer EVPN
		neighbor 192.168.1.4
		inherit peer EVPN

LEAF-1 Configuration

Enabling Features, Label-Range, Route-map, Label-Index	OSPF Configuration	BGP/EVPN Configuration
install feature-set mpls	interface Ethernet1/51	router bgp 65001
feature-set mpls	ip address 172.16.0.2/24	router-id 192.168.1.3
nv overlay evpn	ip ospf network point-to-point	address-family ipv4 unicast
feature ospf	ip router ospf 100 area 0.0.0.0	network 192.168.1.3/32 route-map label-index-leaf-1
feature bgp	mpls ip forwarding	allocate-label all
feature mpls segment-routing	no shutdown	address-family ipv4 labeled-unicast
feature mpls evpn		address-family l2vpn evpn
feature interface-vlan	interface Ethernet1/52	
feature mpls oam	ip address 172.16.2.2/24	template peer EVPN
feature nv overlay	ip ospf network point-to-point	remote-as 65001
	ip router ospf 100 area 0.0.0.0	update-source loopback0
mpls label range 5000 450000	mpls ip forwarding	address-family l2vpn evpn
segment-routing	no shutdown	send-community extended
mpls		encapsulation mpls
global-block 16000 25000	interface loopback0	
connected-prefix-sid-map	ip address 192.168.1.3/32	template peer Labeled-unicast
address-family ipv4	ip router ospf 100 area 0.0.0.0	remote-as 65001
192.168.1.3/32 index 311		address-family ipv4 labeled-unicast
	router ospf 100	send-community extended
ip prefix-list test1 seq 5 permit 61.1.1.0/24	segment-routing mpls	soft-reconfiguration inbound always
ip prefix-list test1 seq 10 permit 131.1.1.1/32	router-id 192.168.1.3	
		neighbor 172.16.0.1
ip prefix-list test3 seq 5 permit 1.1.1.1/32	**PE-CE**	inherit peer Labeled-unicast
	vrf cu101	neighbor 172.16.2.1
	address-family ipv4 unicast	inherit peer Labeled-unicast
route-map bgp65001 permit 10		neighbor 192.168.1.1
match route-type internal	interface Ethernet1/3	inherit peer EVPN
route-map direct1 permit 10	no shutdown	neighbor 192.168.1.2
match ip address prefix-list test1	interface Ethernet1/3.101	inherit peer EVPN
set community 65001:10	encapsulation dot1q 101	
route-map label-index-leaf-1 permit 10	vrf member cu101	
set label-index 311	ip address 61.1.1.1/24	
route-map ospf200 permit 10	ip ospf network point-to-point	vrf cu101
match ip address prefix-list test3	ip router ospf 200 area 0.0.0.0	router-id 131.1.1.1
	no shutdown	address-family ipv4 unicast
vrf context cu101		advertise l2vpn evpn
rd auto	interface loopback10	redistribute direct route-map direct1
address-family ipv4 unicast	vrf member cu101	redistribute ospf 200 route-map ospf200
route-target import 1:101	ip address 131.1.1.1/32	
route-target import 1:101 evpn	ip router ospf 200 area 0.0.0.0	
route-target export 1:101		
route-target export 1:101 evpn	router ospf 200	
	vrf cu101	
	router-id 131.1.1.1	
	redistribute bgp 65001 route-map bgp65001	

LEAF-2 Configuration

Enabling Features, Label-Range, Route-map, Label-Index	OSPF Configuration	BGP/EVPN Configuration
install feature-set mpls	interface Ethernet1/51	
feature-set mpls	ip address 172.16.1.2/24	router bgp 65001
nv overlay evpn	ip ospf network point-to-point	router-id 192.168.1.4
feature ospf	ip router ospf 100 area 0.0.0.0	address-family ipv4 unicast
feature bgp	mpls ip forwarding	network 192.168.1.4/32 route-map label-index-Leaf2
feature mpls segment-routing	no shutdown	allocate-label all
feature mpls evpn		address-family ipv4 labeled-unicast
feature interface-vlan	interface Ethernet1/52	address-family l2vpn evpn
feature mpls oam	ip address 172.16.3.2/24	
feature nv overlay	ip ospf network point-to-point	template peer EVPN
	ip router ospf 100 area 0.0.0.0	remote-as 65001
mpls label range 5000 450000	mpls ip forwarding	update-source loopback0
segment-routing	no shutdown	address-family l2vpn evpn
mpls		send-community extended
global-block 16000 25000	interface loopback0	encapsulation mpls
connected-prefix-sid-map	ip address 192.168.1.4/32	
address-family ipv4	ip router ospf 100 area 0.0.0.0	
192.168.1.4/32 index 321		template peer Labeled-unicast
	router ospf 100	remote-as 65001
ip prefix-list new seq 5 permit 68.1.1.0/24	segment-routing mpls	address-family ipv4 labeled-unicast
ip prefix-list new seq 10 permit 133.1.1.1/32	router-id 192.168.1.4	send-community extended
		soft-reconfiguration inbound always
ip prefix-list new1 seq 5 permit 3.3.3.3/32	**PE-CE**	
	vrf cu101	neighbor 172.16.1.1
ip prefix-list redtoospf seq 5 permit 61.1.1.0/24	address-family ipv4 unicast	inherit peer Labeled-unicast
ip prefix-list redtoospf seq 10 permit 1.1.1.1/32	interface Ethernet1/55	neighbor 172.16.3.1
	no shutdown	inherit peer Labeled-unicast
route-map bgp65001 permit 10	interface Ethernet1/55.200	neighbor 192.168.1.1
match route-type internal	encapsulation dot1q 200	inherit peer EVPN
route-map direct1 permit 10	vrf member cu101	neighbor 192.168.1.2
match ip address prefix-list new	ip address 68.1.1.1/24	inherit peer EVPN
route-map label-index-Leaf2 permit 10	ip ospf network point-to-point	
set label-index 321	ip router ospf 200 area 0.0.0.0	
route-map ospf200 permit 10	no shutdown	vrf cu101
match ip address prefix-list new1		router-id 133.1.1.1
	interface loopback11	address-family ipv4 unicast
vrf context cu101	vrf member cu101	advertise l2vpn evpn
rd auto	ip address 133.1.1.1/32	redistribute direct route-map direct1
address-family ipv4 unicast	ip router ospf 200 area 0.0.0.0	redistribute ospf 200 route-map ospf200
route-target import 1:101		
route-target import 1:101 evpn	router ospf 200	
route-target export 1:101	vrf cu101	
route-target export 1:101 evpn	router-id 133.1.1.1	
	redistribute bgp 65001 route-map bgp65001	

Host-1 / Cat-3750

```
vrf definition custA
 rd 101:1
 !
 address-family ipv4
 exit-address-family
 !


interface Loopback0
 vrf forwarding custA
 ip address 1.1.1.1 255.255.255.255


interface GigabitEthernet1/0/1
 switchport trunk allowed vlan 101
 switchport trunk encapsulation dot1q
 switchport mode trunk
 !


interface Vlan101
 vrf forwarding custA
 ip address 61.1.1.2 255.255.255.0
 ip ospf network point-to-point
 ip ospf 200 area 0.0.0.0


router ospf 200 vrf custA
 router-id 1.1.1.1
 network 1.1.1.1 0.0.0.0 area 0.0.0.0
 network 61.1.1.0 0.0.0.255 area 0.0.0.0
```

Host-2 / N9K

```
feature ospf
feature interface-vlan


interface Ethernet1/52
 switchport
 switchport mode trunk
 switchport trunk allowed vlan 200
 no shutdown

interface Vlan200
 no shutdown
 ip address 68.1.1.2/24
 ip ospf network point-to-point
 ip router ospf 200 area 0.0.0.0


interface loopback0
 ip address 3.3.3.3/32
 ip router ospf 200 area 0.0.0.0


router ospf 200
 router-id 3.3.3.3
```

Verificación

```
Host2# show ip int brief
IP Interface Status for VRF "default"(1)
Interface       IP Address       Interface Status
Vlan200         68.1.1.2         protocol-up/link-up/admin-up
Vlan1001        100.0.0.100      protocol-down/link-down/admin-up
Lo0             3.3.3.3          protocol-up/link-up/admin-up

Host2# show ip route
IP Route Table for VRF "default"
'*' denotes best ucast next-hop
'**' denotes best mcast next-hop
'[x/y]' denotes [preference/metric]
'%<string>' in via output denotes VRF <string>

1.1.1.1/32, ubest/mbest: 1/0
    *via 68.1.1.1, Vlan200, [110/1], 00:29:24, ospf-200, type-2, tag 65001
3.3.3.3/32, ubest/mbest: 2/0, attached
    *via 3.3.3.3, Lo0, [0/0], 20:16:34, local
    *via 3.3.3.3, Lo0, [0/0], 20:16:34, direct
61.1.1.0/24, ubest/mbest: 1/0
    *via 68.1.1.1, Vlan200, [110/1], 00:29:24, ospf-200, type-2, tag 65001
68.1.1.0/24, ubest/mbest: 1/0, attached
    *via 68.1.1.2, Vlan200, [0/0], 20:20:55, direct
68.1.1.2/32, ubest/mbest: 1/0, attached
    *via 68.1.1.2, Vlan200, [0/0], 20:20:55, local
131.1.1.1/32, ubest/mbest: 1/0
    *via 68.1.1.1, Vlan200, [110/1], 00:29:24, ospf-200, type-2, tag 65001
133.1.1.1/32, ubest/mbest: 1/0
    *via 68.1.1.1, Vlan200, [110/41], 20:15:32, ospf-200, intra
```

```
Host2# traceroute 1.1.1.1
traceroute to 1.1.1.1 (1.1.1.1), 30 hops max, 40 byte packets
 1  68.1.1.1 (68.1.1.1)  0.989 ms  0.585 ms  0.407 ms
 2  172.16.3.1 (172.16.3.1)  0.886 ms 172.16.1.1 (172.16.1.1)  0.765 ms  0.731 ms
    [Label=16311 E=0 TTL=1 S=0, Label=492289 E=0 TTL=1 S=1]
    [Label=16311 E=0 TTL=1 S=0, Label=492289 E=0 TTL=1 S=1]
    [Label=16311 E=0 TTL=1 S=0, Label=492289 E=0 TTL=1 S=1]
 3  172.16.0.2 (172.16.0.2)  0.717 ms 172.16.2.2 (172.16.2.2)  0.509 ms 172.16.0.2 (172.16.0.2)  0.678 ms
    [Label=492289 E=0 TTL=1 S=1]
    [Label=492289 E=0 TTL=1 S=1]
    [Label=492289 E=0 TTL=1 S=1]
 4  61.1.1.2 (61.1.1.2)  2.061 ms *  1.315 ms

Host2# ping 1.1.1.1 source 3.3.3.3
PING 1.1.1.1 (1.1.1.1) from 3.3.3.3: 56 data bytes
64 bytes from 1.1.1.1: icmp_seq=0 ttl=251 time=5.538 ms
64 bytes from 1.1.1.1: icmp_seq=1 ttl=251 time=1.338 ms
64 bytes from 1.1.1.1: icmp_seq=2 ttl=251 time=2.201 ms
64 bytes from 1.1.1.1: icmp_seq=3 ttl=251 time=2.217 ms
64 bytes from 1.1.1.1: icmp_seq=4 ttl=251 time=4.021 ms

--- 1.1.1.1 ping statistics ---
5 packets transmitted, 5 packets received, 0.00% packet loss
round-trip min/avg/max = 1.338/3.063/5.538 ms
```

```
Leaf1# show ip route 3.3.3.3/32 vrf cu101
IP Route Table for VRF "cu101"
'*' denotes best ucast next-hop
'**' denotes best mcast next-hop
'[x/y]' denotes [preference/metric]
'%<string>' in via output denotes VRF <string>

3.3.3.3/32, ubest/mbest: 1/0
    *via 192.168.1.4%default, [200/2], 00:44:27, bgp-65001, internal, tag 65001 (mpls-vpn)
```

```
Leaf1# show forwarding mpls 192.168.1.4/32
slot  1
=======

--------+-----------+--------------------+----------------+-------------+-------
Local  |Prefix     |FEC                 |Next-Hop        |Interface    |Out
Label  |Table Id   |(Prefix/Tunnel id)  |                |             |Label
--------+-----------+--------------------+----------------+-------------+-------
16321  |0x1        |192.168.1.4/32      |172.16.0.1      |Eth1/51      |16321    SWAP
   "   |0x1        |192.168.1.4/32      |172.16.2.1      |Eth1/52      |16321    SWAP
```

```
Leaf1# show forwarding 3.3.3.3/32 vrf cu101
slot  1
=======

IPv4 routes for table cu101/base

------------------+-----------------------+-------------------+-------------------+------------------
Prefix            | Next-hop              | Interface         | Labels            | Partial Install
------------------+-----------------------+-------------------+-------------------+------------------
*3.3.3.3/32         172.16.0.1              Ethernet1/51        PUSH 16321 492288
                    172.16.2.1              Ethernet1/52        PUSH 16321 492288
```

Información Relacionada

- [VPN MPLS BGP Multiprotocolo](#)
- [Informe técnico de routing de segmentos en switches de plataforma Cisco Nexus 9500, 9300, 9200, 3200 y 3100](#)
- [Configuración de EVPN de Capa 3 y VPN de Capa 3 sobre MPLS de Ruteo de Segmentos](#)