

# 在Nexus 9300中通过SR MPLS [Ospf / iBGP] [PE-CE是OSPF]部署第3层EVPN

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## 简介

本文档介绍如何在Nexus 9300产品上部署/配置网段路由(SR)多协议标签交换(MPLS)上的第3层EVPN，PE-CE协议为开放最短路径优先(OSPF)。

## 先决条件

### 要求

Cisco 建议您了解以下主题：

- 边界网关协议 (BGP)
- 开放最短路径优先(OSPF)
- L3VPN
- EVPN
- 分段路由(SR)

### 使用的组件

本文档中的信息基于以下软件和硬件版本：

- 主干硬件 — 93360YC-FX2，运行9.3.(3)
- 枝叶硬件 — 93240YC-FX2运行9.3.(3)
- 客户端 — 93216TC-FX2(Host-1)、Catalyst-3750(Host-2)

本文档中的信息都是基于特定实验室环境中的设备编写的。本文档中使用的所有设备最初均采用原始（默认）配置。如果您使用的是真实网络，请确保您已经了解所有命令的潜在影响。

# 背景信息

## MPLS L3VPN重述

VPN是：

- 基于IP的网络，通过公共基础设施提供专用网络服务。
- 允许通过Internet或其他公共或专用网络彼此私下通信的一组站点。

传统VPN是通过为VPN中的所有站点配置全网状隧道或永久虚电路(PVC)而创建的。这种类型的VPN不易维护或扩展，因为添加新站点需要更改VPN中的每个边缘设备。

基于MPLS的VPN在第3层创建，并基于对等体模型。对等模式使服务提供商和客户能够交换第3层路由信息。服务提供商在客户地点之间中继数据，无需客户参与。

MPLS VPN比传统VPN更易于管理和扩展。将新站点添加到MPLS VPN时，只需更新为客户站点提供服务的服务提供商的边缘路由器。

以下是MPLS VPN的组件：

- 提供商(P)路由器 — 提供商网络核心中的路由器。PE路由器运行MPLS交换，不将VPN标签附加到路由的数据包。VPN标签用于将数据包转发到正确的专用网络或客户边缘路由器。
- PE路由器 — 根据接收VPN标签的接口或子接口将VPN标签附加到传入数据包，并且还附加MPLS核心标签的路由器。PE路由器直接连接到CE路由器。
- 客户(C)路由器 — Internet服务提供商(ISP)或企业网络中的路由器。
- 客户边缘(CE)路由器 — ISP网络上连接到网络上PE路由器的边缘路由器。CE路由器必须与PE路由器进行接口。

## 带L3VPN的EVPN概述(MPLS SR)

数据中心(DC)部署已采用VXLAN EVPN (或) MPLS EVPN，其优势包括EVPN控制平面学习、多租户、无缝移动性、冗余和更轻松的POD添加。同样，CORE是基于标签分发协议(LDP)的MPLS L3VPN网络，或从基于传统MPLS L3VPN LDP的底层过渡到更复杂的解决方案，如分段路由(SR)。

网段路由的优点包括：

- 统一IGP和MPLS控制平面
- 更简单的流量工程方法
- 更轻松的配置
- SDN采用
- EVPN(RFC 7432)是基于BGP MPLS的解决方案，已用于虚拟化数据中心网络中的下一代以太网服务。
- EVPN使用现有MPLS技术的RD、RT和VRF等多个构建块。
- NXOS 7.0(3)I6(1)版本中引入的基于SR的L3 EVPN使用带MPLS封装的EVPN第5类路由。
- 基于SR的L3 EVPN为演进的数据中心服务提供多租户、可扩展性和高性能。

注意：在DC中，数据平面可以是VXLAN或MPLS。

### 传统MPLS L3 VPN

主要构建块：RD、RT和VRF

传输的底层：IGP、LDP和RSVP-TE

服务的重叠层：VPNv4和VPNv6

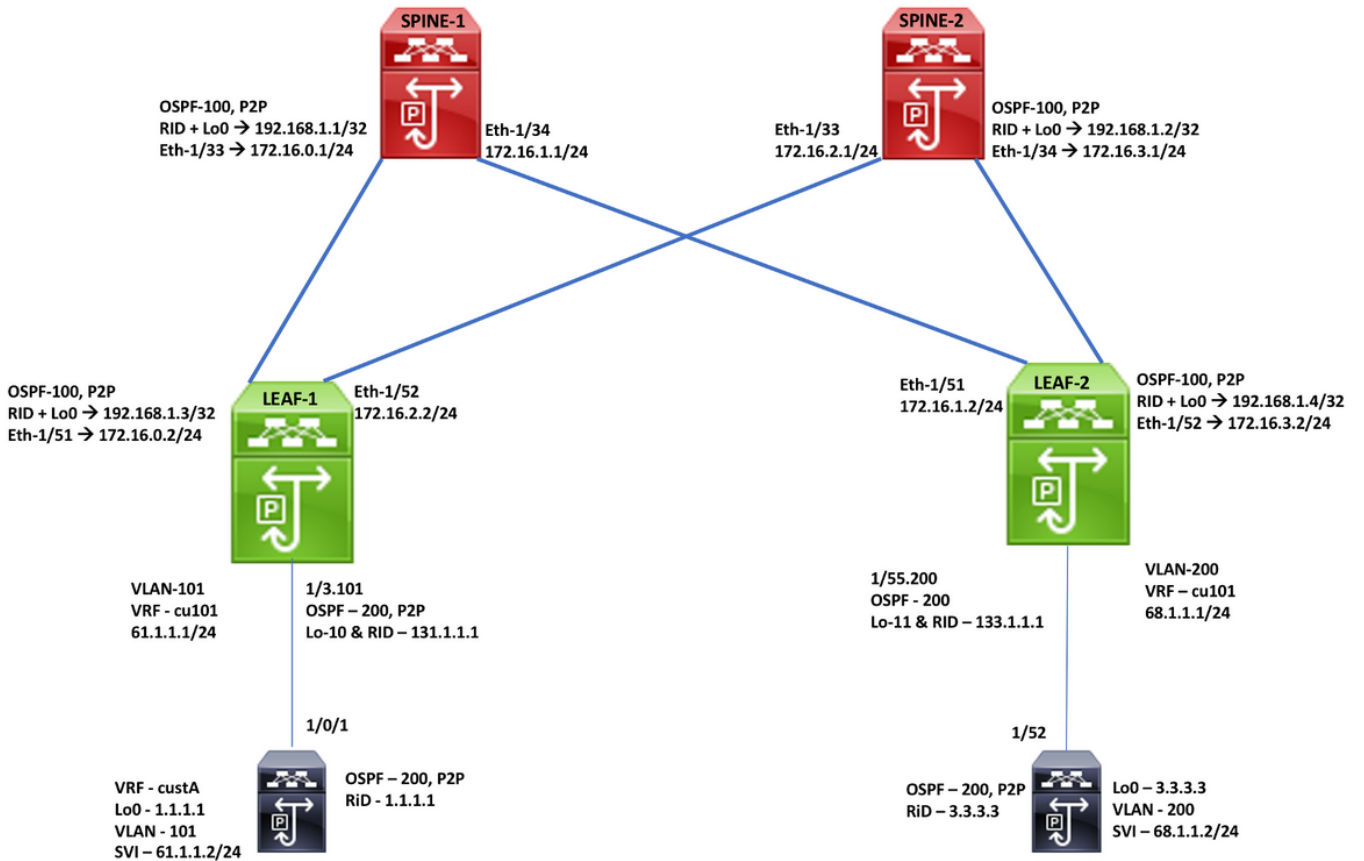
### 基于SR的MPLS L3 VPN

主要构建块：RD、RT和VRF

传输的底层：IGP/BGP-LU和SR-TE

服务的重叠层：EVPN

## 网络图



## 配置

### SPINE-1 Configuration

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

### SPINE-2 Configuration

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

## LEAF-1 Configuration

### Enabling Features, Label-Range, Route-map, Label-Index

```

install feature-set mpls
feature-set mpls
nv overlay evpn
feature ospf
feature bgp
feature mpls segment-routing
feature mpls evpn
feature interface-vlan
feature mpls oam
feature nv overlay

mpls label range 5000 450000
segment-routing
mpls
  global-block 16000 25000
  connected-prefix-sid-map
  address-family ipv4
    192.168.1.3/32 index 311

ip prefix-list test1 seq 5 permit 61.1.1.0/24
ip prefix-list test1 seq 10 permit 131.1.1.1/32

ip prefix-list test3 seq 5 permit 1.1.1.1/32

route-map bgp65001 permit 10
  match route-type internal
route-map direct1 permit 10
  match ip address prefix-list test1
  set community 65001:10
route-map label-index-leaf-1 permit 10
  set label-index 311
route-map ospf200 permit 10
  match ip address prefix-list test3

vrf context cu101
  rd auto
  address-family ipv4 unicast
  route-target import 1:101
  route-target import 1:101 evpn
  route-target export 1:101
  route-target export 1:101 evpn
  
```

### OSPF Configuration

```

interface Ethernet1/51
  ip address 172.16.0.2/24
  ip ospf network point-to-point
  ip router ospf 100 area 0.0.0.0
  mpls ip forwarding
  no shutdown

interface Ethernet1/52
  ip address 172.16.2.2/24
  ip ospf network point-to-point
  ip router ospf 100 area 0.0.0.0
  mpls ip forwarding
  no shutdown

interface loopback0
  ip address 192.168.1.3/32
  ip router ospf 100 area 0.0.0.0

router ospf 100
  segment-routing mpls
  router-id 192.168.1.3

PE-CE
vrf cu101
  address-family ipv4 unicast

interface Ethernet1/3
  no shutdown
interface Ethernet1/3.101
  encapsulation dot1q 101
  vrf member cu101
  ip address 61.1.1.1/24
  ip ospf network point-to-point
  ip router ospf 200 area 0.0.0.0
  no shutdown

interface loopback10
  vrf member cu101
  ip address 131.1.1.1/32
  ip router ospf 200 area 0.0.0.0

router ospf 200
  vrf cu101
  router-id 131.1.1.1
  redistribute bgp 65001 route-map bgp65001
  
```

### BGP/EVPN Configuration

```

router bgp 65001
  router-id 192.168.1.3
  address-family ipv4 unicast
    network 192.168.1.3/32 route-map label-index-leaf-1
  allocate-label all
  address-family ipv4 labeled-unicast
  address-family l2vpn evpn

template peer EVPN
  remote-as 65001
  update-source loopback0
  address-family l2vpn evpn
  send-community extended
  encapsulation mpls

template peer Labeled-unicast
  remote-as 65001
  address-family ipv4 labeled-unicast
  send-community extended
  soft-reconfiguration inbound always

neighbor 172.16.0.1
  inherit peer Labeled-unicast
neighbor 172.16.2.1
  inherit peer Labeled-unicast
neighbor 192.168.1.1
  inherit peer EVPN
neighbor 192.168.1.2
  inherit peer EVPN

vrf cu101
  router-id 131.1.1.1
  address-family ipv4 unicast
  advertise l2vpn evpn
  redistribute direct route-map direct1
  redistribute ospf 200 route-map ospf200
  
```

## LEAF-2 Configuration

### Enabling Features, Label-Range, Route-map, Label-Index

```

install feature-set mpls
feature-set mpls
nv overlay evpn
feature ospf
feature bgp
feature mpls segment-routing
feature mpls evpn
feature interface-vlan
feature mpls oam
feature nv overlay

mpls label range 5000 450000
segment-routing
mpls
  global-block 16000 25000
  connected-prefix-sid-map
  address-family ipv4
    192.168.1.4/32 index 321

ip prefix-list new seq 5 permit 68.1.1.0/24
ip prefix-list new seq 10 permit 133.1.1.1/32

ip prefix-list new1 seq 5 permit 3.3.3.3/32

ip prefix-list redtoospf seq 5 permit 61.1.1.0/24
ip prefix-list redtoospf seq 10 permit 1.1.1.1/32

route-map bgp65001 permit 10
  match route-type internal
route-map direct1 permit 10
  match ip address prefix-list new
route-map label-index-Leaf2 permit 10
  set label-index 321
route-map ospf200 permit 10
  match ip address prefix-list new1

vrf context cu101
  rd auto
  address-family ipv4 unicast
  route-target import 1:101
  route-target import 1:101 evpn
  route-target export 1:101
  route-target export 1:101 evpn
  
```

### OSPF Configuration

```

interface Ethernet1/51
  ip address 172.16.1.2/24
  ip ospf network point-to-point
  ip router ospf 100 area 0.0.0.0
  mpls ip forwarding
  no shutdown

interface Ethernet1/52
  ip address 172.16.3.2/24
  ip ospf network point-to-point
  ip router ospf 100 area 0.0.0.0
  mpls ip forwarding
  no shutdown

interface loopback0
  ip address 192.168.1.4/32
  ip router ospf 100 area 0.0.0.0

router ospf 100
  segment-routing mpls
  router-id 192.168.1.4

PE-CE
vrf cu101
  address-family ipv4 unicast
interface Ethernet1/55
  no shutdown
interface Ethernet1/55.200
  encapsulation dot1q 200
  vrf member cu101
  ip address 68.1.1.1/24
  ip ospf network point-to-point
  ip router ospf 200 area 0.0.0.0
  no shutdown

interface loopback11
  vrf member cu101
  ip address 133.1.1.1/32
  ip router ospf 200 area 0.0.0.0

router ospf 200
  vrf cu101
  router-id 133.1.1.1
  redistribute bgp 65001 route-map bgp65001
  
```

### BGP/EVPN Configuration

```

router bgp 65001
  router-id 192.168.1.4
  address-family ipv4 unicast
    network 192.168.1.4/32 route-map label-index-Leaf2
    allocate-label all
  address-family ipv4 labeled-unicast
  address-family l2vpn evpn

template peer EVPN
  remote-as 65001
  update-source loopback0
  address-family l2vpn evpn
  send-community extended
  encapsulation mpls

template peer Labeled-unicast
  remote-as 65001
  address-family ipv4 labeled-unicast
  send-community extended
  soft-reconfiguration inbound always

neighbor 172.16.1.1
  inherit peer Labeled-unicast
neighbor 172.16.3.1
  inherit peer Labeled-unicast
neighbor 192.168.1.1
  inherit peer EVPN
neighbor 192.168.1.2
  inherit peer EVPN

vrf cu101
  router-id 133.1.1.1
  address-family ipv4 unicast
  advertise l2vpn evpn
  redistribute direct route-map direct1
  redistribute ospf 200 route-map ospf200
  
```

## End-Host Configuration

### 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
```

## 验证

#### 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]
 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]
 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
      |"      |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 |
```

## 相关信息

- [多协议BGP MPLS VPN](#)
- [Cisco Nexus 9500、9300、9200、3200和3100平台交换机上的分段路由白皮书](#)
- [配置第3层EVPN和第3层VPN over Segment Routing MPLS](#)