

IPv6 over MPLS VPN

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简介

IP 版本 6 (IPv6) 是设计用于替换 IP 版本 4 (IPv4) 的新 IP 版本，目前在全世界得到了广泛的部署和应用。IPv6 的优点主要在于具有大得多的地址空间，能满足 Internet 扩张和 Internet 设备急剧增加之后的需求。

IPv6 VPN 在 IPv6 接口或子接口上通过 PE 路由器连接到服务提供商 (SP) 骨干网。该站点可支持 IPv4 和 IPv6。每个 IPv6 VPN 都有自己的地址空间，这意味着在不同的 VPN 中由指定地址表示不同的系统。这通过可在 IP 地址开头添加路由区分符的全新 address-family (**VPN-IPv6** 或 **VPNv6 address-family**) 实现。

一个 VPNv6 地址为 24 字节，以 8 字节的 RD 开始，以 16 字节的 IPv6 地址结束。如果站点支持 IPv4 和 IPv6，则同一 RD 可用于对 IPv4 和 IPv6 地址进行通告。

先决条件

要求

本文档没有任何特定的要求。

注意：对于某些平台（例如7600系列路由器）上的IPv6虚拟路由和转发(VRF)支持，您需要在全局配置中[配置mls ipv6 vrf](#)。

使用的组件

本文档不限于特定的软件和硬件版本。

规则

有关文档规则的详细信息，请参阅 [Cisco 技术提示规则](#)。

配置

本部分提供有关如何配置本文档所述功能的信息。

注意：使用命令查找工具(仅限注册客户)可查找有关本文档中使用的命令的详细信息。

网络图

本文档使用以下网络设置：



VRF 配置

CE1 路由器

```
ipv6 unicast-routing
ipv6 cef
!
interface Serial 0/0
  ipv6 address 2001:1::1/124
!
interface Loopback 0
  ipv6 address ABCD::1/128
!
```

CE2 路由器

```
ipv6 unicast-routing
ipv6 cef
!
interface Serial 0/0
  ipv6 address 2001:2::1/124
!
interface Loopback 0
  ipv6 address ABCD::2/128
!
```

6VPE1 路由器

```

ipv6 unicast-routing
ipv6 cef
!
mpls label protocol ldp
mpls ldp router-id Loopback 0 force
! !----- The VRF is defined with vrf definition vrf
definition CUST1
  rd 1:1
  !
  address-family ipv6
  route-target import 1:1
  route-target export 1:1
  exit-address-family
!
interface Serial 0/0
  vrf forwarding CUST1
  ipv6 address 2001:1::2/124
!
interface Loopback 0
  ip address 1.1.1.1 255.255.255.255
  ip ospf 1 area 0
!

```

6VPE2 路由器

```

ipv6 unicast-routing
ipv6 cef
!
mpls label protocol ldp
mpls ldp router-id Loopback 0 force
!
vrf definition CUST1
  rd 1:1
  !
  address-family ipv6
  route-target import 1:1
  route-target export 1:1
  exit-address-family
!
interface Serial 0/0
  vrf forwarding CUST1
  ipv6 address 2001:2::2/124
!
interface Loopback 0
  ip address 3.3.3.3 255.255.255.255
  ip ospf 1 area 0
!

```

多协议 BGP (MP-BGP) 配置

在 6VPE 路由器上为 iBGP 连接配置了 Address-family VPNv6。在 6VPE 和 CE 路由器之间具有 eBGP 连接。

CE1 路由器

```

router bgp 65101
  neighbor 2001:1::2 remote-as 100
!
  address-family ipv6

```

```
neighbor 2001:1::2 activate
network ABCD::1/128
exit-address-family
!
```

6VPE1 路由器

```
router bgp 100
neighbor 3.3.3.3 remote-as 100
neighbor 3.3.3.3 update-source Loopback 0
!
address-family vpnv6
neighbor 3.3.3.3 activate
exit-address-family
!
address-family ipv6 vrf CUST1
neighbor 2001:1::1 remote-as 65101
neighbor 2001:1::1 activate
redistribute connected
exit-address-family
!
```

CE2 路由器

```
router bgp 65102
neighbor 2001:2::2 remote-as 100
!
address-family ipv6
neighbor 2001:2::2 activate
network ABCD::2/128
exit-address-family
!
```

6VPE2 路由器

```
router bgp 100
neighbor 1.1.1.1 remote-as 100
neighbor 1.1.1.1 update-source Loopback 0
!
address-family vpnv6
neighbor 1.1.1.1 activate
exit-address-family
!
address-family ipv6 vrf CUST1
neighbor 2001:2::1 remote-as 65102
neighbor 2001:2::1 activate
redistribute connected
exit-address-family
!
```

验证

BGP 下一跳地址

6VPE2#

```
show bgp vpnv6 unicast vrf CUST1
```

BGP table version is 30, local router ID is 3.3.3.3

Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
r RIB-failure, S Stale

Origin codes: i - IGP, e - EGP, ? - incomplete

Network	Next Hop	Metric	LocPrf	Weight	Path
Route Distinguisher: 1:1 (default for vrf CUST1)					
*>i2001:1::/124	::FFFF:1.1.1.1	0	100	0	?
*> 2001:2::/124	::	0		32768	?
*>iABCD::1/128	::FFFF:1.1.1.1	0	100	0	65101 i
*> ABCD::2/128	2001:2::1	0		0	65102 i

6VPE2# **show bgp vpnv6 unicast vrf CUST1 ABCD::1/128**

BGP routing table entry for [1:1]ABCD::1/128, version 30

Paths: (1 available, best #1, table CUST1)

Advertised to update-groups:

2

65101

::FFFF:1.1.1.1 (metric 3) from 1.1.1.1 (1.1.1.1)

Origin IGP, metric 0, localpref 100, valid, internal, best

Extended Community: RT:1:1

mpls labels in/out nolabel/20

附加标签

当 6VPE 路由器收到来自所连 CE 路由器的数据包时，它会在与该 CE 路由器对应的 VRF 表中查找数据包 IPv6 目标地址。从而找到 VPNv6 路由。VPNv6 路由具有相关的 MPLS 标签（顶部标签）和相关的 BGP 下一跳标签（底部标签）。

6VPE2# **show bgp vpnv6 unicast vrf CUST1 ABCD::1/128**

BGP routing table entry for [1:1]ABCD::1/128, version 30

Paths: (1 available, best #1, table CUST1)

Advertised to update-groups:

2

65101

::FFFF:1.1.1.1 (metric 3) from 1.1.1.1 (1.1.1.1)

Origin IGP, metric 0, localpref 100, valid, internal, best

Extended Community: RT:1:1

mpls labels in/out nolabel/20

6VPE2#

show ip cef 1.1.1.1

1.1.1.1/32

nexthop 10.2.2.1 FastEthernet2/0 label 16

6VPE2#

show ipv6 cef vrf CUST1 ABCD::1/128 detail

ABCD::1/128, epoch 0

recursive via 1.1.1.1 label 20

nexthop 10.2.2.1 FastEthernet2/0 label 16

向 CE 路由器发出通告的 IPv6 前缀

show ipv6 route bgp **命令** 显示路由器获知的 BGP 路由。

CE1# **show ipv6 route bgp**

IPv6 Routing Table - 6 entries

Codes: C - Connected, L - Local, S - Static, R - RIP, B - BGP

U - Per-user Static route, M - MIPv6

I1 - ISIS L1, I2 - ISIS L2, IA - ISIS interarea, IS - ISIS summary

```

    O - OSPF intra, OI - OSPF inter, OE1 - OSPF ext 1, OE2 - OSPF ext 2
    ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2
    D - EIGRP, EX - EIGRP external
B   2001:2::/124 [20/0]
    via FE80::C808:17FF:FE2C:0, Serial0/0
B   ABCD:2/128 [20/0]
    via FE80::C808:17FF:FE2C:0, Serial0/0

```

CE2# **show ipv6 route bgp**

```

IPv6 Routing Table - 6 entries
Codes: C - Connected, L - Local, S - Static, R - RIP, B - BGP
       U - Per-user Static route, M - MIPv6
       I1 - ISIS L1, I2 - ISIS L2, IA - ISIS interarea, IS - ISIS summary
       O - OSPF intra, OI - OSPF inter, OE1 - OSPF ext 1, OE2 - OSPF ext 2
       ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2
       D - EIGRP, EX - EIGRP external
B   2001:1::/124 [20/0]
    via FE80::C809:14FF:FEB4:0, Serial0/0
B   ABCD:1/128 [20/0]
    via FE80::C809:14FF:FEB4:0, Serial0/0

```

故障排除

使用本部分可排除配置故障。

BGP 功能协商

MP-BGP 用于在 MP_REACH NLRI 中通告 IPv6 VPN 路由。

注：使用的地址系列标识符/后续地址系列标识符(AFI/SAFI)为2/128。AFI = 2的值表示IPv6,SAFI = 128的值表示标有VPNv6的MPLS。

debug ip bgp

```

21:10:10.387: BGP: 3.3.3.3 went from Active to OpenSent
21:10:10.391: BGP: 3.3.3.3 sending OPEN, version 4, my as: 100, holdtime 180
seconds
21:10:10.395: BGP: 3.3.3.3 send message type 1, length (incl. header) 61
21:10:10.579: BGP: 3.3.3.3 rcv message type 1, length (excl. header) 42
21:10:10.579: BGP: 3.3.3.3 rcv OPEN, version 4, holdtime 180 seconds
21:10:10.583: BGP: 3.3.3.3 rcv OPEN w/ OPTION parameter len: 32
21:10:10.583: BGP: 3.3.3.3 rcvd OPEN w/ optional parameter type 2 (Capability)
len 6
21:10:10.583: BGP: 3.3.3.3 OPEN has CAPABILITY code: 1, length 4
21:10:10.587: BGP: 3.3.3.3 OPEN has MP_EXT CAP for afi/safi: 1/1
21:10:10.587: BGP: 3.3.3.3 rcvd OPEN w/ optional parameter type 2 (Capability)
len 6
21:10:10.587: BGP: 3.3.3.3 OPEN has CAPABILITY code: 1, length 4
21:10:10.587: BGP: 3.3.3.3 OPEN has MP_EXT CAP for afi/safi: 2/128
21:10:10.591: BGP: 3.3.3.3 rcvd OPEN w/ optional parameter type 2 (Capability)
len 2
21:10:10.591: BGP: 3.3.3.3 OPEN has CAPABILITY code: 128, length 0
21:10:10.591: BGP: 3.3.3.3 OPEN has ROUTE-REFRESH capability(old) for all
address-families
21:10:10.591: BGP: 3.3.3.3 rcvd OPEN w/ optional parameter type 2 (Capability)
len 2

```

```
21:10:10.595: BGP: 3.3.3.3 OPEN has CAPABILITY code: 2, length 0
21:10:10.595: BGP: 3.3.3.3 OPEN has ROUTE-REFRESH capability(new) for all
    address-families
21:10:10.595: BGP: 3.3.3.3 rcvd OPEN w/ optional parameter type 2 (Capability)
    len 6
21:10:10.595: BGP: 3.3.3.3 OPEN has CAPABILITY code: 65, length 4
21:10:10.599: BGP: 3.3.3.3 OPEN has 4-byte ASN CAP for: 100
BGP: 3.3.3.3 rcvd OPEN w/ remote AS 100, 4-byte remote AS 100
21:10:10.599: BGP: 3.3.3.3 went from OpenSent to OpenConfirm
21:10:10.603: BGP: 3.3.3.3 went from OpenConfirm to Established
21:10:10.603: %BGP-5-ADJCHANGE: neighbor 3.3.3.3 Up
21:10:11.547: %BGP-5-ADJCHANGE: neighbor 2001:1::1 vpn vrf CUST1 Up
```

```
6VPE1# show bgp vpnv6 unicast all neighbors
```

```
BGP neighbor is 3.3.3.3, remote AS 100, internal link
```

```
BGP version 4, remote router ID 3.3.3.3
```

```
BGP state = Established, up for 00:05:32
```

```
Last read 00:00:30, last write 00:00:20, hold time is 180, keepalive interval
    is 60 seconds
```

```
Neighbor capabilities:
```

```
Route refresh: advertised and received(new)
```

```
New ASN Capability: advertised and received
```

```
Address family IPv4 Unicast: advertised and received
```

```
Address family VPNv6 Unicast: advertised and received
```

```
! !---output omitted ! BGP neighbor is 2001:1::1, vrf CUST1, remote AS 65101, external link
```

```
BGP version 4, remote router ID 10.210.0.1
```

```
BGP state = Established, up for 00:05:54
```

```
Last read 00:00:54, last write 00:00:43, hold time is 180, keepalive interval
    is 60 seconds
```

```
Neighbor capabilities:
```

```
Route refresh: advertised and received(new)
```

```
New ASN Capability: advertised
```

```
Address family IPv6 Unicast: advertised and received
```

```
! !---output omitted !
```

[相关信息](#)

- [IP 路由 支持页](#)
- [技术支持和文档 - Cisco Systems](#)