

IPv6 over MPLS VPN

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Related Information

Introduction

IP version 6 (IPv6) is a new version of IP designed to replace IP version 4 (IPv4), which is currently deployed and used extensively throughout the world. The benefits of IPv6 are primarily a result of its much larger addressing space, which is required to cope with the Internet expansion and with the explosion of Internet-capable appliances.

An IPv6 VPN is connected over an IPv6 interface or sub-interface to the Service Provider (SP) backbone via a PE router. The site can be both IPv4 and IPv6 capable. Each IPv6 VPN has its own address space which means a given address denotes different systems in different VPNs. This is achieved via a new address-family, **VPN-IPv6 or VPNv6 address-family**, which prepends a Route Distinguisher (RD) to the IP address.

A VPNv6 address is a 24-byte quantity beginning with an 8-byte RD and ending with a 16-byte IPv6 address. When a site is IPv4 and IPv6 capable, the same RD can be used for the advertisement of both IPv4 and IPv6 addresses.

Prerequisites

Requirements

There are no specific requirements for this document.

Note: For IPv6 Virtual Routing and Forwarding (VRF) support on some platforms (for example, the 7600 Series Router), you will need to configure **mls ipv6 vrf** in global configuration.

Components Used

This document is not restricted to specific software and hardware versions.

Conventions

Refer to Cisco Technical Tips Conventions for more information on document conventions.

Configure

In this section, you are presented with the information to configure the features described in this document.

Note: Use the Command Lookup Tool (registered customers only) to find more information on the commands used in this document.

Network Diagram

This document uses this network setup:



VRF Configuration

CE1 Router

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

CE2 Router

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

6VPE1 Router

```
ipv6 unicast-routing
```

```

ipv6 cef
!
mpls label protocol ldp
mpls ldp router-id Loopback 0 force

!
/----- The VRF is defined with vrf definition <vrf-name> and is made IPv6 aware
!

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 Router

```

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
!

```

Multiprotocol BGP (MP-BGP) Configuration

Address-family VPNv6 is configured on 6VPE routers for iBGP connection. There is an eBGP connection between the 6VPE and the CE routers.

CE1 Router

```

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 Router

```
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 Router

```
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 Router

```
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
!
```

Verify

BGP Next-Hop Address

```
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
```

Label Imposition

When a 6VPE router receives a packet from an attached CE router, it looks up the packet IPv6 destination address in the VRF table corresponding to that CE router. This enables it to find a VPNv6 route. The VPNv6 route has an associated MPLS label (top label) and an associated BGP Next-Hop label (bottom label).

```
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
```

IPv6 Prefixes Advertised to CE Routers

The `show ipv6 route bgp` command displays the BGP routes learned by the router.

```
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

```

Troubleshoot

Use this section to troubleshoot your configuration.

BGP Capability Negotiation

The MP-BGP is used to advertise the IPv6 VPN routes in the MP_REACH NLRI.

Note: The Address Family Identifier/Subsequent Address Family Identifier (AFI/SAFI) used is 2/128. The value of AFI = 2 represents IPv6 and the value of SAFI = 128 represents MPLS labeled VPNv6.

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
!
```

Related Information

- [IP Routing Support Page](#)
- [Technical Support & Documentation – Cisco Systems](#)

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