



MPLS VPN Carrier Supporting Carrier

The carrier supporting carrier feature enables one MPLS VPN-based service provider to allow other service providers to use a segment of its backbone network. This document includes the following sections:

- Feature Overview
- Supported Platforms
- Supported Standards, MIBs, and RFCs
- Prerequisites
- Configuration Tasks
- Configuration Examples
- Glossary

Feature Overview

Carrier supporting carrier is a term used to describe a situation where one service provider allows another service provider to use a segment of its backbone network. The service provider that provides the segment of the backbone network to the other provider is called the backbone carrier. The service provider that uses the segment of the backbone network is called the customer carrier.

This feature module focuses on a backbone carrier that offers Border Gateway Protocol and Multiprotocol Label Switching (BGP/MPLS) VPN services. The customer carrier can be either

- An Internet service provider (ISP)
- A BGP/MPLS VPN service provider

This feature module describes both types of customer carrier.

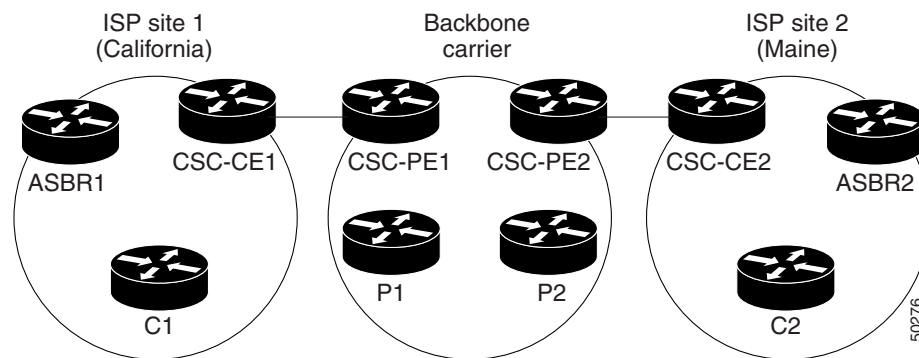
Providing a Backbone Network to a Customer Carrier Who Is an ISP

This section explains how a BGP/MPLS VPN service provider (backbone carrier) can provide a segment of its backbone network to a customer who is an ISP.

Consider the following example and Figure 1:

An ISP has two sites: one in California, the other in Maine. Each site is a point of presence (POP). The ISP wants to connect these sites using a VPN service provided by a backbone carrier. Figure 1 illustrates this situation:

Figure 1 Sample BGP/MPLS Backbone Carrier Supporting an ISP



Note

The CE routers in the figures in this feature module are CE routers to the backbone carrier. However, they are PE routers to the customer carrier.



Note

In this document, the following abbreviations are used, which have the following meanings:

CE router: A customer edge router is part of a customer network and interfaces to a provider edge (PE) router. In this document, the CE router sits on the edge of the customer carrier network.

PE router: A provider edge router is part of a service provider's network connected to a customer edge (CE) router. In this document, the PE routers sits on the edge of the backbone carrier network.

ASBR: In this document, an autonomous system boundary router connects one autonomous system to another.

See the Glossary for the complete definitions of these terms.

In this example, only the backbone carrier uses MPLS. The customer carrier (ISP) uses only IP. As a result, the backbone carrier must carry all the Internet routes of the customer carrier, which could be as many as 100,000 routes. This poses a scalability problem for the backbone carrier. To solve the scalability problem, the backbone carrier is configured as follows:

- The backbone carrier allows only internal routes of the customer carrier (IGP routes) to be exchanged between the CE routers of the customer carrier and the PE routers of the backbone carrier.
- MPLS is enabled on the interface between the CE router of the customer carrier and the PE router of the backbone carrier.

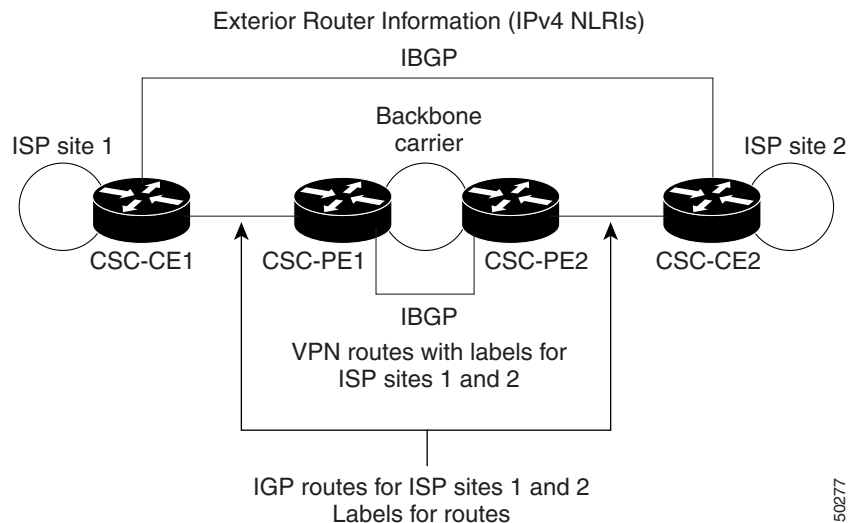
Internal and external routes are differentiated this way:

- Internal routes go to any of the routers within the ISP.
- External routes go to the Internet.

The number of internal routes is much smaller than the number of external routes. Restricting the routes between the CE routers of the customer carrier and the PE routers of the backbone carrier significantly reduces the number of routes that the PE router needs to maintain.

Since the PE routers do not have to carry external routes in the VRF routing table, they can use the incoming label in the packet to forward the customer carrier Internet traffic. Adding MPLS to the routers provides a consistent method of transporting packets from the customer carrier to the backbone carrier. MPLS allows the exchange of an MPLS label between the PE and the CE routers for every internal customer carrier route. The routers in the customer carrier have all the external routes either through IBGP or route redistribution to provide Internet connectivity. Figure 2 shows how information is exchanged when the network is configured in this manner.

Figure 2 Backbone Carrier Exchanging Routing Information with a Customer Carrier Who Is an ISP



Establishing a Route Between the Backbone Carrier and the Customer Carrier Who Is an ISP

In the example shown in Figure 3, routes are created between the backbone carrier and the customer carrier sites. ASBR2 receives an Internet route that originated outside the network. All routers in the ISP sites have all the external routes through IBGP connections among them.

Figure 3 How a Route Is Established Between a Backbone Carrier and a Customer Carrier Who Is an ISP

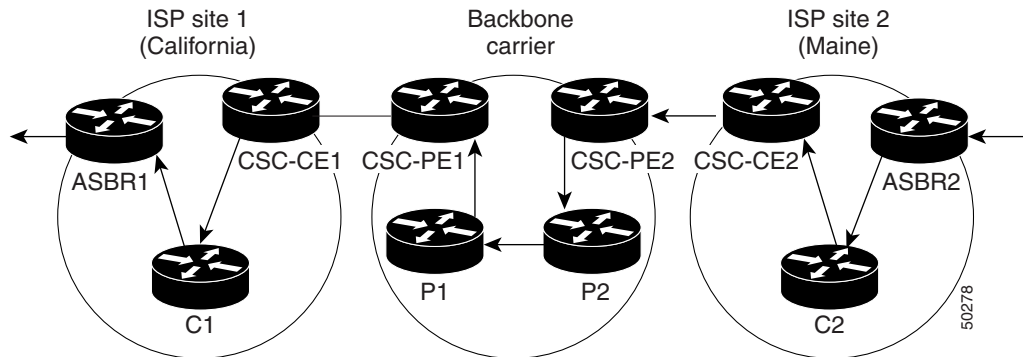


Table 1 describes the process of establishing the route, which can be divided into two distinct steps:

- The backbone carrier propagates the IGP information of the customer carrier, which enables the customer carrier routers to reach all the customer carrier routers in the remote sites.
- Once the routers of the customer carriers in different sites are reachable, external routes can be propagated in the customer carrier sites, using IBGP without using the backbone carrier routers.

Table 1 Establishing a Route Between the Backbone Carrier and the Customer Carrier Who Is an ISP

Step 1	CSC-CE2 sends the internal routes within site 2 to CSC-PE2. The routes include the route to ASBR2.
Step 2	CSC-PE2 sends the routing information for site 2 to CSC-PE1, using MPLS VPN processes. CSC-PE1 gets one label (called L3), which is associated with the route to the VPN-IP address for ASBR2. CSC-PE1 gets another label (called L2) that is associated with the route to CSC-PE2.
Step 3	CSC-PE1 sends the routing information associated with internal routes from site 2 to CSC-CE1. CSC-PE1 also sends the label binding information. As a result, CSC-CE1 gets the route to ASBR2 with CSC-PE1 as the next hop. The label associated with that route is called L1.
Step 4	CSC-CE1 distributes the routing information through site 1. Every router in site 1 gets a route for every internal destination in site 2. Therefore, every router in site 1 can reach routers in site 2 and learn external routes through IBGP.
Step 5	ASBR2 receives an Internet route.
Step 6	The IBGP sessions exchange the external routing information of the ISP, including a route to the Internet. Every router in site 1 knows a route to the Internet, with ASBR2 as the next hop of that route.

Transporting a Packet Through a Network of a Backbone Carrier and Customer Carrier Who Is an ISP

Table 2 explains each step in the process of transporting a packet. The following conventions are used in Table 2:

- The D in the Label Stack and Destination Address column represents an address that is outside the network, such as an Internet address.
- The notation $X(Y)$ means “the label distributed by Y , which represents the route to X .”
- In the column Label Stack and Destination Address, when a label stack is present, the top label is listed first; the destination address is listed last.

Table 2 How Packets Travel From a Customer Carrier Who Is an ISP Through a BGP/MPLS Backbone Carrier

	The Packet Is Received By	Label Stack and Destination Address	Label Stack Operation	How the Label Was Learned	Next Hop
Step 1	ASBR1	D	None	—	C1
Step 2	C1	D	None	—	CSC-CE1
Step 3	CSC-CE1	D	Move ASBR2(CSC-PE1) onto the stack	LDP	CSC-PE1
Step 4	PE1	ASBR2(CSC-PE1) D	Replace the top label with ASBR2(CSC-PE2) Push the IGP label for CSC-PE2 CSC-PE2(P1)	BGP	P1
Step 5	P1	CSC-PE2(P1) ASBR2(CSC-PE2) D	Replace the top label with CSC-PE2(P2)	LDP	P2
Step 6	P2	CSC-PE2(P2) ASBR2(CSC-PE2) D	Remove a label from the stack	LDP	CSC-PE2
Step 7	CSC-PE2	ASBR2(CSC-CE2) D	Replace the top label from the stack	LDP	CSC-CE2
Step 8	CSC-CE2	D	Remove a label from the stack	—	C2
Step 9	C2	D	None	—	ASBR2
Step 10	ASBR2	D			

Providing a Backbone Network to a Customer Carrier Who Is a BGP/MPLS VPN Service Provider

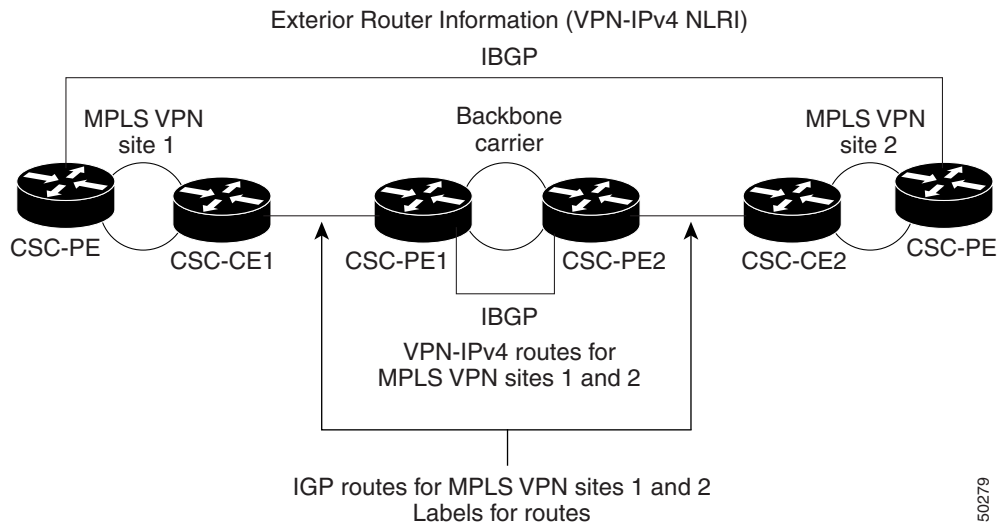
When a backbone carrier and the customer carrier both provide BGP/MPLS VPN services, the method of transporting data is different from when a customer carrier provides only ISP services. The following list highlights those differences.

- When a customer carrier provides BGP/MPLS VPN services, its external routes are VPN-IPv4 routes. When a customer carrier is an ISP, its external routes are IP routes.

- When a customer carrier provides BGP/MPLS VPN services, every site within the customer carrier must use MPLS. When a customer carrier is an ISP, the sites do not need to use MPLS.

Figure 4 shows how information is exchanged when MPLS VPN services reside on all customer carrier sites and on the backbone carrier.

Figure 4 Backbone Carrier Exchanging Information with a Customer Carrier Who Is an MPLS VPN Service Provider



Establishing a Route Between the Backbone Carrier and the Customer Carrier Who Is an MPLS VPN Service Provider

In the example shown in Figure 5, routes are created between the backbone carrier and the customer carrier sites.

Figure 5 How a Route Is Established Between a Backbone Carrier and a Customer Carrier Who Is an MPLS VPN Service Provider

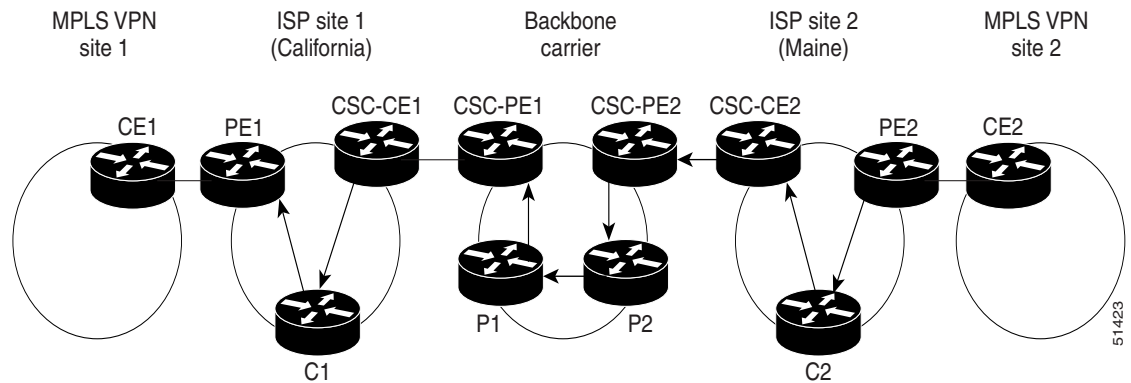


Table 3 describes the process of establishing the route.

Table 3 *Establishing a Route Between the Backbone Carrier and Customer Carrier Sites*

Step 1	CE2 sends all the internal routes within site 2 to CSC-PE2.
Step 2	CSC-PE2 sends the routing information for site 2 to CSC-PE1, using MPLS VPN processes. CSC-PE1 gets one label (called L3), which is associated with the route to the VPN-IP address for PE2. CSC-PE1 gets another label (called L2) that is associated with the route to CSC-PE2.
Step 3	CSC-PE1 sends the routing information associated with internal routes from site 2 to CSC-CE1. CSC-PE1 also sends the label binding information. As a result, CSC-CE1 gets the route to PE2 with CSC-PE1 as the next hop. The label associated with that route is called L1.
Step 4	CE1 distributes the routing and labelling information through site 1. Every router in site 1 gets a route for every internal destination in site 2. Therefore, PE1 can establish an MP-IBGP session with PE2.
Step 5	CE2 advertises the internal routes of MPLS VPN site 2 to PE2.
Step 6	PE2 allocates labels for all the VPN routes (regular MPLS VPN functionality) and advertises it to PE1, using MP-IBGP.
Step 7	PE1 can forward traffic from VPN site 1 that is destined for VPN site 2.

Transporting a Packet Through a Network of a Backbone Carrier and Customer Carrier Who Is an MPLS VPN Service Provider

Table 4 explains each step in the process of transporting the packet. The following conventions are used in Table 4:

- The D in the Label Stack and Destination Address column represents an address that is outside the network, such as an Internet address.
- The notation X(Y) means “the label distributed by Y, which represents the route to X.”
- In the column Label Stack and Destination Address, when a label stack is present, the top label is listed first; the destination address is listed last.

Table 4 *How Packets Travel From a Customer Carrier Running BGP/MPLS VPN Service Through a BGP/MPLS Backbone Carrier*

	The Packet Is Received By	Label Stack and Destination Address	Label Stack Operation	How the Label Was Learned	Next Hop
Step 1	PE1	D	Move D(PE2) onto the stack Move PE2(C1) onto the stack	BGP LDP	C1
Step 2	C1	PE2(C1) D(PE2) D	Replace the top label with PE2(CSC-CE1)	LDP	CSC-CE1
Step 3	CSC-CE1	PE2(CSC-CE1) D(PE2) D	Replace the top label with PE2(CSC-PE1)	LDP	CSC-PE1

	The Packet Is Received By	Label Stack and Destination Address	Label Stack Operation	How the Label Was Learned	Next Hop
Step 4	CSC-PE1	PE2(CSC-PE1) D(PE2) D	Replace the top label with PE2(CSC-PE2) Move CSC-PE2(P1) onto the stack	BGP	P1
Step 5	P1	CSC-PE2(P1) PE2(CSC-PE2) D(PE2) D	Replace the top label with CSC-PE2(P2)	LDP	P2
Step 6	P2	CSC-PE2(P2) PE2(P2) D(PE2) D	Remove a label from the stack	LDP	CSC-PE2
Step 7	CSC-PE2	PE2(CSC-PE2) D(PE2) D	Replace the top label with PE2(CSC-CE2)	BGP	CSC-CE2
Step 8	CSC-CE2	PE2(CSC-CE2) D(PE2) D	Replace the top label with PE2(C2)	LDP	C2
Step 9	C2	PE2(C2) D(PE2) D	Remove a label from the stack	LDP	PE2
Step 10	PE2	D(PE2) D			

Benefits

The MPLS VPN carrier supporting carrier feature provides the benefits listed in the following paragraphs to service providers who are backbone carriers and customer carriers.

Benefits to the Backbone Carrier

Implementing the MPLS VPN carrier supporting carrier feature enables the backbone carrier to realize the following benefits:

- The backbone carrier can accommodate many customer carriers and give them access to its backbone. The backbone carrier does not need to create and maintain separate backbones for its customer carriers. Using one backbone network to support multiple customer carriers simplifies the backbone carrier's VPN operations. The backbone carrier uses a consistent method for managing and maintaining the backbone network. This is also cheaper and more efficient than maintaining separate backbones.
- The MPLS VPN carrier supporting carrier feature is scalable. Carrier supporting carrier can change the VPN to meet changing bandwidth and connectivity needs. The feature can accommodate unplanned growth and changes. The carrier supporting carrier feature enables tens of thousands of VPNs to be set up over the same network, and it allows a service provider to offer both VPN and Internet services.

- The MPLS VPN carrier supporting carrier feature is a flexible solution. The backbone carrier can accommodate many types of customer carriers. The backbone carrier can accept customer carriers who are ISPs or VPN service providers or both. The backbone carrier can accommodate customer carriers that require security and various bandwidths.

Benefits to the Customer Carrier

Implementing the MPLS VPN carrier supporting carrier feature enables the customer carrier to realize the following benefits:

- The MPLS VPN carrier supporting carrier feature removes from the customer carrier the burden of configuring, operating, and maintaining its own backbone. The customer carrier uses the backbone network of a backbone carrier, but the backbone carrier is responsible for network maintenance and operation.
- Customer carriers who use the VPN services provided by the backbone carrier receive the same level of security that Frame Relay or ATM-based VPNs provide. Customer carriers can also use IPsec in their VPNs for a higher level of security; it is completely transparent to the backbone carrier.
- Customer carriers can use any link layer technology (SONET, DSL, Frame Relay, and so on) to connect the CE routers to the PE routers and the PE routers to the P routers. The MPLS VPN carrier supporting carrier feature is link layer independent. The CE routers and PE routers use IP to communicate, and the backbone carrier uses MPLS.
- The customer carrier can use any addressing scheme and still be supported by a backbone carrier. The customer address space and routing information are independent of the address space and routing information of other customer carriers or the backbone provider.

Requirements

The carrier supporting carrier feature includes the following requirements:

- The PE routers of the backbone carrier require 128MB of memory.
- The backbone carrier must enable the PE router to check that the packets it receives from the CE router contain only the labels that the PE router advertised to the CE router. This prevents data spoofing, which occurs when a packet from an unrecognized IP address is sent to a router.
- A routing protocol is required between the PE and CE routers that connect the backbone carrier to the customer carrier. The routing protocol enables the customer carrier to exchange IGP routing information with the backbone carrier. Use the same routing protocol that the customer carrier uses. You can choose RIP, or OSPF as the routing protocol. BGP is not supported.
- Label distribution protocol (LDP) is required between the PE and CE routers that connect the backbone carrier to the customer carrier. LDP is also required on the PE to CE interface for VPN routing and forwarding (VRF). LDP is available on Cisco Release 12.0(10)ST or later.
- All PE routers that link the backbone carrier to the customer carrier must run this IOS software image. Other PE routers, CE routers, and P routers do not need to run this software image, but, they must run a version of IOS software that supports MPLS VPNs (Release 12.0(5)T or later).
- Every packet that crosses the backbone carrier must be encapsulated, so that the packet includes MPLS labels. To ensure that the packets are encapsulated, issue the following command on the PE routers that connect to CE routers:

```
(config-if)# mpls ip
```

For more information, see the IOS Command Reference Guide.

The following features are not supported in the carrier supporting carrier feature:

- ATM MPLS
- Carrier supporting carrier traffic engineering
- Carrier supporting carrier class of service (COS)
- RSVP aggregation
- VPN Multicast between the customer carrier and the backbone carrier network

Related Features and Technologies

The carrier supporting carrier feature is used with the VPN capabilities of MPLS. (MPLS VPNs were introduced in Cisco IOS Release 12.0(5)T.)

Related Documents

- *MPLS Virtual Private Network Feature Module*
- *MPLS Virtual Private Network Enhancements Feature Module*
- *Cisco IOS Release 12.0 Network Protocols Configuration Guide, Part I*
- *Cisco IOS Release 12.0 Network Protocols Command Reference, Part I*

Supported Platforms

The following router platforms are supported on the edge:

- Cisco 7200 series
- Cisco 7500 series

Supported Standards, MIBs, and RFCs

MIBs

No new or modified MIBs are supported by this feature.

RFCs

- RFC 1171, A Border Gateway Protocol 4
- RFC 1164, Application of the Border Gateway Protocol in the Internet
- RFC 2283, Multiprotocol Extensions for BGP-4
- RFC 2547, BGP/MPLS VPNs

Standards

No new or modified standards are supported by this feature.

Prerequisites

The backbone carrier must be properly configured for MPLS VPN operation before the customer carriers can access the backbone network. Refer to the *MPLS Virtual Private Network Feature Module* and the *MPLS Virtual Private Network Enhancements Feature Module*.

Configuration Tasks

See the following sections to enable a backbone carrier to share its backbone network with a customer carrier. Each task entry in the list indicates if the task is optional or required.

- Configuring the Backbone Carrier PE Router (required)
- Configuring the Customer Carrier CE Routers (required)
- Verifying the Carrier Supporting Carrier Configuration (optional)

Configuring the Backbone Carrier PE Router

The following steps explain how to configure the backbone carrier PE route that links to the edge router of the customer carrier.

	Command	Purpose
Step 1	Router(config)# mpls label protocol ldp	Sets the default label distribution protocol for all interfaces to be LDP.
Step 2	Router(config-if)# mpls ip	Enables MPLS on the VRF interface

Configuring the Customer Carrier CE Routers

The following steps explain how to configure the CE router on the customer carrier that links to the edge router of the backbone carrier.

	Command	Purpose
Step 1	Router(config)# mpls label protocol ldp	Sets the default label distribution protocol for all interfaces to LDP.
Step 2	Router(config-if)# mpls ip	Enables MPLS on the VRF interface

Verifying the Carrier Supporting Carrier Configuration

The following command helps to verify that the backbone carrier and customer carrier were correctly configured and now the customer carrier ISP sites can act like one VPN.

```
show mpls ldp discovery vrf vrf-name all
```

The Local LDP Identifier field shows the LDP identifier for the local label switching router for this session. The Interfaces field displays the interfaces engaging in LDP discovery activity:

- xmit indicates that the interface is transmitting LDP discovery hello packets
- rcv indicates that the interface is receiving LDP discovery hello packets.

Configuration Examples

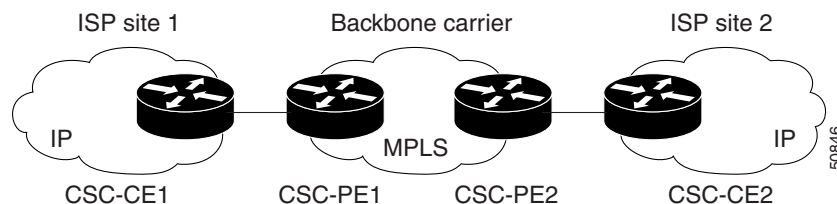
This section provides the following configuration examples:

- Configuring a Carrier Supporting Carrier Network with a Customer Who Is an ISP
- Configuring a Carrier Supporting Carrier Network with a Customer Who Is an MPLS VPN Provider
- Configuring a Carrier Supporting Carrier Network That Contains Route Reflectors
- Configuring a Carrier Supporting Carrier Network with a Customer Who Has VPNs at the Edge of Their Network

Configuring a Carrier Supporting Carrier Network with a Customer Who Is an ISP

Figure 6 shows a carrier supporting carrier network configuration where the customer carrier is an ISP. The customer carrier has two sites, each of which is a point of presence (POP). The customer carrier connects these sites using a VPN service provided by the backbone carrier. The backbone carrier uses MPLS. The ISP sites use IP. To enable packet transfer between the ISP sites and the backbone carrier, the CE routers that connect the ISPs to the backbone carrier run MPLS.

Figure 6 Carrier Supporting Carrier Network with a Customer Carrier Who Is an ISP



The following configuration examples show the configuration of each router in the carrier supporting carrier network. OSPF is the protocol used to connect the customer carrier to the backbone carrier

CSC-CE1 Configuration

```

mpls label protocol ldp
!
interface Loopback0
 ip address 14.14.14.14 255.255.255.255
 no ip directed-broadcast
 no ip route-cache
 no ip mroute-cache
!
interface ATM1/0
 no ip address
 no ip directed-broadcast
 no ip mroute-cache

```

```

atm clock INTERNAL
atm sonet stm-1
no atm enable-ilmi-trap
no atm ilmi-keepalive
!
interface ATM1/0.1 point-to-point
ip address 46.0.0.2 255.0.0.0
no ip directed-broadcast
atm pvc 101 0 51 aal5snap
no atm enable-ilmi-trap
mpls label protocol ldp
mpls ip
!
interface ATM2/0
no ip address
no ip directed-broadcast
no ip mroute-cache
atm clock INTERNAL
atm sonet stm-1
no atm enable-ilmi-trap
no atm ilmi-keepalive
!
interface ATM2/0.1 point-to-point
ip address 38.0.0.2 255.0.0.0
no ip directed-broadcast
atm pvc 100 0 50 aal5snap
no atm enable-ilmi-trap
mpls label protocol ldp
mpls ip
!
router ospf 200
log-adjacency-changes
redistribute connected subnets
network 14.14.14.14 0.0.0.0 area 200
network 38.0.0.0 0.255.255.255 area 200
network 46.0.0.0 0.255.255.255 area 200

```

CSC-PE1 Configuration

```

ip cef distributed
!
ip vrf vpn1
rd 100:0
route-target export 100:0
route-target import 100:0
mpls label protocol ldp
no mpls aggregate-statistics
!
interface Loopback0
ip address 11.11.11.11 255.255.255.255
no ip directed-broadcast
no ip route-cache
no ip mroute-cache
!
interface Loopback100
ip vrf forwarding vpn1
ip address 19.19.19.19 255.255.255.255
no ip directed-broadcast
!
interface ATM1/1/0
no ip address
no ip directed-broadcast

```

```

no ip route-cache distributed
atm clock INTERNAL
no atm enable-ilmi-trap
no atm ilmi-keepalive
!
interface ATM1/1/0.1 point-to-point
ip address 33.0.0.1 255.0.0.0
no ip directed-broadcast
atm pvc 100 0 50 aal5snap
no atm enable-ilmi-trap
mpls label protocol ldp
mpls ip
!
interface ATM3/0/0
no ip address
no ip directed-broadcast
no ip route-cache distributed
atm clock INTERNAL
atm sonet stm-1
no atm enable-ilmi-trap
no atm ilmi-keepalive
!
interface ATM3/0/0.1 point-to-point
ip vrf forwarding vpn1
ip address 46.0.0.1 255.0.0.0
no ip directed-broadcast
atm pvc 101 0 51 aal5snap
no atm enable-ilmi-trap
mpls label protocol ldp
mpls ip
!
router ospf 100
log-adjacency-changes
passive-interface ATM3/0/0.1
passive-interface Loopback100
network 11.11.11.11 0.0.0.0 area 100
network 33.0.0.0 0.255.255.255 area 100
!
router ospf 200 vrf vpn1
log-adjacency-changes
redistribute bgp 100 metric-type 1 subnets
network 19.19.19.19 0.0.0.0 area 200
network 46.0.0.0 0.255.255.255 area 200
!
router bgp 100
bgp log-neighbor-changes
timers bgp 10 30
neighbor 12.12.12.12 remote-as 100
neighbor 12.12.12.12 update-source Loopback0
!
address-family ipv4
neighbor 12.12.12.12 activate
neighbor 12.12.12.12 send-community extended
no synchronization
exit-address-family
!
address-family vpnv4
neighbor 12.12.12.12 activate
neighbor 12.12.12.12 send-community extended
exit-address-family
!
address-family ipv4 vrf vpn1
redistribute ospf 200 match internal external 1 external 2
no auto-summary

```

```
no synchronization
exit-address-family
```

CSC-PE2 Configuration

```
ip cef distributed
!
ip vrf vpn1
 rd 100:0
  route-target export 100:0
  route-target import 100:0
mpls label protocol ldp
no mpls aggregate-statistics
!
interface Loopback0
 ip address 12.12.12.12 255.255.255.255
 no ip directed-broadcast
 no ip route-cache
 no ip mroute-cache
!
interface Loopback100
 ip vrf forwarding vpn1
 ip address 20.20.20.20 255.255.255.255
 no ip directed-broadcast
!
interface ATM0/1/0
 no ip address
 no ip directed-broadcast
 no ip route-cache distributed
 no ip mroute-cache
 atm clock INTERNAL
 atm sonet stm-1
 no atm enable-ilmi-trap
 no atm ilmi-keepalive
!
interface ATM0/1/0.1 point-to-point
 ip address 33.0.0.2 255.0.0.0
 no ip directed-broadcast
 atm pvc 100 0 50 aal5snap
 no atm enable-ilmi-trap
 mpls label protocol ldp
 mpls ip
!
interface ATM3/0/0
 no ip address
 no ip directed-broadcast
 no ip route-cache distributed
 no ip mroute-cache
 atm clock INTERNAL
 atm sonet stm-1
 no atm enable-ilmi-trap
 no atm ilmi-keepalive
!
interface ATM3/0/0.1 point-to-point
 ip vrf forwarding vpn1
 ip address 47.0.0.1 255.0.0.0
 no ip directed-broadcast
 atm pvc 100 0 50 aal5snap
 no atm enable-ilmi-trap
 mpls label protocol ldp
 mpls ip
!
```

```

router ospf 100
  log-adjacency-changes
  passive-interface ATM3/0/0.1
  passive-interface Loopback100
  network 12.12.12.12 0.0.0.0 area 100
  network 33.0.0.0 0.255.255.255 area 100
!
router ospf 200 vrf vpn1
  log-adjacency-changes
  redistribute bgp 100 metric-type 1 subnets
  network 20.20.20.20 0.0.0.0 area 200
  network 47.0.0.0 0.255.255.255 area 200
!
router bgp 100
  bgp log-neighbor-changes
  timers bgp 10 30
  neighbor 11.11.11.11 remote-as 100
  neighbor 11.11.11.11 update-source Loopback0
!
  address-family ipv4
    neighbor 11.11.11.11 activate
    neighbor 11.11.11.11 send-community extended
    no synchronization
    exit-address-family
!
  address-family vpv4
    neighbor 11.11.11.11 activate
    neighbor 11.11.11.11 send-community extended
    exit-address-family
!
  address-family ipv4 vrf vpn1
    redistribute ospf 200 match internal external 1 external 2
    no auto-summary
    no synchronization
    exit-address-family

```

CSC-CE2 Configuration

```

ip cef
!
mpls label protocol ldp
!
interface Loopback0
  ip address 16.16.16.16 255.255.255.255
  no ip directed-broadcast
  no ip route-cache
  no ip mroute-cache
!
interface ATM1/0
  no ip address
  no ip directed-broadcast
  no ip mroute-cache
  atm clock INTERNAL
  atm sonet stm-1
  no atm enable-ilmi-trap
  no atm ilmi-keepalive
!
interface ATM1/0.1 point-to-point
  ip address 47.0.0.2 255.0.0.0
  no ip directed-broadcast
  atm pvc 100 0 50 aal5snap
  no atm enable-ilmi-trap

```

```

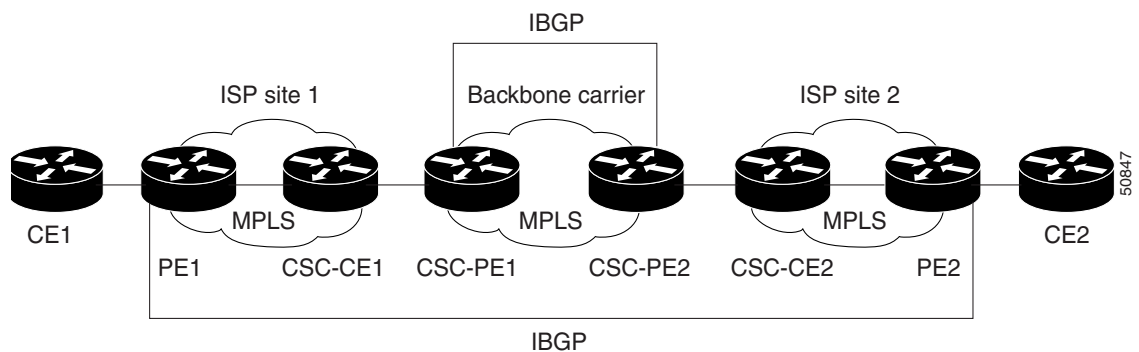
mpls label protocol ldp
mpls ip
!
interface ATM5/0
no ip address
no ip directed-broadcast
no ip mroute-cache
atm clock INTERNAL
atm sonet stm-1
no atm enable-ilmi-trap
no atm ilmi-keepalive
!
interface ATM5/0.1 point-to-point
ip address 43.0.0.2 255.0.0.0
no ip directed-broadcast
atm pvc 100 0 50 aal5snap
no atm enable-ilmi-trap
mpls label protocol ldp
mpls ip
!
router ospf 200
log-adjacency-changes
redistribute connected subnets
network 16.16.16.16 0.0.0.0 area 200
network 43.0.0.0 0.255.255.255 area 200
network 47.0.0.0 0.255.255.255 area 200

```

Configuring a Carrier Supporting Carrier Network with a Customer Who Is an MPLS VPN Provider

Figure 7 shows a carrier supporting carrier network configuration where the customer carrier is an MPLS VPN provider. The customer carrier has two sites. The backbone carrier and the customer carrier use MPLS. The IBGP sessions exchange the external routing information of the ISP.

Figure 7 Carrier Supporting Carrier Network with a Customer Carrier Who Is an MPLS VPN Provider



The following configuration examples show the configuration of each router in the carrier supporting carrier network. OSPF is the protocol used to connect the customer carrier to the backbone carrier

CE1 Configuration

```
ip cef
```

```

!
interface Loopback0
 ip address 17.17.17.17 255.255.255.255
 no ip directed-broadcast
!
interface Ethernet0/1
 ip address 37.0.0.2 255.0.0.0
 no ip directed-broadcast
!
router ospf 300
 log-adjacency-changes
 redistribute bgp 300 subnets
 passive-interface Ethernet0/1
 network 17.17.17.17 0.0.0.0 area 300
!
router bgp 300
 no synchronization
 bgp log-neighbor-changes
 timers bgp 10 30
 redistribute connected
 redistribute ospf 300 match internal external 1 external 2
 neighbor 37.0.0.1 remote-as 200
 neighbor 37.0.0.1 advertisement-interval 5
 no auto-summary

```

PE1 Configuration

```

ip cef
!
ip vrf vpn2
 rd 200:1
 route-target export 200:1
 route-target import 200:1
mpls label protocol ldp
!
interface Loopback0
 ip address 13.13.13.13 255.255.255.255
 no ip directed-broadcast
 no ip route-cache
 no ip mroute-cache
!
interface ATM1/0
 no ip address
 no ip directed-broadcast
 no ip mroute-cache
 atm clock INTERNAL
 atm sonet stm-1
 no atm enable-ilmi-trap
 no atm ilmi-keepalive
!
interface ATM1/0.1 point-to-point
 ip address 38.0.0.1 255.0.0.0
 no ip directed-broadcast
 atm pvc 100 0 50 aal5snap
 no atm enable-ilmi-trap
 mpls label protocol ldp
 mpls ip
!
interface Ethernet3/0
 ip vrf forwarding vpn2
 ip address 37.0.0.1 255.0.0.0
 no ip directed-broadcast

```

```

no ip mroute-cache
!
router ospf 200
log-adjacency-changes
redistribute connected subnets
passive-interface Ethernet3/0
network 13.13.13.13 0.0.0.0 area 200
network 38.0.0.0 0.255.255.255 area 200
!
router bgp 200
no bgp default ipv4-unicast
bgp log-neighbor-changes
timers bgp 10 30
neighbor 15.15.15.15 remote-as 200
neighbor 15.15.15.15 update-source Loopback0
!
address-family ipv4
neighbor 15.15.15.15 activate
neighbor 15.15.15.15 send-community extended
no synchronization
exit-address-family
!
address-family vpnv4
neighbor 15.15.15.15 activate
neighbor 15.15.15.15 send-community extended
exit-address-family
!
address-family ipv4 vrf vpn2
neighbor 37.0.0.2 remote-as 300
neighbor 37.0.0.2 activate
neighbor 37.0.0.2 as-override
neighbor 37.0.0.2 advertisement-interval 5
no auto-summary
no synchronization
exit-address-family

```

CSC-CE1 Configuration

```

mpls label protocol ldp
!
interface Loopback0
ip address 14.14.14.14 255.255.255.255
no ip directed-broadcast
no ip route-cache
no ip mroute-cache
!
interface ATM1/0
no ip address
no ip directed-broadcast
no ip mroute-cache
atm clock INTERNAL
atm sonet stm-1
no atm enable-ilmi-trap
no atm ilmi-keepalive
!
interface ATM1/0.1 point-to-point
ip address 46.0.0.2 255.0.0.0
no ip directed-broadcast
atm pvc 101 0 51 aal5snap
no atm enable-ilmi-trap
mpls label protocol ldp
mpls ip

```

```

!
interface ATM2/0
  no ip address
  no ip directed-broadcast
  no ip mroute-cache
  atm clock INTERNAL
  atm sonet stm-1
  no atm enable-ilmi-trap
  no atm ilmi-keepalive
!
interface ATM2/0.1 point-to-point
  ip address 38.0.0.2 255.0.0.0
  no ip directed-broadcast
  atm pvc 100 0 50 aal5snap
  no atm enable-ilmi-trap
  mpls label protocol ldp
  mpls ip
!
router ospf 200
  log-adjacency-changes
  redistribute connected subnets
  network 14.14.14.14 0.0.0.0 area 200
  network 38.0.0.0 0.255.255.255 area 200
  network 46.0.0.0 0.255.255.255 area 200

```

CSC-PE1 Configuration

```

ip cef distributed
!
ip vrf vpn1
  rd 100:0
  route-target export 100:0
  route-target import 100:0
mpls label protocol ldp
no mpls aggregate-statistics
!
interface Loopback0
  ip address 11.11.11.11 255.255.255.255
  no ip directed-broadcast
  no ip route-cache
  no ip mroute-cache
!
interface Loopback100
  ip vrf forwarding vpn1
  ip address 19.19.19.19 255.255.255.255
  no ip directed-broadcast
!
interface ATM1/1/0
  no ip address
  no ip directed-broadcast
  no ip route-cache distributed
  atm clock INTERNAL
  no atm enable-ilmi-trap
  no atm ilmi-keepalive
!
interface ATM1/1/0.1 point-to-point
  ip address 33.0.0.1 255.0.0.0
  no ip directed-broadcast
  atm pvc 100 0 50 aal5snap
  no atm enable-ilmi-trap
  mpls label protocol ldp
  mpls ip

```

```

!
interface ATM3/0/0
 no ip address
 no ip directed-broadcast
 no ip route-cache distributed
 atm clock INTERNAL
 atm sonet stm-1
 no atm enable-ilmi-trap
 no atm ilmi-keepalive
!
interface ATM3/0/0.1 point-to-point
 ip vrf forwarding vpn1
 ip address 46.0.0.1 255.0.0.0
 no ip directed-broadcast
 atm pvc 101 0 51 aal5snap
 no atm enable-ilmi-trap
 mpls label protocol ldp
 mpls ip
!
router ospf 100
 log-adjacency-changes
 passive-interface ATM3/0/0.1
 passive-interface Loopback100
 network 11.11.11.11 0.0.0.0 area 100
 network 33.0.0.0 0.255.255.255 area 100
!
router ospf 200 vrf vpn1
 log-adjacency-changes
 redistribute bgp 100 metric-type 1 subnets
 network 19.19.19.19 0.0.0.0 area 200
 network 46.0.0.0 0.255.255.255 area 200
!
router bgp 100
 bgp log-neighbor-changes
 timers bgp 10 30
 neighbor 12.12.12.12 remote-as 100
 neighbor 12.12.12.12 update-source Loopback0
!
 address-family ipv4
 neighbor 12.12.12.12 activate
 neighbor 12.12.12.12 send-community extended
 no synchronization
 exit-address-family
!
 address-family vpnv4
 neighbor 12.12.12.12 activate
 neighbor 12.12.12.12 send-community extended
 exit-address-family
!
 address-family ipv4 vrf vpn1
 redistribute ospf 200 match internal external 1 external 2
 no auto-summary
 no synchronization
 exit-address-family

```

CSC-PE2 Configuration

```

ip cef distributed
!
ip vrf vpn1
 rd 100:0
 route-target export 100:0

```

```

    route-target import 100:0
mpls label protocol ldp
no mpls aggregate-statistics
!
interface Loopback0
 ip address 12.12.12.12 255.255.255.255
 no ip directed-broadcast
 no ip route-cache
 no ip mroute-cache
!
interface Loopback100
 ip vrf forwarding vpn1
 ip address 20.20.20.20 255.255.255.255
 no ip directed-broadcast
!
interface ATM0/1/0
 no ip address
 no ip directed-broadcast
 no ip route-cache distributed
 no ip mroute-cache
 atm clock INTERNAL
 atm sonet stm-1
 no atm enable-ilmi-trap
 no atm ilmi-keepalive
!
interface ATM0/1/0.1 point-to-point
 ip address 33.0.0.2 255.0.0.0
 no ip directed-broadcast
 atm pvc 100 0 50 aal5snap
 no atm enable-ilmi-trap
 mpls label protocol ldp
 mpls ip
!
interface ATM3/0/0
 no ip address
 no ip directed-broadcast
 no ip route-cache distributed
 no ip mroute-cache
 atm clock INTERNAL
 atm sonet stm-1
 no atm enable-ilmi-trap
 no atm ilmi-keepalive
!
interface ATM3/0/0.1 point-to-point
 ip vrf forwarding vpn1
 ip address 47.0.0.1 255.0.0.0
 no ip directed-broadcast
 atm pvc 100 0 50 aal5snap
 no atm enable-ilmi-trap
 mpls label protocol ldp
 mpls ip
!
router ospf 100
 log-adjacency-changes
 passive-interface ATM3/0/0.1
 passive-interface Loopback100
 network 12.12.12.12 0.0.0.0 area 100
 network 33.0.0.0 0.255.255.255 area 100
!
router ospf 200 vrf vpn1
 log-adjacency-changes
 redistribute bgp 100 metric-type 1 subnets
 network 20.20.20.20 0.0.0.0 area 200
 network 47.0.0.0 0.255.255.255 area 200

```

```

!
router bgp 100
  bgp log-neighbor-changes
  timers bgp 10 30
  neighbor 11.11.11.11 remote-as 100
  neighbor 11.11.11.11 update-source Loopback0
  !
  address-family ipv4
    neighbor 11.11.11.11 activate
    neighbor 11.11.11.11 send-community extended
    no synchronization
  exit-address-family
  !
  address-family vpnv4
    neighbor 11.11.11.11 activate
    neighbor 11.11.11.11 send-community extended
  exit-address-family
  !
  address-family ipv4 vrf vpn1
    redistribute ospf 200 match internal external 1 external 2
    no auto-summary
    no synchronization
  exit-address-family

```

CSC-CE2 Configuration

```

ip cef
!
mpls label protocol ldp
!
interface Loopback0
  ip address 16.16.16.16 255.255.255.255
  no ip directed-broadcast
  no ip route-cache
  no ip mroute-cache
!
interface ATM1/0
  no ip address
  no ip directed-broadcast
  no ip mroute-cache
  atm clock INTERNAL
  atm sonet stm-1
  no atm enable-ilmi-trap
  no atm ilmi-keepalive
!
interface ATM1/0.1 point-to-point
  ip address 47.0.0.2 255.0.0.0
  no ip directed-broadcast
  atm pvc 100 0 50 aal5snap
  no atm enable-ilmi-trap
  mpls label protocol ldp
  mpls ip
!
interface ATM5/0
  no ip address
  no ip directed-broadcast
  no ip mroute-cache
  atm clock INTERNAL
  atm sonet stm-1
  no atm enable-ilmi-trap
  no atm ilmi-keepalive
!

```

```

interface ATM5/0.1 point-to-point
 ip address 43.0.0.2 255.0.0.0
 no ip directed-broadcast
 atm pvc 100 0 50 aal5snap
 no atm enable-ilmi-trap
 mpls label protocol ldp
 mpls ip
!
router ospf 200
 log-adjacency-changes
 redistribute connected subnets
 network 16.16.16.16 0.0.0.0 area 200
 network 43.0.0.0 0.255.255.255 area 200
 network 47.0.0.0 0.255.255.255 area 200

```

PE2 Configuration

```

ip cef
 ip cef accounting non-recursive
!
ip vrf vpn2
 rd 200:1
 route-target export 200:1
 route-target import 200:1
 mpls label protocol ldp
!
interface Loopback0
 ip address 15.15.15.15 255.255.255.255
 no ip directed-broadcast
!
interface Ethernet3/0
 ip vrf forwarding vpn2
 ip address 42.0.0.1 255.0.0.0
 no ip directed-broadcast
!
interface ATM5/0
 no ip address
 no ip directed-broadcast
 atm clock INTERNAL
 atm sonet stm-1
 no atm enable-ilmi-trap
 no atm ilmi-keepalive
!
interface ATM5/0.1 point-to-point
 ip address 43.0.0.1 255.0.0.0
 no ip directed-broadcast
 atm pvc 100 0 50 aal5snap
 no atm enable-ilmi-trap
 mpls label protocol ldp
 mpls ip
!
router ospf 200
 log-adjacency-changes
 redistribute connected subnets
 passive-interface Ethernet3/0
 network 15.15.15.15 0.0.0.0 area 200
 network 43.0.0.0 0.255.255.255 area 200
!
router bgp 200
 no bgp default ipv4-unicast
 bgp log-neighbor-changes
 timers bgp 10 30

```

```
neighbor 13.13.13.13 remote-as 200
neighbor 13.13.13.13 update-source Loopback0
!
address-family ipv4
neighbor 13.13.13.13 activate
neighbor 13.13.13.13 send-community extended
no synchronization
exit-address-family
!
address-family vpnv4
neighbor 13.13.13.13 activate
neighbor 13.13.13.13 send-community extended
exit-address-family
!
address-family ipv4 vrf vpn2
neighbor 42.0.0.2 remote-as 300
neighbor 42.0.0.2 activate
neighbor 42.0.0.2 as-override
neighbor 42.0.0.2 advertisement-interval 5
no auto-summary
no synchronization
exit-address-family
```

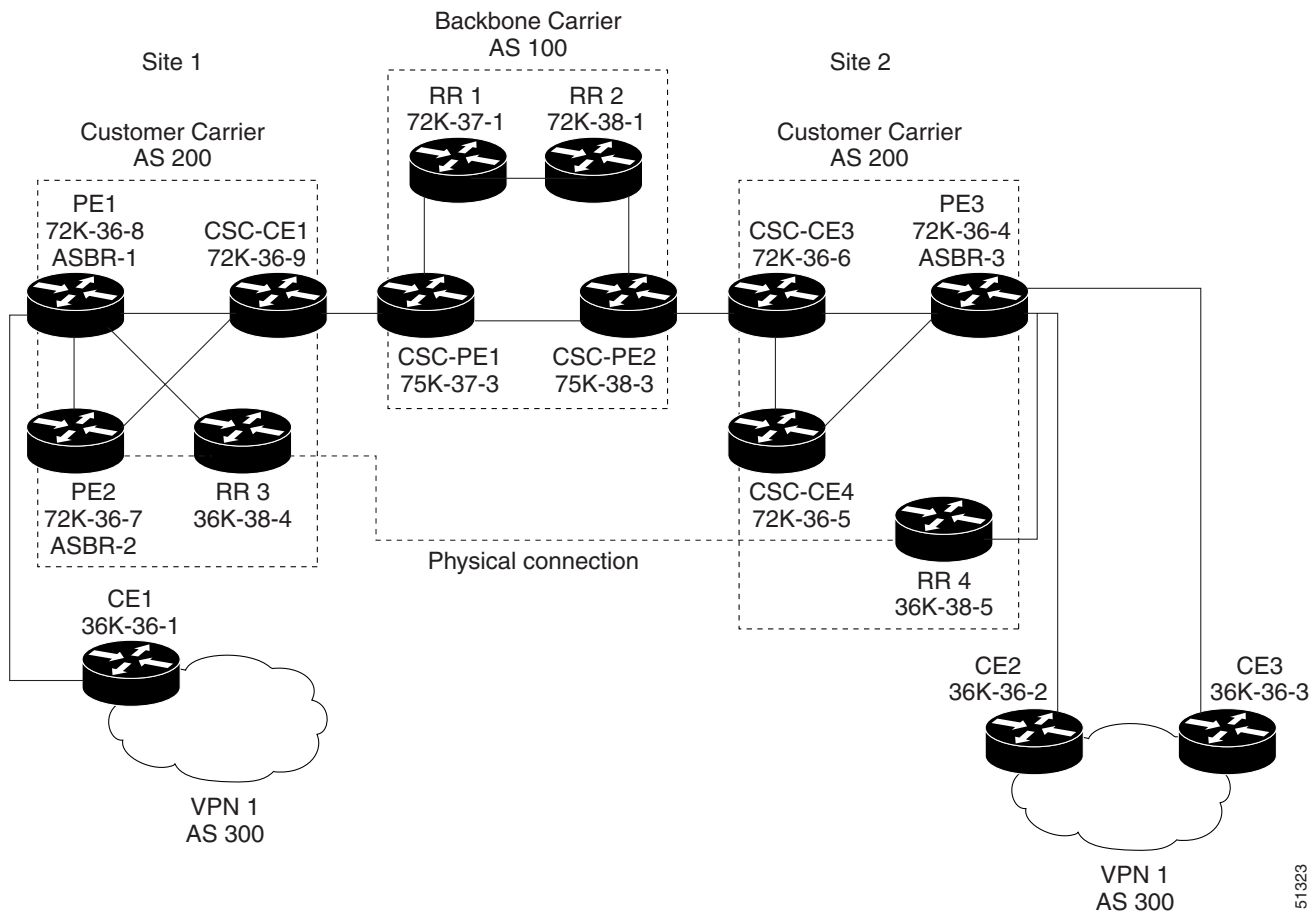
CE2 Configuration

```
ip cef
!
interface Loopback0
ip address 18.18.18.18 255.255.255.255
no ip directed-broadcast
!
interface Ethernet0/1
ip address 42.0.0.2 255.0.0.0
no ip directed-broadcast
!
router ospf 300
log-adjacency-changes
redistribute bgp 300 subnets
passive-interface Ethernet0/1
network 18.18.18.18 0.0.0.0 area 300
!
router bgp 300
no synchronization
bgp log-neighbor-changes
timers bgp 10 30
redistribute connected
redistribute ospf 300 match internal external 1 external 2
neighbor 42.0.0.1 remote-as 200
neighbor 42.0.0.1 advertisement-interval 5
no auto-summary
```

Configuring a Carrier Supporting Carrier Network That Contains Route Reflectors

Figure 8 shows a carrier supporting carrier network configuration that contains route reflectors. The customer carrier has two sites.

Figure 8 Carrier Supporting Carrier Network that Contains Route Reflectors



The following configuration examples show the configuration of each router in the carrier supporting carrier network. Note the following:

- The router IP addresses are abbreviated for ease of reading. For example, the loopback address for PE 1 is 25, which is equivalent to 25.25.25.25.
- The following list shows the loopback addresses for the CSC-PE routers:
 - CSC-PE1 (75K-37-3): loopback 0 = 15.15.15.15, loopback 1 = 18.18.18.18
 - CSC-PE2 (75K-38-3): loopback 0 = 16.16.16.16, loopback 1 = 20.20.20.20

Backbone Carrier Configuration

Route Reflector 1 (72K-37-1) Configuration

```
interface Loopback0
 ip address 13.13.13.13 255.255.255.255
 no ip directed-broadcast
 no ip route-cache
 no ip mroute-cache
!
interface ATM1/0
 no ip address
 no ip directed-broadcast
 atm clock INTERNAL
 no atm enable-ilmi-trap
 no atm ilmi-keepalive
!
interface ATM1/0.1 mpls
 ip address 51.0.0.2 255.0.0.0
 no ip directed-broadcast
 no atm enable-ilmi-trap
 mpls label protocol ldp
 mpls atm vpi 2-5
 mpls ip
!
interface ATM1/1
 no ip address
 no ip directed-broadcast
 atm clock INTERNAL
 no atm enable-ilmi-trap
 no atm ilmi-keepalive
!
interface ATM1/1.1 mpls
 ip address 52.0.0.1 255.0.0.0
 no ip directed-broadcast
 no atm enable-ilmi-trap
 mpls label protocol ldp
 mpls atm vpi 2-5
 mpls ip
!
router ospf 100
 auto-cost reference-bandwidth 10000
 network 13.0.0.0 0.255.255.255 area 100
 network 51.0.0.0 0.255.255.255 area 100
 network 52.0.0.0 0.255.255.255 area 100
!
router bgp 100
 no synchronization
 no bgp default ipv4-unicast
 bgp cluster-id 1
 redistribute static
 neighbor 15.15.15.15 remote-as 100
 neighbor 15.15.15.15 update-source Loopback0
 neighbor 16.16.16.16 remote-as 100
 neighbor 16.16.16.16 update-source Loopback0
!
 address-family ipv4 vrf vpn1
 no auto-summary
 no synchronization
 exit-address-family
!
 address-family vpnv4
 neighbor 15.15.15.15 activate
```

```

neighbor 15.15.15.15 route-reflector-client
neighbor 15.15.15.15 send-community extended
neighbor 16.16.16.16 activate
neighbor 16.16.16.16 route-reflector-client
neighbor 16.16.16.16 send-community extended
bgp scan-time import 5
exit-address-family

```

Route Reflector 2 (72K-38-1) Configuration

```

interface Loopback0
 ip address 14.14.14.14 255.255.255.255
 no ip directed-broadcast
 no ip mroute-cache
!
interface ATM1/0
 no ip address
 no ip directed-broadcast
 atm clock INTERNAL
 no atm enable-ilmi-trap
 no atm ilmi-keepalive
!
interface ATM1/0.1 mpls
 ip address 53.0.0.1 255.0.0.0
 no ip directed-broadcast
 no atm enable-ilmi-trap
 mpls label protocol ldp
 mpls atm vpi 2-5
 mpls ip
!
interface ATM1/1
 no ip address
 no ip directed-broadcast
 atm clock INTERNAL
 no atm enable-ilmi-trap
 no atm ilmi-keepalive
!
interface ATM1/1.1 mpls
 ip address 52.0.0.2 255.0.0.0
 no ip directed-broadcast
 no atm enable-ilmi-trap
 mpls label protocol ldp
 mpls atm vpi 2-5
 mpls ip
!
router ospf 100
 auto-cost reference-bandwidth 10000
 network 14.0.0.0 0.255.255.255 area 100
 network 52.0.0.0 0.255.255.255 area 100
 network 53.0.0.0 0.255.255.255 area 100
!
router bgp 100
 no synchronization
 no bgp default ipv4-unicast
 bgp cluster-id 1
 redistribute static
 neighbor 15.15.15.15 remote-as 100
 neighbor 15.15.15.15 update-source Loopback0
 neighbor 16.16.16.16 remote-as 100
 neighbor 16.16.16.16 update-source Loopback0
!
 address-family ipv4 vrf vpn1
 no auto-summary

```

```

no synchronization
exit-address-family
!
address-family vpnv4
neighbor 15.15.15.15 activate
neighbor 15.15.15.15 route-reflector-client
neighbor 15.15.15.15 send-community extended
neighbor 16.16.16.16 activate
neighbor 16.16.16.16 route-reflector-client
neighbor 16.16.16.16 send-community extended
bgp scan-time import 5
exit-address-family

```

CSC-PE1 (75K-37-3) Configuration

```

ip cef distributed
!
ip vrf vpn1
rd 100:1
route-target export 100:1
route-target import 100:1
!
interface Loopback0
ip address 15.15.15.15 255.255.255.255
no ip directed-broadcast
!
interface Loopback1
ip vrf forwarding vpn1
ip address 18.18.18.18 255.255.255.255
no ip directed-broadcast
!
interface Ethernet0/0/1
ip vrf forwarding vpn1
ip address 55.0.0.2 255.0.0.0
no ip directed-broadcast
no ip route-cache distributed
mpls label protocol ldp
mpls ip
!
interface ATM1/1/0
no ip address
no ip directed-broadcast
no ip route-cache distributed
atm clock INTERNAL
atm sonet stm-1
no atm enable-ilmi-trap
no atm ilmi-keepalive
!
interface ATM1/1/0.1 mpls
ip address 56.0.0.1 255.0.0.0
no ip directed-broadcast
no atm enable-ilmi-trap
mpls label protocol ldp
mpls atm vpi 2-5
mpls ip
!
interface ATM3/0/0
no ip address
no ip directed-broadcast
no ip route-cache distributed
atm clock INTERNAL
atm sonet stm-1
no atm enable-ilmi-trap

```

```

no atm ilmi-keepalive
!
interface ATM3/0/0.1 point-to-point
ip vrf forwarding vpn1
ip address 50.0.0.2 255.0.0.0
no ip directed-broadcast
atm pvc 100 6 32 aal5snap
no atm enable-ilmi-trap
mpls label protocol ldp
mpls ip
!
interface ATM3/1/0
no ip address
no ip directed-broadcast
no ip route-cache distributed
atm clock INTERNAL
atm sonet stm-1
no atm enable-ilmi-trap
no atm ilmi-keepalive
!
interface ATM3/1/0.1 mpls
ip address 51.0.0.1 255.0.0.0
no ip directed-broadcast
no atm enable-ilmi-trap
mpls label protocol ldp
mpls atm vpi 2-5
mpls ip
!
router ospf 100
auto-cost reference-bandwidth 10000
network 15.0.0.0 0.255.255.255 area 100
network 50.0.0.0 0.255.255.255 area 100
network 51.0.0.0 0.255.255.255 area 100
network 55.0.0.0 0.255.255.255 area 100
network 56.0.0.0 0.255.255.255 area 100
!
router ospf 1 vrf vpn1
redistribute bgp 100 metric-type 1 subnets
network 17.0.0.0 0.255.255.255 area 101
network 18.0.0.0 0.255.255.255 area 101
network 50.0.0.0 0.255.255.255 area 101
network 55.0.0.0 0.255.255.255 area 101
!
router bgp 100
no bgp default ipv4-unicast
bgp log-neighbor-changes
neighbor 13.13.13.13 remote-as 100
neighbor 13.13.13.13 update-source Loopback0
neighbor 14.14.14.14 remote-as 100
neighbor 14.14.14.14 update-source Loopback0
!
address-family ipv4
redistribute static
no synchronization
exit-address-family
!
address-family vpv4
neighbor 13.13.13.13 activate
neighbor 13.13.13.13 send-community extended
neighbor 14.14.14.14 activate
neighbor 14.14.14.14 send-community extended
exit-address-family
!
address-family ipv4 vrf vpn1

```

```
redistribute ospf 1 match internal external 1 external 2
no auto-summary
no synchronization
exit-address-family
```

CSC-PE2 (75K-38-3) Configuration

```
ip cef distributed
!
ip vrf vpn1
rd 100:1
route-target export 100:1
route-target import 100:1
!
interface Loopback0
ip address 16.16.16.16 255.255.255.255
no ip directed-broadcast
!
interface Loopback1
ip vrf forwarding vpn1
ip address 20.20.20.20 255.255.255.255
no ip directed-broadcast
!
interface ATM0/1/0
no ip address
no ip directed-broadcast
no ip route-cache distributed
atm clock INTERNAL
atm sonet stm-1
no atm enable-ilmi-trap
no atm ilmi-keepalive
!
interface ATM0/1/0.1 mpls
ip address 56.0.0.2 255.0.0.0
no ip directed-broadcast
no atm enable-ilmi-trap
mpls label protocol ldp
mpls atm vpi 2-5
mpls ip
!
interface ATM2/1/0
no ip address
no ip directed-broadcast
no ip route-cache distributed
atm clock INTERNAL
atm sonet stm-1
no atm enable-ilmi-trap
no atm ilmi-keepalive
!
interface ATM2/1/0.1 mpls
ip address 53.0.0.2 255.0.0.0
no ip directed-broadcast
no atm enable-ilmi-trap
mpls label protocol ldp
mpls atm vpi 2-5
mpls ip
!
interface ATM3/0/0
no ip address
no ip directed-broadcast
no ip route-cache distributed
atm clock INTERNAL
atm sonet stm-1
```

```

no atm enable-ilmi-trap
no atm ilmi-keepalive
!
interface ATM3/0/0.1 point-to-point
ip vrf forwarding vpn1
ip address 54.0.0.1 255.0.0.0
no ip directed-broadcast
atm pvc 100 6 32 aal5snap
no atm enable-ilmi-trap
mpls label protocol ldp
mpls ip
!
interface ATM3/1/0
no ip address
no ip directed-broadcast
no ip route-cache distributed
atm clock INTERNAL
atm sonet stm-1
no atm enable-ilmi-trap
no atm ilmi-keepalive
!
interface ATM3/1/0.1 point-to-point
ip vrf forwarding vpn1
ip address 57.0.0.1 255.0.0.0
no ip directed-broadcast
atm pvc 101 6 33 aal5snap
no atm enable-ilmi-trap
mpls label protocol ldp
mpls ip
!
router ospf 100
auto-cost reference-bandwidth 10000
network 16.0.0.0 0.255.255.255 area 100
network 53.0.0.0 0.255.255.255 area 100
network 54.0.0.0 0.255.255.255 area 100
network 56.0.0.0 0.255.255.255 area 100
network 57.0.0.0 0.255.255.255 area 100
!
router ospf 1 vrf vpn1
redistribute bgp 100 metric-type 1 subnets
network 19.0.0.0 0.255.255.255 area 101
network 20.0.0.0 0.255.255.255 area 101
network 54.0.0.0 0.255.255.255 area 101
network 57.0.0.0 0.255.255.255 area 101
!
router bgp 100
no bgp default ipv4-unicast
bgp log-neighbor-changes
neighbor 13.13.13.13 remote-as 100
neighbor 13.13.13.13 update-source Loopback0
neighbor 14.14.14.14 remote-as 100
neighbor 14.14.14.14 update-source Loopback0
!
address-family ipv4
redistribute static
no synchronization
exit-address-family
!
address-family vpnv4
neighbor 13.13.13.13 activate
neighbor 13.13.13.13 send-community extended
neighbor 14.14.14.14 activate
neighbor 14.14.14.14 send-community extended
exit-address-family

```

```

!
address-family ipv4 vrf vpn1
redistribute ospf 1 match internal external 1 external 2
no auto-summary
no synchronization
exit-address-family

```

Customer Carrier Site 1 Configuration

PE1 (72K-36-8) Configuration

```

ip cef
!
ip vrf vpn2
rd 200:1
route-target export 200:1
route-target import 200:1
no mpls ip propagate-ttl
!
interface Loopback0
ip address 25.25.25.25 255.255.255.255
no ip directed-broadcast
no ip route-cache
no ip mroute-cache
!
interface ATM1/0
no ip address
no ip directed-broadcast
no ip mroute-cache
atm clock INTERNAL
no atm ilmi-keepalive
!
interface ATM1/0.1 point-to-point
ip address 66.0.0.2 255.0.0.0
no ip directed-broadcast
atm pvc 100 0 50 aal5snap
mpls label protocol ldp
mpls ip
!
interface Ethernet3/0
ip vrf forwarding vpn2
ip address 70.0.0.1 255.0.0.0
no ip directed-broadcast
no ip mroute-cache
!
interface Ethernet3/1
ip address 67.0.0.1 255.0.0.0
no ip directed-broadcast
no ip mroute-cache
mpls label protocol ldp
mpls ip
!
interface Ethernet3/2
ip address 64.0.0.2 255.0.0.0
no ip directed-broadcast
no ip mroute-cache
mpls label protocol ldp
mpls ip
!
router ospf 1
network 25.0.0.0 0.255.255.255 area 101
network 64.0.0.0 0.255.255.255 area 101

```

```

network 66.0.0.0 0.255.255.255 area 101
network 67.0.0.0 0.255.255.255 area 101
!
router bgp 200
neighbor 22.22.22.22 remote-as 200
neighbor 22.22.22.22 update-source Loopback0
neighbor 23.23.23.23 remote-as 200
neighbor 23.23.23.23 update-source Loopback0
!
address-family ipv4 vrf vpn2
redistribute connected
neighbor 70.0.0.2 remote-as 300
neighbor 70.0.0.2 activate
neighbor 70.0.0.2 as-override
no auto-summary
no synchronization
exit-address-family
!
address-family vpnv4
neighbor 22.22.22.22 activate
neighbor 22.22.22.22 send-community extended
neighbor 23.23.23.23 activate
neighbor 23.23.23.23 send-community extended
exit-address-family

```

CSC-CE1 (72K-36-9) Configuration

```

ip cef
no ip domain-lookup
!
interface Loopback0
ip address 11.11.11.11 255.255.255.255
no ip directed-broadcast
no ip route-cache
no ip mroute-cache
!
interface ATM1/0
no ip address
no ip directed-broadcast
no ip mroute-cache
atm clock INTERNAL
no atm ilmi-keepalive
!
interface ATM1/0.1 point-to-point
ip address 50.0.0.1 255.0.0.0
no ip directed-broadcast
atm pvc 100 6 32 aal5snap
mpls label protocol ldp
mpls ip
!
interface ATM2/0
no ip address
no ip directed-broadcast
no ip mroute-cache
atm clock INTERNAL
no atm ilmi-keepalive
!
interface ATM2/0.1 point-to-point
ip address 66.0.0.1 255.0.0.0
no ip directed-broadcast
atm pvc 100 0 50 aal5snap
mpls label protocol ldp
mpls ip

```

```
!  
interface Ethernet3/0  
 ip address 65.0.0.2 255.0.0.0  
 no ip directed-broadcast  
 no ip mroute-cache  
 mpls label protocol ldp  
 mpls ip  
!  
interface Ethernet3/1  
 ip address 55.0.0.1 255.0.0.0  
 no ip directed-broadcast  
 no ip mroute-cache  
 mpls label protocol ldp  
 mpls ip  
!  
router ospf 1  
 network 11.0.0.0 0.255.255.255 area 101  
 network 50.0.0.0 0.255.255.255 area 101  
 network 55.0.0.0 0.255.255.255 area 101  
 network 65.0.0.0 0.255.255.255 area 101  
 network 66.0.0.0 0.255.255.255 area 101
```

PE2 (72K-36-7) Configuration

```
ip cef  
!  
ip vrf vpn2  
 rd 200:1  
 route-target export 200:1  
 route-target import 200:1  
no mpls ip propagate-ttl  
!  
interface Loopback0  
 ip address 24.24.24.24 255.255.255.255  
 no ip directed-broadcast  
 no ip route-cache  
 no ip mroute-cache  
!  
interface Ethernet3/0  
 ip address 65.0.0.1 255.0.0.0  
 no ip directed-broadcast  
 no ip mroute-cache  
 mpls label protocol ldp  
 mpls ip  
!  
interface Ethernet3/1  
 ip vrf forwarding vpn2  
 ip address 71.0.0.1 255.0.0.0  
 no ip directed-broadcast  
 no ip mroute-cache  
!  
interface Ethernet3/2  
 ip address 67.0.0.2 255.0.0.0  
 no ip directed-broadcast  
 no ip mroute-cache  
 mpls label protocol ldp  
 mpls ip  
!  
interface Ethernet3/3  
 ip address 63.0.0.2 255.0.0.0  
 no ip directed-broadcast  
 no ip mroute-cache  
 mpls label protocol ldp
```

```

mpls ip
!
router ospf 1
 network 24.0.0.0 0.255.255.255 area 101
 network 63.0.0.0 0.255.255.255 area 101
 network 65.0.0.0 0.255.255.255 area 101
 network 67.0.0.0 0.255.255.255 area 101
!
router bgp 200
 neighbor 22.22.22.22 remote-as 200
 neighbor 22.22.22.22 update-source Loopback0
 neighbor 23.23.23.23 remote-as 200
 neighbor 23.23.23.23 update-source Loopback0
!
 address-family ipv4 vrf vpn2
  neighbor 71.0.0.2 remote-as 300
  neighbor 71.0.0.2 activate
  neighbor 71.0.0.2 as-override
 no auto-summary
 no synchronization
 exit-address-family
!
 address-family vpnv4
  neighbor 22.22.22.22 activate
  neighbor 22.22.22.22 send-community extended
  neighbor 23.23.23.23 activate
  neighbor 23.23.23.23 send-community extended
 exit-address-family

```

Route Reflector 3 (36K-38-4) Configuration

```

ip cef
!
interface Loopback0
 ip address 23.23.23.23 255.255.255.255
!
interface Ethernet1/1
 ip address 64.0.0.1 255.0.0.0
 mpls label protocol ldp
 mpls ip
!
interface Ethernet1/2
 ip address 63.0.0.1 255.0.0.0
 mpls label protocol ldp
 mpls ip
!
interface ATM3/0
 no ip address
 no ip mroute-cache
 atm clock INTERNAL
 no atm scrambling cell-payload
 no atm ilmi-keepalive
!
interface ATM3/0.1 point-to-point
 ip address 62.0.0.2 255.0.0.0
 atm pvc 100 0 55 aal5snap
 mpls label protocol ldp
 mpls ip
!
router ospf 1
 log-adjacency-changes
 network 23.0.0.0 0.255.255.255 area 101
 network 62.0.0.0 0.255.255.255 area 101

```

```

network 63.0.0.0 0.255.255.255 area 101
network 64.0.0.0 0.255.255.255 area 101
!
router bgp 200
no synchronization
no bgp default ipv4-unicast
bgp cluster-id 2
redistribute static
neighbor 21.21.21.21 remote-as 200
neighbor 21.21.21.21 update-source Loopback0
neighbor 24.24.24.24 remote-as 200
neighbor 24.24.24.24 update-source Loopback0
neighbor 25.25.25.25 remote-as 200
neighbor 25.25.25.25 update-source Loopback0
!
address-family ipv4 vrf vpn2
no auto-summary
no synchronization
exit-address-family
!
address-family vpnv4
neighbor 21.21.21.21 activate
neighbor 21.21.21.21 route-reflector-client
neighbor 21.21.21.21 send-community extended
neighbor 24.24.24.24 activate
neighbor 24.24.24.24 route-reflector-client
neighbor 24.24.24.24 send-community extended
neighbor 25.25.25.25 activate
neighbor 25.25.25.25 route-reflector-client
neighbor 25.25.25.25 send-community extended
exit-address-family

```

CE1 (36K-36-1) Configuration

```

ip cef
!
interface Loopback0
ip address 28.28.28.28 255.255.255.255
no ip directed-broadcast
!
interface Ethernet0/1
ip address 70.0.0.2 255.0.0.0
no ip directed-broadcast
!
interface Ethernet0/2
ip address 71.0.0.2 255.0.0.0
no ip directed-broadcast
!
router bgp 300
network 28.0.0.0
network 70.0.0.0
network 71.0.0.0
neighbor 70.0.0.1 remote-as 200
neighbor 71.0.0.1 remote-as 200

```

Customer Carrier Site 2 Configuration

CSC-CE3 (72K-36-6) Configuration

```

ip cef
!

```

```

interface Loopback0
 ip address 12.12.12.12 255.255.255.255
 no ip directed-broadcast
 no ip route-cache
 no ip mroute-cache
!
interface ATM1/0
 no ip address
 no ip directed-broadcast
 no ip mroute-cache
 atm clock INTERNAL
 no atm ilmi-keepalive
!
interface ATM1/0.1 point-to-point
 ip address 54.0.0.2 255.0.0.0
 no ip directed-broadcast
 atm pvc 100 6 32 aal5snap
 mpls label protocol ldp

 mpls ip
!
interface POS2/0
 ip address 58.0.0.2 255.0.0.0
 no ip directed-broadcast
 encapsulation ppp
 mpls label protocol ldp
 mpls ip
!
interface ATM5/0
 no ip address
 no ip directed-broadcast
 no ip mroute-cache
 atm clock INTERNAL
 no atm ilmi-keepalive
!
interface ATM5/0.1 point-to-point
 ip address 59.0.0.1 255.0.0.0
 no ip directed-broadcast
 atm pvc 100 0 40 aal5snap
 mpls ip
!
router ospf 1
 network 12.0.0.0 0.255.255.255 area 101
 network 54.0.0.0 0.255.255.255 area 101
 network 58.0.0.0 0.255.255.255 area 101
 network 59.0.0.0 0.255.255.255 area 101

```

PE3 (72K-36-4) Configuration

```

ip cef
!
ip vrf vpn2
 rd 200:1
 route-target export 200:1
 route-target import 200:1
!
!
!
interface Loopback0
 ip address 21.21.21.21 255.255.255.255
 no ip directed-broadcast
!
interface Ethernet3/0

```

```
ip vrf forwarding vpn2
ip address 80.0.0.1 255.0.0.0
no ip directed-broadcast
!
interface Ethernet3/1
ip vrf forwarding vpn2
ip address 81.0.0.1 255.0.0.0
no ip directed-broadcast
!
interface Ethernet3/2
ip address 61.0.0.1 255.0.0.0
no ip directed-broadcast
mpls label protocol ldp
mpls ip
!
interface ATM5/0
no ip address
no ip directed-broadcast
atm clock INTERNAL
no atm ilmi-keepalive
!
interface ATM5/0.1 point-to-point
ip address 59.0.0.2 255.0.0.0
no ip directed-broadcast
atm pvc 100 0 40 aal5snap
mpls label protocol ldp
mpls ip
!
interface ATM6/0
no ip address
no ip directed-broadcast
atm clock INTERNAL
no atm ilmi-keepalive
!
interface ATM6/0.1 point-to-point
ip address 60.0.0.2 255.0.0.0
no ip directed-broadcast
atm pvc 100 0 20 aal5snap
mpls label protocol ldp
mpls ip
!
router ospf 1
network 21.0.0.0 0.255.255.255 area 101
network 59.0.0.0 0.255.255.255 area 101
network 60.0.0.0 0.255.255.255 area 101
network 61.0.0.0 0.255.255.255 area 101
!
router bgp 200
neighbor 22.22.22.22 remote-as 200
neighbor 22.22.22.22 update-source Loopback0
neighbor 23.23.23.23 remote-as 200
neighbor 23.23.23.23 update-source Loopback0
!
address-family ipv4 vrf vpn2
redistribute connected
neighbor 80.0.0.2 remote-as 300
neighbor 80.0.0.2 activate
neighbor 80.0.0.2 as-override
neighbor 81.0.0.2 remote-as 300
neighbor 81.0.0.2 activate
no auto-summary
no synchronization
exit-address-family
!
```

```

address-family vpnv4
neighbor 22.22.22.22 activate
neighbor 22.22.22.22 send-community extended
neighbor 23.23.23.23 activate
neighbor 23.23.23.23 send-community extended
exit-address-family

```

CSC-CE2 (72K-36-5) Configuration

```

ip cef
!
interface Loopback0
 ip address 10.10.10.10 255.255.255.255
 no ip directed-broadcast
!
interface POS4/0
 ip address 58.0.0.1 255.0.0.0
 no ip directed-broadcast
 encapsulation ppp
 mpls label protocol ldp
 mpls ip
 clock source internal
!
interface ATM5/0
 no ip address
 no ip directed-broadcast
 atm clock INTERNAL
 no atm ilmi-keepalive
!
interface ATM5/0.1 point-to-point
 ip address 60.0.0.1 255.0.0.0
 no ip directed-broadcast
 atm pvc 100 0 20 aal5snap
 mpls label protocol ldp
 mpls ip
!
interface ATM6/0
 no ip address
 no ip directed-broadcast
 atm clock INTERNAL
 no atm ilmi-keepalive
!
interface ATM6/0.1 point-to-point
 ip address 57.0.0.2 255.0.0.0
 no ip directed-broadcast
 atm pvc 100 6 33 aal5snap
 mpls label protocol ldp
 mpls ip
!
router ospf 1
 network 10.0.0.0 0.255.255.255 area 101
 network 57.0.0.0 0.255.255.255 area 101
 network 58.0.0.0 0.255.255.255 area 101
 network 60.0.0.0 0.255.255.255 area 101

```

Route Reflector 4 (36K-38-5) Configuration

```

ip cef
!
interface Loopback0
 ip address 22.22.22.22 255.255.255.255
!
interface Ethernet0/1

```

```

ip address 61.0.0.2 255.0.0.0
mpls label protocol ldp
mpls ip
!
interface ATM2/0
no ip address
no ip mroute-cache
atm clock INTERNAL
no atm scrambling cell-payload
no atm ilmi-keepalive
!
interface ATM2/0.1 point-to-point
ip address 62.0.0.1 255.0.0.0
atm pvc 100 0 55 aal5snap
mpls label protocol ldp
mpls ip
!
router ospf 1
log-adjacency-changes
network 22.0.0.0 0.255.255.255 area 101
network 61.0.0.0 0.255.255.255 area 101
network 62.0.0.0 0.255.255.255 area 101
!
router bgp 200
no synchronization
no bgp default ipv4-unicast
bgp cluster-id 2
redistribute static
neighbor 21.21.21.21 remote-as 200
neighbor 21.21.21.21 update-source Loopback0
neighbor 24.24.24.24 remote-as 200
neighbor 24.24.24.24 update-source Loopback0
neighbor 25.25.25.25 remote-as 200
neighbor 25.25.25.25 update-source Loopback0
!
address-family ipv4 vrf vpn2
no auto-summary
no synchronization
exit-address-family
!
address-family vpnv4
neighbor 21.21.21.21 activate
neighbor 21.21.21.21 route-reflector-client
neighbor 21.21.21.21 send-community extended
neighbor 24.24.24.24 activate
neighbor 24.24.24.24 route-reflector-client
neighbor 24.24.24.24 send-community extended
neighbor 25.25.25.25 activate
neighbor 25.25.25.25 route-reflector-client
neighbor 25.25.25.25 send-community extended
exit-address-family

```

CE2 (36K-36-2) Configuration

```

ip cef
!
interface Loopback0
ip address 26.26.26.26 255.255.255.255
no ip directed-broadcast
!
interface Ethernet0/1
ip address 80.0.0.2 255.0.0.0
no ip directed-broadcast

```

```

!
interface Ethernet0/2
 ip address 82.0.0.1 255.0.0.0
 no ip directed-broadcast
!
router ospf 300
 redistribute bgp 300
 network 26.0.0.0 0.255.255.255 area 300
 network 82.0.0.0 0.255.255.255 area 300
!
router bgp 300
 network 26.0.0.0
 network 80.0.0.0
 network 82.0.0.0
 neighbor 80.0.0.1 remote-as 200

```

CE3 (36K-36-3) Configuration

```

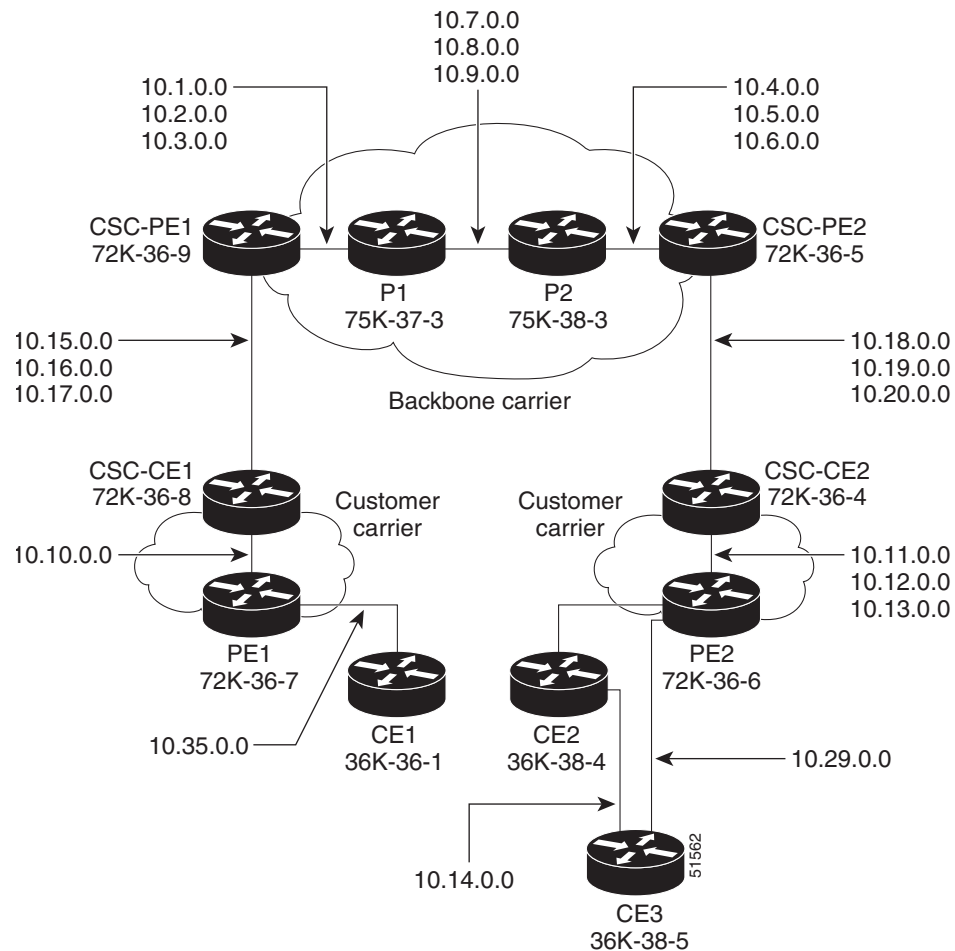
ip cef
!
interface Loopback0
 ip address 27.27.27.27 255.255.255.255
 no ip directed-broadcast
!
interface Ethernet1/1
 ip address 81.0.0.2 255.0.0.0
 no ip directed-broadcast
!
interface Ethernet1/2
 ip address 82.0.0.2 255.0.0.0
 no ip directed-broadcast
!
router ospf 300
 redistribute bgp 300
 network 27.0.0.0 0.255.255.255 area 300
 network 82.0.0.0 0.255.255.255 area 300
!
router bgp 300
 network 27.0.0.0
 network 81.0.0.0
 network 82.0.0.0
 neighbor 81.0.0.1 remote-as 200

```

Configuring a Carrier Supporting Carrier Network with a Customer Who Has VPNs at the Edge of Their Network

Figure 9 shows a carrier supporting carrier network configuration where the customer carrier has VPNs at the edge of their network.

Figure 9 Carrier Supporting Carrier Network



Backbone Carrier Configuration

CSC-PE1 (72K-36-9) Configuration

```

ip cef
!
ip vrf vpn1
rd 100:0
route-target export 100:0
route-target import 100:0
mpls label protocol ldp
!
!
!
interface Loopback0
ip address 14.14.14.14 255.255.255.255
no ip directed-broadcast
no ip route-cache
no ip mroute-cache
!
interface Loopback100

```

```
ip vrf forwarding vpn1
ip address 22.22.22.22 255.255.255.255
no ip directed-broadcast
!
interface ATM1/0
no ip address
no ip directed-broadcast
no ip mroute-cache
atm clock INTERNAL
no atm enable-ilmi-trap
no atm ilmi-keepalive
!
interface ATM1/0.1 point-to-point
ip address 30.1.0.1 255.255.0.0
no ip directed-broadcast
atm pvc 100 0 50 aal5snap
no atm enable-ilmi-trap
mpls label protocol ldp
tag-switching ip
!
interface ATM1/0.2 point-to-point
ip address 30.2.0.1 255.255.0.0
no ip directed-broadcast
atm pvc 101 0 51 aal5snap
no atm enable-ilmi-trap
mpls label protocol ldp
tag-switching ip
!
interface ATM1/0.3 point-to-point
ip address 30.3.0.1 255.255.0.0
no ip directed-broadcast
atm pvc 102 0 52 aal5snap
no atm enable-ilmi-trap
mpls label protocol ldp
tag-switching ip
!
interface ATM2/0
no ip address
no ip directed-broadcast
no ip mroute-cache
atm clock INTERNAL
no atm enable-ilmi-trap
no atm ilmi-keepalive
!
interface ATM2/0.1 point-to-point
ip vrf forwarding vpn1
ip address 30.15.0.2 255.255.0.0
no ip directed-broadcast
atm pvc 100 0 50 aal5snap
no atm enable-ilmi-trap
mpls label protocol ldp
tag-switching ip
!
interface ATM2/0.2 point-to-point
ip vrf forwarding vpn1
ip address 30.16.0.2 255.255.0.0
no ip directed-broadcast
atm pvc 101 0 51 aal5snap
no atm enable-ilmi-trap
mpls label protocol ldp
tag-switching ip
!
interface ATM2/0.3 point-to-point
ip vrf forwarding vpn1
```

```

ip address 30.17.0.2 255.255.0.0
no ip directed-broadcast
atm pvc 102 0 52 aal5snap
no atm enable-ilmi-trap
mpls label protocol ldp
tag-switching ip
!
router ospf 100
log-adjacency-changes
redistribute connected subnets
passive-interface ATM2/0.1
passive-interface ATM2/0.2
passive-interface ATM2/0.3
passive-interface Loopback100
network 14.14.14.14 0.0.0.0 area 100
network 30.1.0.0 0.0.255.255 area 100
network 30.2.0.0 0.0.255.255 area 100
network 30.3.0.0 0.0.255.255 area 100
!
router ospf 200 vrf vpn1
log-adjacency-changes
redistribute connected subnets
redistribute bgp 100 metric-type 1 subnets
network 22.22.22.22 0.0.0.0 area 200
network 30.15.0.0 0.0.255.255 area 200
network 30.16.0.0 0.0.255.255 area 200
network 30.17.0.0 0.0.255.255 area 200
!
router bgp 100
bgp log-neighbor-changes
timers bgp 10 30
neighbor 11.11.11.11 remote-as 100
neighbor 11.11.11.11 update-source Loopback0
!
address-family ipv4
neighbor 11.11.11.11 activate
neighbor 11.11.11.11 send-community extended
no synchronization
exit-address-family
!
address-family vpnv4
neighbor 11.11.11.11 activate
neighbor 11.11.11.11 send-community extended
exit-address-family
!
address-family ipv4 vrf vpn1
redistribute ospf 200 match internal external 1 external 2
no auto-summary
no synchronization
exit-address-family

```

P1 (75K-37-3) Configuration

```

ip cef distributed
!
mpls label protocol ldp
!
interface Loopback0
ip address 12.12.12.12 255.255.255.255
no ip directed-broadcast
no ip route-cache
no ip mroute-cache
!

```

```
interface ATM1/1/0
no ip address
no ip directed-broadcast
ip route-cache distributed
atm clock INTERNAL
no atm enable-ilmi-trap
no atm ilmi-keepalive
!
interface ATM1/1/0.1 point-to-point
ip address 30.7.0.1 255.255.0.0
no ip directed-broadcast
atm pvc 103 0 53 aal5snap
no atm enable-ilmi-trap
mpls label protocol ldp
tag-switching ip
!
interface ATM1/1/0.2 point-to-point
ip address 30.8.0.1 255.255.0.0
no ip directed-broadcast
atm pvc 104 0 54 aal5snap
no atm enable-ilmi-trap
mpls label protocol ldp
tag-switching ip
!
interface ATM1/1/0.3 point-to-point
ip address 30.9.0.1 255.255.0.0
no ip directed-broadcast
atm pvc 105 0 55 aal5snap
no atm enable-ilmi-trap
mpls label protocol ldp
tag-switching ip
!
interface ATM3/0/0
no ip address
no ip directed-broadcast
ip route-cache distributed
atm clock INTERNAL
atm sonet stm-1
no atm enable-ilmi-trap
no atm ilmi-keepalive
!
interface ATM3/0/0.1 point-to-point
ip address 30.1.0.2 255.255.0.0
no ip directed-broadcast
atm pvc 100 0 50 aal5snap
no atm enable-ilmi-trap
mpls label protocol ldp
mpls accounting experimental input
tag-switching ip
!
interface ATM3/0/0.2 point-to-point
ip address 30.2.0.2 255.255.0.0
no ip directed-broadcast
atm pvc 101 0 51 aal5snap
no atm enable-ilmi-trap
mpls label protocol ldp
tag-switching ip
!
interface ATM3/0/0.3 point-to-point
ip address 30.3.0.2 255.255.0.0
no ip directed-broadcast
atm pvc 102 0 52 aal5snap
no atm enable-ilmi-trap
mpls label protocol ldp
```

```
tag-switching ip
!
router ospf 100
log-adjacency-changes
redistribute connected subnets
network 12.12.12.12 0.0.0.0 area 100
network 30.1.0.0 0.0.255.255 area 100
network 30.2.0.0 0.0.255.255 area 100
network 30.3.0.0 0.0.255.255 area 100
network 30.7.0.0 0.0.255.255 area 100
network 30.8.0.0 0.0.255.255 area 100
network 30.9.0.0 0.0.255.255 area 100
```

P3 (75K-38-3) Configuration

```
ip cef distributed
!
mpls label protocol ldp
!
interface Loopback0
ip address 13.13.13.13 255.255.255.255
no ip directed-broadcast
no ip route-cache
no ip mroute-cache
!
interface ATM0/1/0
no ip address
no ip directed-broadcast
ip route-cache distributed
atm clock INTERNAL
atm sonet stm-1
no atm enable-ilmi-trap
no atm ilmi-keepalive
!
interface ATM0/1/0.1 point-to-point
ip address 30.7.0.2 255.255.0.0
no ip directed-broadcast
atm pvc 103 0 53 aal5snap
no atm enable-ilmi-trap
mpls label protocol ldp
tag-switching ip
!
interface ATM0/1/0.2 point-to-point
ip address 30.8.0.2 255.255.0.0
no ip directed-broadcast
atm pvc 104 0 54 aal5snap
no atm enable-ilmi-trap
mpls label protocol ldp
tag-switching ip
!
interface ATM0/1/0.3 point-to-point
ip address 30.9.0.2 255.255.0.0
no ip directed-broadcast
atm pvc 105 0 55 aal5snap
no atm enable-ilmi-trap
mpls label protocol ldp
tag-switching ip
!
interface ATM3/1/0
no ip address
no ip directed-broadcast
ip route-cache distributed
atm clock INTERNAL
```

```

atm sonet stm-1
no atm enable-ilmi-trap
no atm ilmi-keepalive
!
interface ATM3/1/0.1 point-to-point
ip address 30.4.0.2 255.255.0.0
no ip directed-broadcast
atm pvc 100 0 50 aal5snap
no atm enable-ilmi-trap
mpls label protocol ldp
tag-switching ip
!
interface ATM3/1/0.2 point-to-point
ip address 30.5.0.2 255.255.0.0
no ip directed-broadcast
atm pvc 101 0 51 aal5snap
no atm enable-ilmi-trap
mpls label protocol ldp
tag-switching ip
!
interface ATM3/1/0.3 point-to-point
ip address 30.6.0.2 255.255.0.0
no ip directed-broadcast
atm pvc 102 0 52 aal5snap
no atm enable-ilmi-trap
mpls label protocol ldp
tag-switching ip
!
router ospf 100
log-adjacency-changes
redistribute connected subnets
network 13.13.13.13 0.0.0.0 area 100
network 30.4.0.0 0.0.255.255 area 100
network 30.5.0.0 0.0.255.255 area 100
network 30.6.0.0 0.0.255.255 area 100
network 30.7.0.0 0.0.255.255 area 100
network 30.8.0.0 0.0.255.255 area 100
network 30.9.0.0 0.0.255.255 area 100
!

```

CSC-PE2 (72K-36-5) Configuration

```

ip cef
!
ip vrf vpn1
rd 100:0
route-target export 100:0
route-target import 100:0
mpls label protocol ldp
!
interface Loopback0
ip address 11.11.11.11 255.255.255.255
no ip directed-broadcast
no ip route-cache
no ip mroute-cache
!
interface Loopback100
ip vrf forwarding vpn1
ip address 23.23.23.23 255.255.255.255
no ip directed-broadcast
!
interface ATM5/0
no ip address

```

```
no ip directed-broadcast
no ip mroute-cache
atm clock INTERNAL
atm sonet stm-1
no atm enable-ilmi-trap
no atm ilmi-keepalive
!
interface ATM5/0.1 point-to-point
ip vrf forwarding vpn1
ip address 30.18.0.2 255.255.0.0
no ip directed-broadcast
atm pvc 100 0 50 aal5snap
no atm enable-ilmi-trap
mpls label protocol ldp
tag-switching ip
!
interface ATM5/0.2 point-to-point
ip vrf forwarding vpn1
ip address 30.19.0.2 255.255.0.0
no ip directed-broadcast
atm pvc 101 0 51 aal5snap
no atm enable-ilmi-trap
mpls label protocol ldp
tag-switching ip
!
interface ATM5/0.3 point-to-point
ip vrf forwarding vpn1
ip address 30.20.0.2 255.255.0.0
no ip directed-broadcast
atm pvc 102 0 52 aal5snap
no atm enable-ilmi-trap
mpls label protocol ldp
tag-switching ip
!
interface ATM6/0
no ip address
no ip directed-broadcast
no ip mroute-cache
atm clock INTERNAL
atm sonet stm-1
no atm enable-ilmi-trap
no atm ilmi-keepalive
!
interface ATM6/0.1 point-to-point
ip address 30.4.0.1 255.255.0.0
no ip directed-broadcast
atm pvc 100 0 50 aal5snap
no atm enable-ilmi-trap
mpls label protocol ldp
tag-switching ip
!
interface ATM6/0.2 point-to-point
ip address 30.5.0.1 255.255.0.0
no ip directed-broadcast
atm pvc 101 0 51 aal5snap
no atm enable-ilmi-trap
mpls label protocol ldp
tag-switching ip
!
interface ATM6/0.3 point-to-point
ip address 30.6.0.1 255.255.0.0
no ip directed-broadcast
atm pvc 102 0 52 aal5snap
no atm enable-ilmi-trap
```

```

mpls label protocol ldp
tag-switching ip
!
router ospf 100
log-adjacency-changes
redistribute connected subnets
passive-interface ATM5/0.1
passive-interface ATM5/0.2
passive-interface ATM5/0.3
passive-interface Loopback100
network 11.11.11.11 0.0.0.0 area 100
network 30.4.0.0 0.0.255.255 area 100
network 30.5.0.0 0.0.255.255 area 100
network 30.6.0.0 0.0.255.255 area 100
!
router ospf 200 vrf vpn1
log-adjacency-changes
redistribute connected subnets
redistribute bgp 100 metric-type 1 subnets
network 23.23.23.23 0.0.0.0 area 200
network 30.18.0.0 0.0.255.255 area 200
network 30.19.0.0 0.0.255.255 area 200
network 30.20.0.0 0.0.255.255 area 200
!
router bgp 100
bgp log-neighbor-changes
timers bgp 10 30
neighbor 14.14.14.14 remote-as 100
neighbor 14.14.14.14 update-source Loopback0
!
address-family ipv4
neighbor 14.14.14.14 activate
neighbor 14.14.14.14 send-community extended
no synchronization
exit-address-family
!
address-family vpnv4
neighbor 14.14.14.14 activate
neighbor 14.14.14.14 send-community extended
exit-address-family
!
address-family ipv4 vrf vpn1
redistribute ospf 200 match internal external 1 external 2
no auto-summary
no synchronization
exit-address-family

```

Customer Carrier Site 1 Configuration

CSC-CE1 (72K-36-8) Configuration

```

ip cef
!
mpls label protocol ldp
!
interface Loopback0
ip address 15.15.15.15 255.255.255.255
no ip directed-broadcast
no ip route-cache
no ip mroute-cache
!
interface ATM1/0

```

```

no ip address
no ip directed-broadcast
no ip mroute-cache
atm clock INTERNAL
atm sonet stm-1
no atm enable-ilmi-trap
no atm ilmi-keepalive
!
interface ATM1/0.1 point-to-point
ip address 30.15.0.1 255.255.0.0
no ip directed-broadcast
atm pvc 100 0 50 aal5snap
no atm enable-ilmi-trap
mpls label protocol ldp
tag-switching ip
!
interface ATM1/0.2 point-to-point
ip address 30.16.0.1 255.255.0.0
no ip directed-broadcast
atm pvc 101 0 51 aal5snap
no atm enable-ilmi-trap
mpls label protocol ldp
tag-switching ip
!
interface ATM1/0.3 point-to-point
ip address 30.17.0.1 255.255.0.0
no ip directed-broadcast
atm pvc 102 0 52 aal5snap
no atm enable-ilmi-trap
mpls label protocol ldp
tag-switching ip
!
interface Ethernet3/1
ip address 30.10.0.2 255.255.0.0
no ip directed-broadcast
no ip mroute-cache
mpls label protocol ldp
tag-switching ip
!
router ospf 200
log-adjacency-changes
redistribute connected subnets
network 15.15.15.15 0.0.0.0 area 200
network 30.10.0.0 0.0.255.255 area 200
network 30.15.0.0 0.0.255.255 area 200
network 30.16.0.0 0.0.255.255 area 200
network 30.17.0.0 0.0.255.255 area 200

```

PE1 (72K-36-7) Configuration

```

ip cef
!
ip vrf customersite
rd 200:1
route-target export 200:1
route-target import 200:1
mpls label protocol ldp
!
interface Loopback0
ip address 16.16.16.16 255.255.255.255
no ip directed-broadcast
no ip route-cache
no ip mroute-cache

```

```

!
interface Ethernet3/1
ip vrf forwarding customersite
ip address 30.35.0.2 255.255.0.0
no ip directed-broadcast
no ip mroute-cache
!
interface Ethernet3/2
ip address 30.10.0.1 255.255.0.0
no ip directed-broadcast
no ip mroute-cache
mpls label protocol ldp
tag-switching ip
!
router ospf 200
log-adjacency-changes
redistribute connected subnets
passive-interface Ethernet3/1
network 16.16.16.16 0.0.0.0 area 200
network 30.10.0.0 0.0.255.255 area 200
!
router bgp 200
no bgp default ipv4-unicast
bgp log-neighbor-changes
timers bgp 10 30
neighbor 18.18.18.18 remote-as 200
neighbor 18.18.18.18 update-source Loopback0
!
address-family ipv4
neighbor 18.18.18.18 activate
neighbor 18.18.18.18 send-community extended
no synchronization
exit-address-family
!
address-family vpnv4
neighbor 18.18.18.18 activate
neighbor 18.18.18.18 send-community extended
exit-address-family
!
address-family ipv4 vrf customersite
neighbor 30.35.0.1 remote-as 300
neighbor 30.35.0.1 activate
neighbor 30.35.0.1 as-override
neighbor 30.35.0.1 advertisement-interval 5
no auto-summary
no synchronization
exit-address-family

```

CE1 (36K-36-1) Configuration

```

ip cef
!
interface Loopback0
ip address 19.19.19.19 255.255.255.255
no ip directed-broadcast
!
interface Ethernet0/2
ip address 30.35.0.1 255.255.0.0
no ip directed-broadcast
!
router ospf 300
log-adjacency-changes
redistribute connected subnets

```

```

redistribute bgp 300 subnets
passive-interface Ethernet0/2
network 19.19.19.19 0.0.0.0 area 300
!
router bgp 300
no synchronization
bgp log-neighbor-changes
timers bgp 10 30
redistribute connected
redistribute ospf 300 match internal external 1 external 2
neighbor 30.35.0.2 remote-as 200
neighbor 30.35.0.2 advertisement-interval 5
no auto-summary

```

Customer Carrier Site 2 Configuration

CSC-CE2 (72K-36-4) Configuration

```

ip cef
!
mpls label protocol ldp
!
interface Loopback0
ip address 17.17.17.17 255.255.255.255
no ip directed-broadcast
!
interface ATM5/0
no ip address
no ip directed-broadcast
atm clock INTERNAL
atm sonet stm-1
no atm enable-ilmi-trap
no atm ilmi-keepalive
!
interface ATM5/0.1 point-to-point
ip address 30.11.0.2 255.255.0.0
no ip directed-broadcast
atm pvc 100 0 50 aal5snap
no atm enable-ilmi-trap
mpls label protocol ldp
tag-switching ip
!
interface ATM5/0.2 point-to-point
ip address 30.12.0.2 255.255.0.0
no ip directed-broadcast
atm pvc 101 0 51 aal5snap
no atm enable-ilmi-trap
mpls label protocol ldp
tag-switching ip
!
interface ATM5/0.3 point-to-point
ip address 30.13.0.2 255.255.0.0
no ip directed-broadcast
atm pvc 102 0 52 aal5snap
no atm enable-ilmi-trap
mpls label protocol ldp
tag-switching ip
!
interface ATM6/0
no ip address
no ip directed-broadcast
atm clock INTERNAL

```

```

atm sonet stm-1
no atm enable-ilmi-trap
no atm ilmi-keepalive
!
interface ATM6/0.1 point-to-point
ip address 30.18.0.1 255.255.0.0
no ip directed-broadcast
atm pvc 100 0 50 aal5snap
no atm enable-ilmi-trap
mpls label protocol ldp
tag-switching ip
!
interface ATM6/0.2 point-to-point
ip address 30.19.0.1 255.255.0.0
no ip directed-broadcast
atm pvc 101 0 51 aal5snap
no atm enable-ilmi-trap
mpls label protocol ldp
tag-switching ip
!
interface ATM6/0.3 point-to-point
ip address 30.20.0.1 255.255.0.0
no ip directed-broadcast
atm pvc 102 0 52 aal5snap
no atm enable-ilmi-trap
mpls label protocol ldp
tag-switching ip
!
router ospf 200
log-adjacency-changes
redistribute connected subnets
network 17.17.17.17 0.0.0.0 area 200
network 30.11.0.0 0.0.255.255 area 200
network 30.12.0.0 0.0.255.255 area 200
network 30.13.0.0 0.0.255.255 area 200
network 30.18.0.0 0.0.255.255 area 200
network 30.19.0.0 0.0.255.255 area 200
network 30.20.0.0 0.0.255.255 area 200

```

PE2 (72K-36-4) Configuration

```

ip cef
!
ip vrf customersite
rd 200:1
route-target export 200:1
route-target import 200:1
mpls label protocol ldp
!
interface Loopback0
ip address 18.18.18.18 255.255.255.255
no ip directed-broadcast
no ip route-cache
no ip mroute-cache
!
interface Ethernet3/0
ip vrf forwarding customersite
ip address 30.29.0.2 255.255.0.0
no ip directed-broadcast
!
interface Ethernet3/1
ip vrf forwarding customersite
ip address 30.30.0.2 255.255.0.0

```

```
no ip directed-broadcast
!
interface ATM5/0
no ip address
no ip directed-broadcast
no ip mroute-cache
atm clock INTERNAL
atm sonet stm-1
no atm enable-ilmi-trap
no atm ilmi-keepalive
!
interface ATM5/0.1 point-to-point
ip address 30.11.0.1 255.255.0.0
no ip directed-broadcast
atm pvc 100 0 50 aal5snap
no atm enable-ilmi-trap
mpls label protocol ldp
tag-switching ip
!
interface ATM5/0.2 point-to-point
ip address 30.12.0.1 255.255.0.0
no ip directed-broadcast
atm pvc 101 0 51 aal5snap
no atm enable-ilmi-trap
mpls label protocol ldp
tag-switching ip
!
interface ATM5/0.3 point-to-point
ip address 30.13.0.1 255.255.0.0
no ip directed-broadcast
atm pvc 102 0 52 aal5snap
no atm enable-ilmi-trap
mpls label protocol ldp
tag-switching ip
!
router ospf 200
log-adjacency-changes
redistribute connected subnets
passive-interface Ethernet3/0
passive-interface Ethernet3/1
network 18.18.18.18 0.0.0.0 area 200
network 30.11.0.0 0.0.255.255 area 200
network 30.12.0.0 0.0.255.255 area 200
network 30.13.0.0 0.0.255.255 area 200
!
router bgp 200
no bgp default ipv4-unicast
bgp log-neighbor-changes
timers bgp 10 30
neighbor 16.16.16.16 remote-as 200
neighbor 16.16.16.16 update-source Loopback0
!
address-family ipv4
neighbor 16.16.16.16 activate
neighbor 16.16.16.16 send-community extended
no synchronization
exit-address-family
!
address-family vpv4
neighbor 16.16.16.16 activate
neighbor 16.16.16.16 send-community extended
exit-address-family
!
address-family ipv4 vrf customersite
```

```

neighbor 30.29.0.1 remote-as 300
neighbor 30.29.0.1 activate
neighbor 30.29.0.1 as-override
neighbor 30.29.0.1 advertisement-interval 5
neighbor 30.30.0.1 remote-as 300
neighbor 30.30.0.1 activate
neighbor 30.30.0.1 as-override
neighbor 30.30.0.1 advertisement-interval 5
no auto-summary
no synchronization
exit-address-family

```

CE2 (36K-38-4) Configuration

```

ip cef
!
interface Loopback0
ip address 21.21.21.21 255.255.255.255
!
interface Ethernet1/3
ip address 30.29.0.1 255.255.0.0
!
interface Ethernet5/0
ip address 30.14.0.1 255.255.0.0
!
router ospf 300
log-adjacency-changes
redistribute connected subnets
redistribute bgp 300 subnets
passive-interface Ethernet1/3
network 21.21.21.21 0.0.0.0 area 300
network 30.14.0.0 0.0.255.255 area 300
!
router bgp 300
no synchronization
timers bgp 10 30
redistribute connected
redistribute ospf 300 match internal external 1 external 2
neighbor 30.29.0.2 remote-as 200
neighbor 30.29.0.2 advertisement-interval 5
no auto-summary

```

CE3 (36K-38-5) Configuration

```

ip cef
!
interface Loopback0
ip address 20.20.20.20 255.255.255.255
no ip directed-broadcast
!
interface Ethernet0/2
ip address 30.30.0.1 255.255.0.0
no ip directed-broadcast
!
interface Ethernet0/3
ip address 30.14.0.2 255.255.0.0
no ip directed-broadcast
!
router ospf 300
log-adjacency-changes
redistribute connected subnets
redistribute bgp 300 subnets
passive-interface Ethernet0/2

```

```
network 20.20.20.20 0.0.0.0 area 300
network 30.14.0.0 0.0.255.255 area 300
!
router bgp 300
no synchronization
bgp log-neighbor-changes
timers bgp 10 30
redistribute connected
redistribute ospf 300 match internal external 1 external 2
neighbor 30.30.0.2 remote-as 200
neighbor 30.30.0.2 advertisement-interval 5
no auto-summary
```

Glossary

AS—Autonomous system. A collection of networks under a common administration sharing a common routing strategy.

ASBR—Autonomous system boundary router. An edge router located between an OSPF autonomous system and a non-OSPF network. ASBRs run both OSPF and another routing protocol, such as RIP.

BGP—Border Gateway Protocol. A routing protocol that exchanges network reachability information with other BGP systems, which may be within the same autonomous system or between multiple autonomous systems.

CE router—Customer edge router. A router that is part of a customer network and that interfaces to a provider edge (PE) router.

EBGP—External Border Gateway Protocol. A Border Gateway Protocol between routers located in different autonomous systems.

IBGP—Internal Border Gateway Protocol. A Border Gateway Protocol between routers within the same autonomous system.

LDP—Label Distribution Protocol. A standard protocol used by MPLS-enabled routers to assign the labels (addresses) used to forward packets.

LSR—Label switching router. An LSR forwards packets in an MPLS network by looking only at the fixed-length label.

LSP—Label-switched path. A sequence of hops in which a packet travels from one router to another router by means of label switching mechanisms. A label-switched path can be established dynamically, based on normal routing mechanisms, or through configuration.

MPLS—Multiprotocol label switching. MPLS is a method for forwarding packets (frames) through a network. It enables routers at the edge of a network to apply labels to packets (frames). ATM switches or existing routers in the network core can switch packets according to the labels.

Multihop BGP—A Border Gateway Protocol between two routers in different autonomous systems that are more than one hop away from each other.

NLRI—Network layer reachability information. BGP routers exchange network layer reachability information, which includes the full route (BGP AS numbers) to reach the destination network.

PE router—Provider edge router. A router that is part of a service provider's network connected to a customer edge (CE) router. All MPLS VPN processing occurs in the PE router.

POP—Point of presence. An access point to the Internet. A POP has a unique IP address. The ISP or online service provider (such as AOL) has one or more POPs on the Internet. ISP users dial into the POP to connect to the Internet. A POP can reside in rented space owned by the telecommunications carrier (such as Sprint) to which the ISP is connected. A POP usually includes routers, digital/analog call aggregators, servers, and frequently frame relay or ATM switches.

RD—Route distinguisher. An 8-byte value that is concatenated with an IPv4 prefix to create a unique VPN-IPv4 prefix.

RIP—Routing Information Protocol. An internal gateway protocol used to exchange routing information within an autonomous system. RIP uses hop count as a routing metric.

VPN—Virtual private network. VPNs connect branch offices and remote users through a shared or public network, such as the Internet, and provide the same security and availability as a private network. Because VPNs use an existing shared WAN infrastructure, costs are lower and deployment is faster than is the case with traditional private networks. A VPN can consist of sites (or systems) that are all from the same enterprise (intranet) or from different enterprises (extranet); it can consist of sites (or systems) that all attach to the same service provider backbone or to different service provider backbones.

VPN-IPv4—A prefix that consists of a customer VPN address that has been made unique by the addition of an 8-byte route distinguisher.

VRF table—VPN routing and forwarding table. A VRF table includes the routing information that defines a customer VPN site that is attached to a PE router. A VRF table consists of the following elements:

- An IP routing table
- A derived forwarding table
- A set of interfaces that use the forwarding table
- A set of rules and routing protocols that determine what goes into the forwarding table

