Configuring a Basic MPLS VPN

Contents

Introduction

This document provides a sample configuration of a Multiprotocol Label Switching (MPLS) Virtual Private Network (VPN) over ATM when Border Gateway Protocol (BGP) or Routing Information Protocol (RIP) is present on the customer's site.

When used with MPLS, the VPN feature allows several sites to interconnect transparently through a service provider's network. One service provider network can support several different IP VPNs. Each of these appears to its users as a private network, separate from all other networks. Within a VPN, each site can send IP packets to any other site in the same VPN.

Each VPN is associated with one or more VPN routing or forwarding instances (VRFs). A VRF consists of an IP routing table, a derived Cisco express forwarding (CEF) table, and a set of interfaces that use this forwarding table.

The router maintains a separate routing and CEF table for each VRF. This prevents information being sent outside the VPN and allows the same subnet to be used i n several VPNs without causing duplicate IP address problems.

The router using Multiprotocol BGP (MP-BGP) distributes the VPN routing information using the MP-BGP extended communities.

For more information regarding the propagation of updates through a VPN, see the following URLs:

- VPN Route Target Communities
- BGP Distribution of VPN Routing Information
- MPLS Forwarding

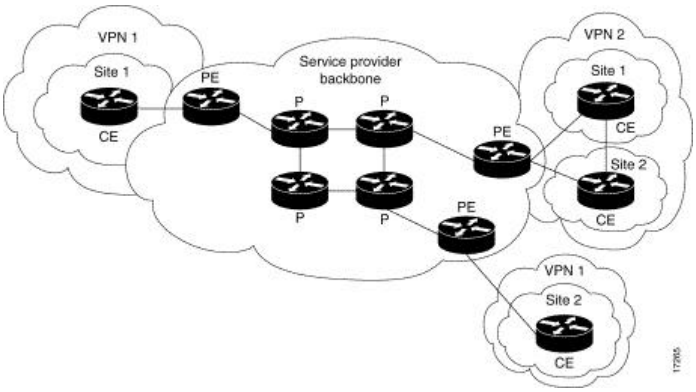
Conventions

The letters below represent the different types of routers and switches used.

- P : Provider's core router
- PE : Provider's edge router
- CE : Customer's edge router

- C : Customer's router

This diagram shows a typical configuration illustrating the conventions outlined above.

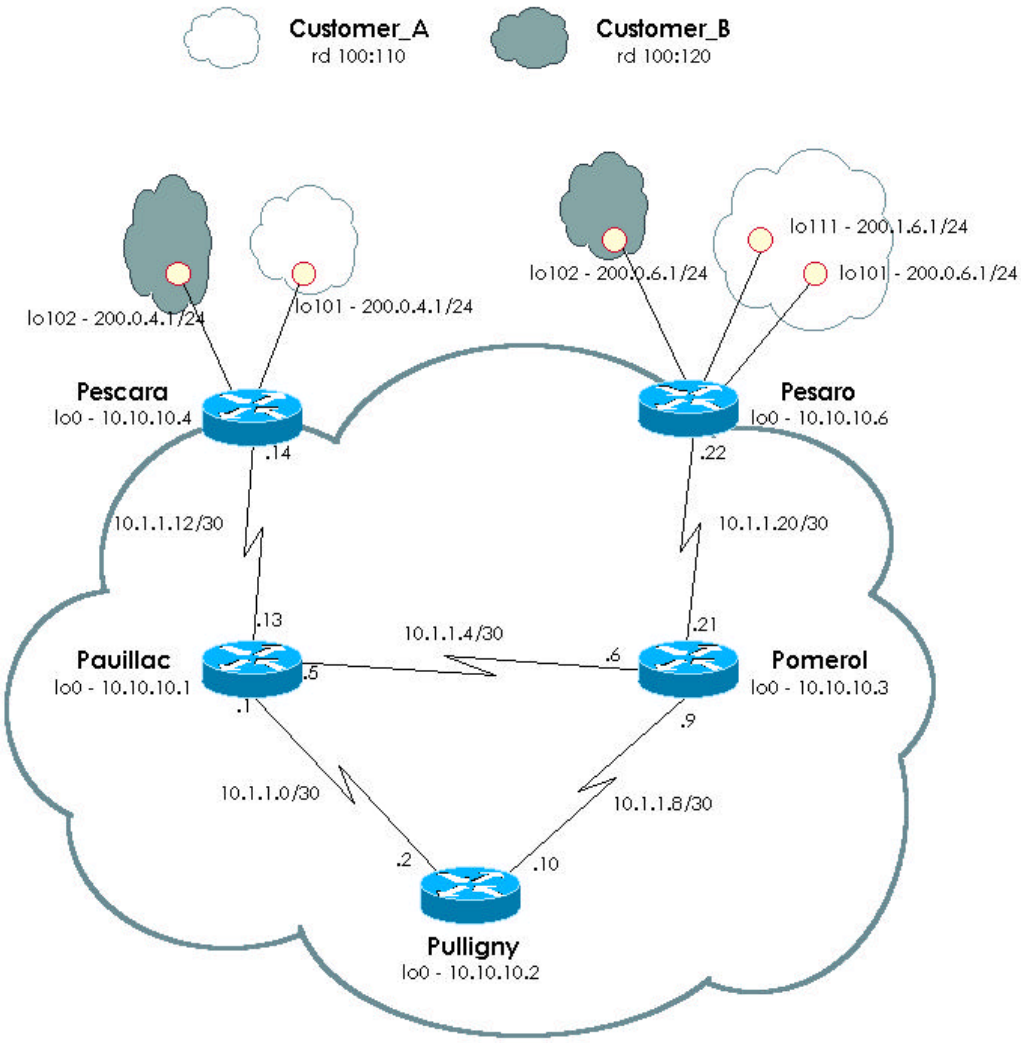


Hardware and Software Versions

This configuration was developed and tested using the software and hardware versions shown below.

- **P and PE routers:**
  - Software - Cisco IOS® Software Release 12.1(3)T. Release 12.0(5)T includes the MPLS VPN feature.
  - Hardware - Any Cisco router from the 3600 series or higher, such as the Cisco 3660 or 7206.
- **C and CE routers:** You can use any router that can exchange routing information with its PE router.

Network Diagram



Configuration Procedures

For more information, see MPLS Virtual Private Networks.

Enabling `ip cef`

Make sure that **ip cef** is enabled. For improved performance, use **ip cef distributed** (where available). Complete the following steps on the PEs after MPLS has been set up (configuring **tag-switching ip** on the interfaces).

1. Create one VRF for each VPN connected using the **ip vrf** command. When doing this:
   - Specify the correct route distinguisher used for that VPN. This is used to extend the IP address so that you can identify which VPN it belongs to.

     rd
   - Set up the import and export properties for the MP-BGP extended communities. These are used for filtering the import and export process.

     route-target ***[export|import|both]***
2. Configure the forwarding details for the respective interfaces using the following command.

   ip vrf forwarding

   Remember to set up the IP address after doing this.

3. Depending on the PE-CE routing protocol you are using, you can configure static routes or routing protocols (RIP, Open Shortest Path First [OSPF], or BGP) between PE and CE. Detailed configurations are available on the MPLS over ATM Support Page.

Configuring MP-BGP

Configure MP-BGP between the PE routers. There are several ways to configure BGP, such as using the route reflector or confederation methods. The method used here—direct neighbor configuration—is the simplest and the least scalable.

1. Declare the different neighbors.
2. Enter the **address-family ipv4 vrf** command for each VPN present at this PE router. Carry out one or more of the following steps, as necessary:
    - Redistribute the static routing, RIP, or OSPF information.
    - Redistribute connected routing information.
    - Activate BGP neighboring with the CE routers.
3. Enter the **address-family vpnv4** mode, and complete the following steps:
    - Activate the neighbors.
    - Specify that extended community must be used. This is mandatory.

Configurations

Configuration commands specific to Customer_A are in red, to Customer_B in blue, and to both in fuchsia.

Pescara

```
Current configuration:
!
version 12.0
!
hostname Pescara
!
ip cef
!
ip vrf Customer_A
 rd 100:110
 route-target export 100:1000
 route-target import 100:1000
!
ip vrf Customer_B
 rd 100:120
 route-target export 100:2000
 route-target import 100:2000
!
clns routing
mpls traffic-eng tunnels
!
interface Loopback0
 ip address 10.10.10.4 255.255.255.255
 ip router isis
 clns router isis
!
interface Loopback101
 ip vrf forwarding Customer_A
 ip address 200.0.4.1 255.255.255.0
 no ip directed-broadcast
!
interface Loopback102
 ip vrf forwarding Customer_B
 ip address 200.0.4.1 255.255.255.0
 no ip directed-broadcast
!
interface Serial0/1
 no ip address
```

```
 no ip directed-broadcast
 encapsulation frame-relay
 no fair-queue
!
interface Serial0/1.1 point-to-point
 description link to Pauillac
 bandwidth 512
 ip address 10.1.1.14 255.255.255.252
 no ip directed-broadcast
 ip router isis
 tag-switching ip
 clns router isis
 frame-relay interface-dlci 401
!
router isis
 net 49.0001.0000.0000.0004.00
 is-type level-1
!
router bgp 100
 bgp log-neighbor-changes
 neighbor 10.10.10.6 remote-as 100
 neighbor 10.10.10.6 update-source Loopback0
 !
 address-family vpnv4
 neighbor 10.10.10.6 activate
 neighbor 10.10.10.6 send-community both
 exit-address-family
 !
 address-family ipv4 vrf Customer_B
 redistribute connected
 no auto-summary
 no synchronization
 exit-address-family
 !
 address-family ipv4 vrf Customer_A
 redistribute connected
 no auto-summary
 no synchronization
 exit-address-family
!
ip classless
!
end
```

Pesaro

```
Current configuration:
!
version 12.1
!
hostname Pesaro
!
ip vrf Customer_A
 rd 100:110
 route-target export 100:1000
 route-target import 100:1000
!
ip vrf Customer_B
 rd 100:120
 route-target export 100:2000
 route-target import 100:2000
!
ip cef
clns routing
!
!
interface Loopback0
 ip address 10.10.10.6 255.255.255.255
 ip router isis
 clns router isis
!
interface Loopback101
 ip vrf forwarding Customer_A
 ip address 200.0.6.1 255.255.255.0
!
interface Loopback102
 ip vrf forwarding Customer_B
 ip address 200.0.6.1 255.255.255.0
```

```
!
interface Loopback111
 ip vrf forwarding Customer_A
 ip address 200.1.6.1 255.255.255.0
!
interface Serial0/0
 no ip address
 encapsulation frame-relay
 no ip mroute-cache
 random-detect
!
interface Serial0/0.1 point-to-point
 description link to Pomerol
 bandwidth 512
 ip address 10.1.1.22 255.255.255.252
 ip router isis
 tag-switching ip
 clns router isis
 frame-relay interface-dlci 603
!
router isis
 net 49.0001.0000.0000.0006.00
 is-type level-1
!
router bgp 100
 neighbor 10.10.10.4 remote-as 100
 neighbor 10.10.10.4 update-source Loopback0
 !
 address-family ipv4 vrf Customer_B
 redistribute connected
 no auto-summary
 no synchronization
 exit-address-family
 !
 address-family ipv4 vrf Customer_A
 redistribute connected
 no auto-summary
 no synchronization
 exit-address-family
 !
 address-family vpnv4
 neighbor 10.10.10.4 activate
 neighbor 10.10.10.4 send-community both
 exit-address-family
!
ip classless
!
end
```

Pomerol

```
Current configuration:
!
version 12.0
!
hostname Pomerol
!
ip cef
clns routing
!
interface Loopback0
 ip address 10.10.10.3 255.255.255.255
 ip router isis
 clns router isis
!
interface Serial0/1
 no ip address
 no ip directed-broadcast
 encapsulation frame-relay
 random-detect
!
interface Serial0/1.1 point-to-point
 description link to Pauillac
 ip address 10.1.1.6 255.255.255.252
 no ip directed-broadcast
 ip router isis
 tag-switching mtu 1520
 tag-switching ip
```

```
 clns router isis
 frame-relay interface-dlci 301
!
interface Serial0/1.2 point-to-point
 description link to Pulligny
 ip address 10.1.1.9 255.255.255.252
 no ip directed-broadcast
 ip router isis
 tag-switching ip
 clns router isis
 frame-relay interface-dlci 302
!
interface Serial0/1.3 point-to-point
 description link to Pesaro
 ip address 10.1.1.21 255.255.255.252
 no ip directed-broadcast
 ip router isis
 tag-switching ip
 clns router isis
 frame-relay interface-dlci 306
!
router isis
 net 49.0001.0000.0000.0003.00
 is-type level-1
!
ip classless
!
end
```

Pulligny

```
Current configuration:
!
version 12.1
!
hostname Pulligny
!
!
ip cef
clns routing
cns event-service server
!
!
interface Loopback0
 ip address 10.10.10.2 255.255.255.255
!
interface Serial0/1
 no ip address
 encapsulation frame-relay
 random-detect
!
interface Serial0/1.1 point-to-point
 description link to Pauillac
 ip address 10.1.1.2 255.255.255.252
 ip router isis
 tag-switching ip
 clns router isis
 frame-relay interface-dlci 201
!
interface Serial0/1.2 point-to-point
 description link to Pomerol
 ip address 10.1.1.10 255.255.255.252
 ip router isis
 tag-switching ip
 clns router isis
 frame-relay interface-dlci 203
!
router isis
 passive-interface Loopback0
 net 49.0001.0000.0000.0002.00
 is-type level-1
!
ip classless
!
end
```

Pauillac

```
!
version 12.1
!
hostname pauillac
!
ip cef
clns routing
cns event-service server
!
interface Loopback0
 ip address 10.10.10.1 255.255.255.255
 ip router isis
 clns router isis
!
interface Serial0/0
 no ip address
 encapsulation frame-relay
 no ip mroute-cache
 tag-switching ip
 no fair-queue
!
interface Serial0/0.1 point-to-point
 description link to Pomerol
 bandwith 512
 ip address 10.1.1.1 255.255.255.252
 ip router isis
 tag-switching ip
 clns router isis
 frame-relay interface-dlci 102
!
interface Serial0/0.2 point-to-point
 description link to Pulligny ip address 10.1.1.5 255.255.255.252
 ip access-group 150 out
 ip router isis
 tag-switching ip
 clns router isis
 frame-relay interface-dlci 103
!
interface Serial0/0.3 point-to-point
 description link to Pescara
 bandwidth 512
 ip address 10.1.1.13 255.255.255.252
 ip router isis
 tag-switching ip
 clns router isis
 frame-relay interface-dlci 104
!
router isis
 net 49.0001.0000.0000.0001.00
 is-type level-1
!
ip classless
!
end
```

show Commands

The following commands are illustrated below:

- **show ip vrf**
- **show ip vrf interfaces**
- **show ip route vrf Customer_A**
- **traceroute vrf Customer_A 200.0.6.1**

Other interesting commands (not illustrated here) include:

- **show ip bgp vpnv4 tag**
- **show ip cef vrf Customer_A 200.0.6.1 detail**

More commands are detailed in the MPLS VPN Solution Troubleshooting Guide.

Sample show Output

You can use the following command to verify that the correct VRF exists:

```
Pescara#show ip vrf
  Name                              Default RD          Interfaces
  Customer_A                        100:110             Loopback101
  Customer_B                        100:120             Loopback102
```

To check the activated interfaces, use the following command.

```
Pesaro#show ip vrf interfaces
Interface              IP-Address      VRF                             Protocol
Loopback101            200.0.6.1       Customer_A                      up
Loopback111            200.1.6.1       Customer_A                      up
Loopback102            200.0.6.1       Customer_B                      up
```

Routing Information

You can check routing information on the PE routers using the **show ip route** command followed by `vrf` and the VRF name.

```
Pescara#show ip route vrf Customer_A
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
       * - candidate default, U - per-user static route, o - ODR

Gateway of last resort is not set

C    200.0.4.0/24 is directly connected, Loopback101
B    200.0.6.0/24 [200/0] via 10.10.10.6, 05:10:11
B    200.1.6.0/24 [200/0] via 10.10.10.6, 04:48:11
```

MPLS Labels

By running a traceroute between two sites of Customer_A, it is possible to see the label stack used by the MPLS network (if it is configured to do so by **mpls ip ttl ...**).

```
Pescara#traceroute vrf Customer_A 200.0.6.1

Type escape sequence to abort.
Tracing the route to 200.0.6.1

  1 10.1.1.13 [MPLS: Labels 20/26 Exp 0] 400 msec 276 msec 264 msec
  2 10.1.1.6 [MPLS: Labels 18/26 Exp 0] 224 msec 460 msec 344 msec
  3 200.0.6.1 108 msec *  100 msec
```

Note: `Exp 0` is an experimental field used for Quality of Service.

Related Information

- **MPLS Support Page**
- **IP Routing Top Issues**
- **More IP Routing Technical Tips**
