Configure MPLS on the Cisco Catalyst 8540 MSR Enhanced ARM (ARM 2) with PVPs

Contents

Introduction

This document provides a sample configuration for the Multiprotocol Layer Switching (MPLS) on the Catalyst 8540 Enhanced ATM Router module (ARM). The ARM module's main function is to increase the capability to connect two different worlds - packet/switching (which is frame based) and ATM (which is cell based). This functionality could be extended to the MPLS as well. The Catalyst 8540 MSR with an Enhanced ARM can be installed at the edge of a packet and cell based network with both MPLS modes enabled in the same chassis. The Enhanced ARM (ARM2) on the Catalyst 8540 MSR is required for Label Edge Routing (LER) functionality on ATM interfaces - it acts as the proxy interface for every incoming and outgoing ATM interface in the Label Switch Path (LSP) to do the MPLS packet processing. The Catalyst 8540 is ideally suited for cell-mode to frame-mode MPLS integration (accomplished by deployment of the Enhanced ATM router module). Up to two ARM2 cards can be used in a single chassis.

This document provides examples of two different configurations that explain the usage of the ARM 2.

- Use the Enhanced ARM for cell mode (terminating cell mode MPLS on the ARM 2)
- Use the Enhanced ARM for frame mode MPLS over ATM over ATM VP tunnel.

Prerequisites

Requirements

There are no specific requirements for this document.

Components Used

The information in this document is based on these software and hardware versions:

- Two Cisco C8540 MSRs, Cisco IOS$^{®}$ version 12.1(10)EY (256 MB DRAM)
- Cisco C8510 MSR, Cisco IOS version Version 12.1(7a)EY1 (64 MB DRAM)
- C8540-ARM2 (Enhanced ATM Router module)
- WAI-OC3-4MM (4 port OC-3 line card)
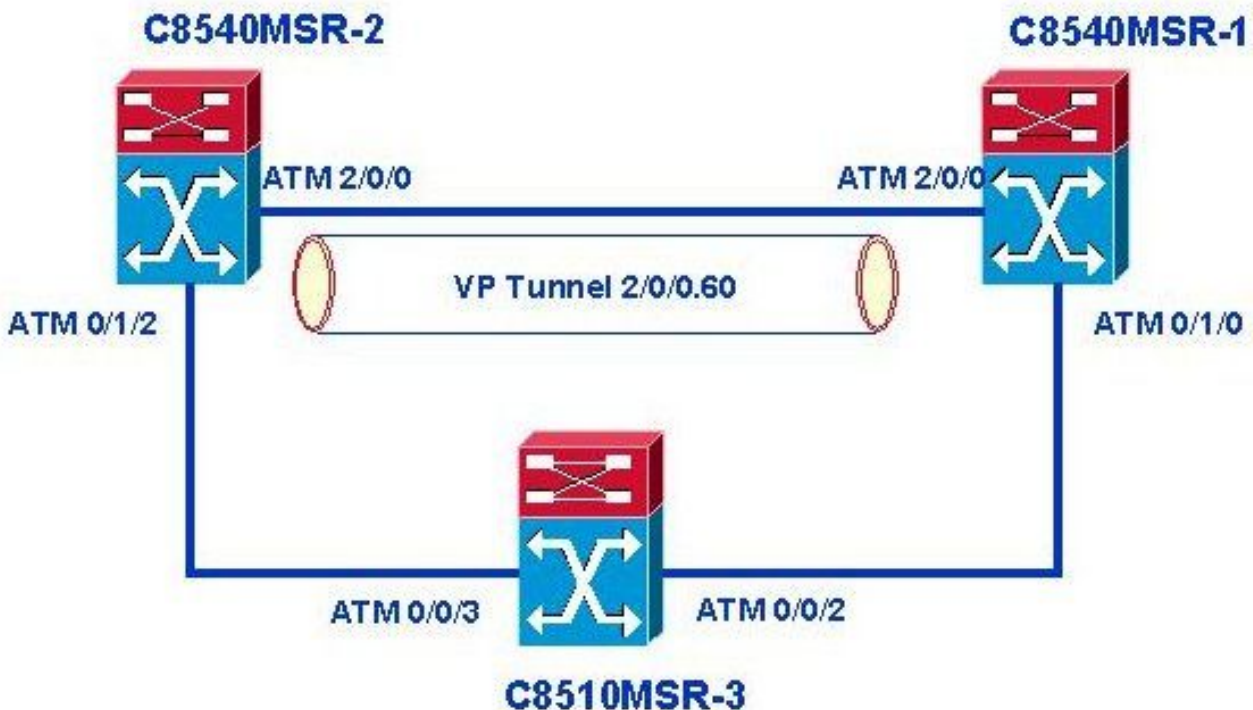- C85MS-4F-OC12MM (4 port OC-12 line card)

The information presented in this document was created from devices in a specific lab environment. All of the devices used in this document started with a cleared (default) configuration. If you are working in a live network, ensure that you understand the potential impact of any command before using it.

Configure

In this section, you are presented with the information to configure the features described in this document. The OSPF was used as an internal routing protocol.

Network Diagram

This document uses the network setup shown in this diagram:

The previous diagram is used for these scenarios:

- Use the Enhanced ARM for cell mode (terminating cell mode MPLS on the ARM 2)
- Use the Enhanced ARM for frame mode MPLS over ATM over ATM VP tunnel.

Notice that the configuration for the cell mode uses the path C8540MSR-2 to C8510MSR-3 to

C8540MSR-1, while the configurations described in this document for frame mode uses the VP Tunnel to connect C8540MSR-2 and C8540MSR-1.

Use the Enhanced ARM for Cell Mode MPLS

On the Catalyst 8540 MSR cell-mode MPLS is supported on all ATM interfaces and works in parallel with ATM signaling (such as ILMI) and ATM routing (PNNI). The cell-mode MPLS is enabled when you add the **mpls ip** interface command (or **tag-switching ip** in older Cisco IOS versions) and requires establishment of one unidirectional Label Virtual Circuit (LVC), or a Tag Virtual Circuit (TVC) for each Forwarding Equivalent Class (FEC) or an IP destination. Label virtual circuits are known as **head-end** LVC at the originator LER, **tail-end** LVC at the destination LER, and **transit** LVC at the LSR. In case a Cat8540 MSR acts as a pure ATM LSR (MPLS P router), the CPU does not establish head-end LVC for the routes learned in the ATM core. The traffic that originates from the CPU and is destined to a remote LSR is sent over the MPLS control VC. An ATM interface could be linked to an ARM2 port and the LVC will terminate on the ARM2 port if that is the case. In fact, when you link an ATM interface to an ARM2 port, the ARM2 acts as an ATM LER (MPLS PE router) and will initiate head-end LVC (terminating LVC) for the routes learned in the ATM core.

ATM interfaces, ATM VP, and hierarchical VP tunnels can be configured to terminate on the ARM2 port (available on 8540 MSR platform only). For load balancing purposes, ATM interfaces can be linked to either of the two ports of an Enhanced ARM . In order to terminate cell mode MPLS on an ARM2 port, use the **mpls-forwarding interface ATMx/y/z** interface configuration command, where ATMx/y/z is the Enhanced ARM port). That command applies to the main interface only.

Configurations

- [C8540MSR-2](#)
- [C8510MSR-3](#)

C8540MSR-2 (Catalyst 8540MSR)

```
C8540MSR-2#show hardware
C8540 named c8540MSR-2, Date: 04:46:41 UTC Mon Feb 10 2003
Slot Ctrlr-Type     Part No. Rev Ser No Mfg Date RMA No. Hw Vrs  Tst EEP
---- ------------ ---------- -- -------- --------- -------- ------- --- ---
 0/* Super Cam      73-2739-03 B0 03170SXG Apr 27 99 0          3.0
0/1 155MM PAM      73-1496-03 A0 09006167 Aug 01 95 00-00-00  3.1     0   2
 2/* OCM Board      73-2833-06 A0 03210XWB May 26 99 0          6.0
 2/0 QUAD 622 Gen  73-2852-05 A0 03210YN8 May 26 99 0          5.0
 9/* ETHERNET PAM  73-3754-05 A0 03374A9K Mar 17 99 0          4.1
12/* CMPM Card      73-3944-05 A0 04209EX0 Aug 29 00 0          5.0
12/0 ARM2 PAM       73-5533-01 A0 0424A160 Aug 29 00 0          5.1
12/1 ARM2 PAM       73-5533-01 A0 0424A183 Aug 29 00 0          5.1
C8540MSR-2#conf t

Enter configuration commands, one per line.  End with CNTL/Z.

C8540MSR-2(config)#int atm 0/1/2
C8540MSR-2(config-if)#mpls ip
! Cell mode MPLS enabled
C8540MSR-2(config-if)#ip add 10.254.14.237 255.255.255.252
C8540MSR-2(config-if)#mpls label protocol ldp
```

```
! LDP enabled on the interface
C8540MSR-2(config-if)#end

C8540MSR-2#show atm vc int atm 0/1/2
Interface        VPI  VCI    Type    X-Interface     X-VPI X-VCI Encap  Status
ATM0/1/2         0    5      PVC     ATM0            0     57    QSAAL  UP
ATM0/1/2         0    16     PVC     ATM0            0     37    ILMI   UP
ATM0/1/2         0    18     PVC     ATM0            0     202   PNNI   UP
ATM0/1/2         0    32     PVC     ATM0            0     256   SNAP   UP

C8540MSR-2#show mpls int atm 0/1/2
Interface       IP           Tunnel   Operational
ATM0/1/2        Yes (ldp)    No       Yes        (ATM labels)

C8540MSR-2#show mpls int atm 0/1/2 det

Interface ATM0/1/2:
        IP labeling enabled (ldp)
LSP Tunnel labeling not enabled
        MPLS operational
        MTU = 4470
ATM tagging: Label VPI = 1
Label VCI range = 33 - 65535
        Control VC = 0/32

C8540MSR-2#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
C8540MSR-2(config)#int atm 0/1/2
C8540MSR-2(config-if)#mpls-forwarding int atm 12/0/1
! Terminate Cell mode MPLS on ARM2
C8540MSR-2(config-if)#end
C8540MSR-2#show atm vc int atm 0/1/2

Interface        VPI  VCI    Type     X-Interface    X-VPI X-VCI Encap  Status
ATM0/1/2         0    5      PVC      ATM0           0     57    QSAAL  UP
ATM0/1/2         0    16     PVC      ATM0           0     37    ILMI   UP
ATM0/1/2         0    18     PVC      ATM0           0     202   PNNI   UP
ATM0/1/2         0    32     PVC      ATM12/0/1      2     120   SNAP   UP
ATM0/1/2         1    35     TVC(O)   ATM12/0/1      2     121   MUX    UP
ATM0/1/2         1    36     TVC(O)   ATM12/0/1      2     122   MUX    UP
ATM0/1/2         1    37     TVC(O)   ATM12/0/1      2     123   MUX    UP
ATM0/1/2         1    41     TVC(O)   ATM12/0/1      2     124   MUX    UP

C8540MSR-2#show mpls int

Interface        IP           Tunnel   Operational
FastEthernet9/0/0 Yes (ldp)   No       Yes
ATM0/1/2         Yes (ldp)    No       Yes     (ATM labels)
! Note: ATM labels -> Cell mode
ATM12/0/0.60     Yes(ldp)     No       Yes
```

> **Note**: The same configuration procedure shown previously should be used on the second 8540 MSR (C8540MSR-1).This configuration is not shown here because the same steps are required to get the MPLS up and running.

C8510MSR-3 (Catalyst 8510MSR)

```
C8510MSR-1#show running-config
Building configuration...
```

```
!         interface Loopback0
 ip address 10.254.231.1 255.255.255.255
! interface ATM0/0/2
 ip address 10.254.14.245 255.255.255.252
 logging event subif-link-status
 no atm ilmi-keepalive
 mpls label protocol ldp
 tag-switching ip
!
interface ATM0/0/3
 ip address 10.254.14.238 255.255.255.252
 logging event subif-link-status
 load-interval 30
 no atm ilmi-keepalive
 mpls label protocol ldp
 tag-switching ip
!
router ospf 1
 log-adjacency-changes
 network 10.0.0.0 0.255.255.255 area 0.0.0.0
```

Use the Enhanced ARM for Frame Mode MPLS over ATM VP Tunnels

The Catalyst 8540 MSR with an Enhanced ARM line card can also run frame mode MPLS over ATM. In order to illustrate usage of the Enhanced ARM in the frame mode MPLS, view the "Use the Enhanced ARM for Frame Mode MPLS over ATM Tunnels" configuration example located in this document. ATM VP tunnels are sometimes used to connect two sites. Instead of configuring individual VCs, the large "pipe" VP tunnel can be used. In order to illustrate this option, which is normally used by companies that need a large number of VCs between the remote sites, the VP tunnel was created between C8540MSR-1 and C8540MSR-2. Two 8540MSR's are directly connected through the ATM2/0/0 (OC-12, an hierarchical VP tunnel ATM2/0/0.60 has been used). Both Enhanced ARM modules run frame mode MPLS on an ATM subinterface. For that reason, a data PVC/aal5snap has been configured.

This example displays the steps performed in C8540MSR-1 in order to configure the Enhanced ARM for Frame Mode MPLS over ATM VP Tunnels.

C8540MSR-1 (Catalyst 8540MSR)

```
C8540MSR-1#show hardware

C8540 named c8540-r6-1, Date: 04:46:41 UTC Mon Feb 10 2003

Slot Ctrlr-Type    Part No.   Rev Ser No  Mfg Date  RMA No.  Hw Vrs  Tst EEP
---- ------------  ---------- --  -------- --------- -------- ------- --- ---
 0/* Super Cam     73-2739-03 B0  03170SUQ Apr 27 99 0        3.0
 0/1 155MM PAM     73-1496-03 A6  03199939 Aug 01 95 00-00-00 3.1      0   2
 2/* OCM Board     73-2833-06 A0  03210XWB May 26 99 0        6.0
 2/0 QUAD 622 Gen  73-2852-05 A0  03210YN8 May 26 99 0        5.0
 9/* ETHERNET PAM  73-3754-05 A0  031111EO Mar 17 99 0        4.1
11/* CMPM Card     73-3944-05 A0  04209F5E Aug 29 00 0        5.0
11/0 ARM2 PAM      73-5533-01 A0  0424A162 Aug 29 00 0        5.1
11/1 ARM2 PAM      73-5533-01 A0  0424A17C Aug 29 00 0        5.1

C8540MSR-1#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
C8540MSR-1(config)#atm hierarchical-tunnel
C8540MSR-1(config)#atm connection-traffic-table-row index 60 cbr pbr 120000
C8540MSR-1(config)#int atm 2/0/0
```

```
C8540MSR-1(config-if)#atm pvp 6 hierarchical rx-cttr 60 tx-cttr 60
C8540MSR-1(config-if)#int atm 2/0/0.60
C8540MSR-1(config-subif)#exit
C8540MSR-1(config)#int atm 11/0/0.60 point-to-point
C8540MSR-1(config-subif)#ip address 10.254.14.10 255.255.255.252
C8540MSR-1(conf-sif)#atm pvc 2 60 pd on encap aal5snap int atm 2/0/0.60 60 60
C8540MSR-1(config-subif)#mpls label protocol ldp
C8540MSR-1(config-subif)#mpls ip
C8540MSR-1(config-subif)#end


C8540MSR-1#show atm vc int atm 11/0/0.60 | include ATM2/
ATM11/0/0          2    60    PVC   ATM2/0/0.60      60    60    SNAP    UP
C8540MSR-1#show mpls int
Interface           IP            Tunnel   Operational
ATM0/0/1            Yes (ldp)     No       Yes          (ATM labels)
ATM0/0/2            Yes           No       No           (ATM labels)
FastEthernet9/0/4   Yes           No       No
ATM0/1/0            Yes (ldp)     No       No           (ATM labels)
ATM11/0/1           Yes           No       No
ATM11/0/0.5         Yes (tdp)     No       Yes
ATM11/0/0.60        Yes (ldp)     No       Yes

! Note: no ATM labels -> Frame mode

C8540MSR-1#show mpls int atm 11/0/0.60 det
Interface ATM11/0/0.60:
      IP labeling enabled (ldp)       LSP Tunnel labeling not enabled
      MPLS operational         MTU = 4470

C8540MSR-1#show atm vp
Interface        VPI  Type  X-Interface        X-VPI     Status
ATM2/0/0         60   PVP                                 HIE. TUNNEL
```

Configurations

The relevant parts of the MSR's configurations from the network diagram are shown next:

- [C8540MSR-2](#)
- [C8540MSR-1](#)
- [C8510MSR-3](#) (This configuration is the same as the one in [Use the Enhanced ARM for Cell Mode MPLS](#).)

C8540MSR-2 (Catalyst 8540MSR)

```
C8540MSR-2#show running-config
Building configuration...
!
mpls label protocol ldp
atm hierarchical-tunnel
atm connection-traffic-table-row index 60 cbr pcr 120000

!
interface Loopback0
 ip address 10.254.225.1 255.255.255.255
!
interface ATM0/1/2
 description IP subnet 10.254.14.236
 ip address 10.254.14.237 255.255.255.252
 ip ospf cost 4
 no atm ilmi-keepalive
```

```
 mpls label protocol ldp
 tag-switching ip
 mpls-forwarding interface ATM12/0/1
! terminates cell mode MPLS on the ARM module
interface ATM2/0/0
 no ip address
 no atm ilmi-keepalive
atm pvp 60 hierarchical rx-cttr 60 tx-cttr 60
!
interface ATM2/0/0.60 point-to-point
description Hierarchical VP Tunnel for frame mode MPLS over ATM
!
interface FastEthernet9/0/0
 ip address 10.64.0.2 255.255.255.252
 load-interval 30
 duplex full
 speed 100
 tag-switching ip
 mpls-forwarding interface ATM12/0/0
! EPIF based FE line cards do not support MPLS natively
! link to ARM2 (ATM 12/0/0) enables MPLS on those cards
interface ATM12/0/0

 description Enhanced ARM - ARM2
no ip address


!
interface ATM12/0/0.60 point-to-point

description ARM2 subinterface used for Frame mode MPLS over HVPT 60
 ip address 10.254.14.9 255.255.255.252
 atm pvc 2 60 pd on   encap
al5snap interface  ATM2/0/0.60 60 60
 mpls label protocol ldp  tag-switching ip
! an ARM2 point-to-point subinterface (point-to-point) supported as of
! Cisco IOS release 12.1(10)EY only
!    router ospf 1
 router-id 10.254.225.1
 log-adjacency-changes  network 10.0.0.0 0.255.255.255 area 0.0.0.0
!
```

C8540MSR-1 (Catalyst 8540MSR)


```
C8540MSR-1#show running-config
Building configuration...
sdm sram Label 32768
sdm sram Tag-Cos 32768
! tag-switching tdp router-id Loopback0
!
atm hierarchical-tunnel
atm connection-traffic-table-row index 60 cbr pcr 120000
!
interface Loopback0
 ip address 10.254.232.1 255.255.255.255
!
interface ATM0/1/0
 ip address 10.254.14.246 255.255.255.252
 ip ospf cost 100
 logging event subif-link-status
 no atm ilmi-keepalive
 mpls label protocol ldp
 tag-switching ip
 mpls-forwarding interface ATM11/0/0
```

```
!
interface ATM2/0/0
 no ip address
 no atm ilmi-keepalive
 atm pvp 60 hierarchical rx-cttr 60 tx-cttr 60
!
interface ATM2/0/0.60 point-to-point
 no atm ilmi-keepalive
!
interface FastEthernet9/0/4
 ip address 10.177.1.1 255.255.255.252
 tag-switching ip
 mpls-forwarding interface ATM11/0/0
!
interface ATM11/0/0
 no ip address
!
interface ATM11/0/0.60 point-to-point
 ip address 10.254.14.10 255.255.255.252
 atm pvc 2 60 pd on  encap aal5snap interface  ATM2/0/0.60 60 60
 mpls label protocol ldp
 tag-switching ip
!
router ospf 1
 router-id 10.254.232.1
 log-adjacency-changes
 network 10.177.1.0 0.0.0.3 area 0.0.0.0
 network 10.254.0.0 0.0.255.255 area 0.0.0.0
!
end
```

Verify

Use these commands in order to verify if the MPLS is up and works properly:

- **show mpls interfaces [detail]** - Verifies whether a label distribution protocol is running on the requested interface
- **show mpls ldp neighbors** - Displays the status of LDP sessions/neighbor connections
- **show mpls ldp discovery** - Determines the LDP identifier and LDP hello exchange status of the interfaces
- **show mpls forwarding-table -** Checks the MPLS Forwarding Information Base (FIB) table
- **show mpls ip binding -** Checks the MPLS IP Label Information Base (LIB) table

```
C8540MSR-1#show mpls interfaces
 Interface              IP            Tunnel   Operational
 ATM0/0/1               Yes (ldp)     No       Yes          (ATM labels)
 ATM0/1/0               Yes (ldp)     No       Yes          (ATM labels)
 ATM11/0/0.60           Yes (ldp)     No       Yes

C8540MSR-1#show mpls interfaces atm 0/1/0 detail
   Interface ATM0/1/0:
        IP labeling enabled (ldp)
        LSP Tunnel labeling not enabled
        MPLS operational
        MTU = 4470
        ATM tagging: Label VPI = 1
                Label VCI range = 33 - 65535
                Control VC = 0/32
```

```
C8540MSR-1#show mpls ldp neighbor
   Peer LDP Ident: 10.254.225.1:0; Local LDP Ident 10.254.232.1:0
       TCP connection: 10.254.225.1.646 - 10.254.232.1.11016
       State: Oper; Msgs sent/rcvd: 106/93; Downstream
       Up time: 00:56:36
       LDP discovery sources:
         ATM11/0/0.60, Src IP addr: 10.254.14.9
       Addresses bound to peer LDP Ident:
         2.2.2.1         10.64.4.190     10.254.225.1    1.254.8.1
         10.254.14.221   10.254.14.225   10.254.14.237   10.254.14.9
   Peer LDP Ident: 10.254.231.1:4; Local LDP Ident 10.254.232.1:2
       TCP connection: 10.254.14.245.646 - 10.254.14.246.11017
       State: Oper; Msgs sent/rcvd: 45/45; Downstream on demand
       Up time: 00:38:27
       LDP discovery sources:
         ATM0/1/0, Src IP addr: 10.254.14.245


C8540MSR-1#show mpls ldp discovery
   Local LDP Identifier:      10.254.232.1:0
   Discovery Sources:
   Interfaces:

       ATM0/1/0 (ldp): xmit/recv          LDP Id: 10.254.231.1:4; IP addr:   10.254.14.245
       ATM11/0/0.60 (ldp): xmit/recv      LDP Id: 10.254.225.1:0


C8540MSR-1#show mpls forwarding-table
   Local  Outgoing    Prefix            Bytes tag  Outgoing    Next Hop
   tag    tag or VC   or Tunnel Id      switched   interface
   16     Untagged    10.254.14.220/30  0          AT11/0/0.60 point2point
   17     27          10.254.247.1/32   0          AT11/0/0.60
point2point
   20     22          10.254.14.240/30  0          AT11/0/0.60
point2point
   21     26          10.254.231.1/32   0          AT11/0/0.60
point2point
   24     Untagged    10.254.14.224/30  0          AT11/0/0.60
point2point
   25     24          10.254.227.1/32   0          AT11/0/0.60
point2point
   26     Pop tag     10.254.14.236/30  0          AT11/0/0.60
point2point
   33     Untagged    10.254.221.1/32   0          AT11/0/0.60
point2point
   45     18          10.254.14.12/30   0          AT11/0/0.60 point2point


SORBRCV0(c8540-r6-1)#show mpls ip bind
 ...
 10.254.221.1/32
     in label:      33
 10.254.222.1/32
     in label:      36
     out vc label: 1/53      lsr: 10.254.233.1:2   ATM0/0/1
                   Active    ingress 4 hops (vcd 49)
 10.254.223.1/32
     in label:      34
     out vc label: 1/54      lsr: 10.254.233.1:2   ATM0/0/1
                   Active    ingress 3 hops (vcd 43)
 10.254.225.1/32
     in label:      28
     out label:    imp-null  lsr: 10.254.225.1:0
   10.254.227.1/32
```

```
     in label:      25
     out label:     24        lsr: 10.254.225.1:0
 10.254.232.1/32
     in label:      imp-null
     in vc label:   1/34      lsr: 10.254.233.1:2   ATM0/0/1
                    Active    egress (vcd 59)
     out label:     33        lsr: 10.254.225.1:0
 10.254.233.1/32
     in label:      29
     out label:     34        lsr: 10.254.225.1:0
     out vc label:  1/60      lsr: 10.254.233.1:2   ATM0/0/1
                    Active    ingress 2 hops (vcd 38)
 10.254.242.1/32
     in label:      19
     out vc label:  1/61      lsr: 10.254.233.1:2   ATM0/0/1
                    Active    ingress 5 hops (vcd 50)
 10.254.247.1/32
     in label:      17
     out label:     27        lsr: 10.254.225.1:0
```

Troubleshoot

For additional information on MPLS troubleshooting, refer to the [MPLS Troubleshooting](#) general troubleshooting document which explains MPLS troubleshooting in detail.

Related Information

- **[MPLS Technology Support](#)**
- **[ATM Technology Support](#)**
- **[Tools & Resources - Cisco Systems](#)**
- **[Technical Support & Documentation - Cisco Systems](#)**