

MPLS CoS over ATM: Multi-VC TBR (using CAR)

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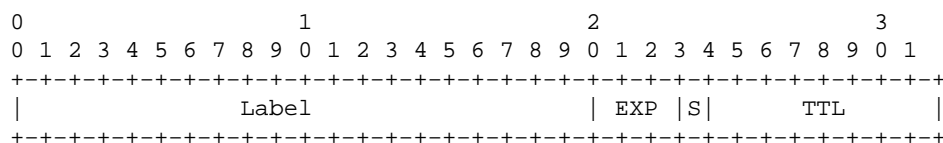
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Introduction

The Multiprotocol Label Switching Class of Service (MPLS CoS) mechanism is a feature that performs differentiated services over ATM. It allows the ATM network to treat different packets based on the EXP (experimental) field (also called CoS) of the MPLS header, which has the same properties and which can be mapped to IP precedence.



This document explains how to make use of this mechanism within an MPLS core network that receives IP packets (without precedence bits set) from different sources.

Prerequisites

Multi-Virtual Circuit Tagged Bit Rate (Multi-VC TBR)

Multi-VC TBR uses different paths and new-service classes to support different treatment over ATM. This method consists of up to four parallel Label Virtual Circuits (LVCs) (or "Tag VC" in old terminology) and maps to MPLS CoS. This table shows the default mapping:

Label Virtual Circuit Type	Class of Service	IP Type of Service
Available	0	0,4
Standard	1	1,5
Premium	2	2,6
Control	3	3,7

Every Label Switch Router (LSR) has a number of VCs (from one to four) that corresponds for the same destination or "multi-VC". These parallel LVCs are set up by the upstream edge router with label distribution protocol.

In order to support the LVCs at the switch level, four new CoS categories have been introduced. They are called Tagged Bit Rate (TBR) classes and are best-effort services (as with traditional unspecified bit rate (UBR)). They can be configured in the same way. That is, their relative weights or the limits of their thresholds can be changed.

ATM Forum Service Class	CoS	Relative Class Weight	Label Virtual Circuit
CBR	2	Not applicable	
VBR-RT	2	8	
VBR-nRT	3	1	
ABR	4	1	
UBR	5	1	
TBR_1 (WRR_1)	1	1	Available
TBR_2 (WRR_2)	6	2	Standard
TBR_3 (WRR_3)	7	3	Premium
TBR_4 (WRR_4)	8	4	Control

Note: The new CoS categories are in **bold**.

Mechanism

The edge LSR sets the MPLS CoS field with Committed Access Rate (CAR) on the correct inbound interface. CAR can be configured to act in accordance with a contract or any other specific rule. The LSR at the edge of the ATM network queues the cells that contain the packet in the correct queue (available, standard, premium, or control), dependent on the CoS map. The cells then transit through the MPLS ATM network with the same LVC. The result is that, at any ATM LSR, the cells receive a treatment per CoS:

- Per CoS Weighted Fair Queuing (WFQ) is proportional to the Relative Class Weights.
- Per CoS Weighted Early Packet Discard (WEPD) is a method to discard packets when queues fill up (similar to Weighted Random Early Detection (WRED)).

As a result, for the LS1010 and the 8540MSR, this per CoS behavior is emulated over per VC queuing.

VC Space

MPLS CoS supports standard VC merges. In order to use fewer VCs, you can reduce the LVC used (from four to two, for example). Refer to MPLS CoS over ATM: CoS Map for a sample configuration.

The subject of the number of VCs is treated in Designing MPLS for ATM: Dimensioning MPLS Label VC Space.

Hardware and Software Versions

This configuration was developed and tested with these software and hardware versions:

Edge LSR

- Software – Cisco IOS® Software Release 12.1(3)T; the Multi-VC feature appeared in Cisco IOS Software Release 12.0(5)T.
- Hardware – Cisco 7200 Routers with PA-A1.

Note: This feature only works with Cisco 7200s and 7500s with PA-A1.

Core ATM LSR

- Software – Any software release that supports MPLS; the latest versions are recommended.
- Hardware – The LS1010 and 8540MSR.

Note: A feature card per-flow queueing (FC-PFQ) is mandatory for the LS1010.

Conventions

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

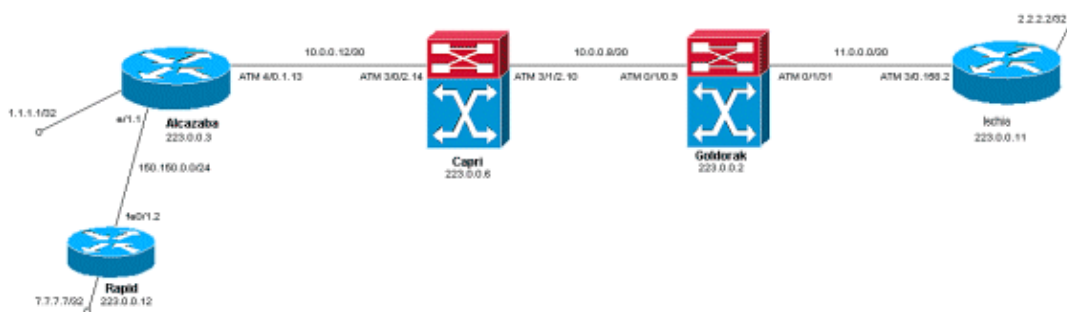
Configure

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

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

Network Diagram

This document uses this network setup:



Configuration Procedure

This document uses this configuration procedure:

1. In order to set up four default LVCs (with default mapping), add this instruction to the ATM subinterface configuration of the edge LSRs:

```
tag-switching atm multi-vc
```

2. The parallel LVCs set up automatically on the ATM switches. In order to classify the packets, use CAR (refer to the CAR documentation) to set the EXPerimental field of the MPLS header to the desired value. This example sets the CoS of all inbound packets on Ethernet 1/1 interface to 1 (and sets the map to "standard"):

```
interface Ethernet1/1
  rate-limit input 8000 1500 200 conform-action set-mpls-exp-transmit 1 exceed-action
```

3. You can also perform traffic control and set the CoS to 2 (map to "premium") for traffic that conforms and to 0 (map to "available") for traffic that exceeds:

```
interface Ethernet1/1
  rate-limit input 64000 8000 16000 conform-action set-mpls-exp-transmit 2 exceed-action
```

Note: You can also use the **tag-switching atm vpi 2-4** command, but it is not mandatory to specify which virtual path identifiers (VPIs) are used for MPLS.

Note: Remember to configure **ip cef** (ip cef distributed on a Cisco 7500) on the general configuration of the routers.

Sample Configurations

This document uses these configurations:

- Rapid
- Alcazaba
- Capri
- Goldorak
- Ischia

Rapid

```
!
interface Loopback0
  ip address 223.0.0.12 255.255.255.255
!
interface Loopback2
  ip address 7.7.7.7 255.255.255.0
!
!
interface FastEthernet0/1
  ip address 150.150.0.2 255.255.255.0
  duplex auto
  speed auto
!
!
router ospf 1
  network 7.7.7.7 0.0.0.0 area 0
  network 150.150.0.0 0.0.0.255 area 0
  network 223.0.0.0 0.0.0.255 area 0
!
```

Alcazaba

```
!
ip cef
!
!
interface Loopback0
  ip address 223.0.0.3 255.255.255.255
!
interface Loopback1
  ip address 1.1.1.1 255.255.255.255
!
interface Ethernet1/1
  ip address 150.150.0.1 255.255.255.0
  rate-limit input 64000 32000 64000 conform-action set-mpls-exp-transmit 2
```

```

exceed-action set-mpls-exp-transmit 1
no ip mroute-cache
!
!
interface ATM4/0
no ip address
no ip mroute-cache
no atm ilmi-keepalive
!
interface ATM4/0.1 tag-switching
ip address 10.0.0.13 255.255.255.252
tag-switching atm multi-vc
tag-switching atm vpi 2-4
tag-switching ip
!
router ospf 1
network 1.1.1.1 0.0.0.0 area 0
network 10.0.0.0 0.0.0.255 area 0
network 150.150.0.0 0.0.0.255 area 0
network 223.0.0.3 0.0.0.0 area 0
!

```

Capri

```

!
interface Loopback1
ip address 223.0.0.6 255.255.255.255
no ip directed-broadcast
!
!
interface ATM3/0/2
ip address 10.0.0.14 255.255.255.252
no ip directed-broadcast
tag-switching atm vpi 2-4
tag-switching ip
!
interface ATM3/1/2
ip address 10.0.0.10 255.255.255.252
no ip directed-broadcast
tag-switching atm vpi 2-4
tag-switching ip
!
router ospf 2
network 10.0.0.0 0.0.0.255 area 0
network 223.0.0.6 0.0.0.0 area 0
!

```

Goldorak

```

!
interface Loopback0
ip address 223.0.0.2 255.255.255.255
no ip directed-broadcast
!
!
interface ATM0/1/0
ip address 10.0.0.9 255.255.255.252
no ip directed-broadcast
tag-switching atm vpi 2-4
tag-switching ip
!
!
interface ATM0/1/3
ip address 11.0.0.1 255.255.255.252
no ip directed-broadcast
tag-switching atm vpi 5-7

```

```
tag-switching ip
!
!
router ospf 1
 network 10.0.0.0 0.0.0.255 area 0
 network 11.0.0.0 0.0.0.255 area 0
 network 223.0.0.2 0.0.0.0 area 0
!
```

Ischia

```
!
ip cef
!
interface Loopback0
 ip address 223.0.0.11 255.255.255.255
!
interface Loopback1
 ip address 2.2.2.2 255.255.255.255
!
!
interface ATM3/0.158 tag-switching
 ip address 11.0.0.2 255.255.255.252
 tag-switching atm multi-vc
 tag-switching atm vpi 5-7
 tag-switching ip
!
router ospf 1
 log-adjacency-changes
 network 2.2.2.2 0.0.0.0 area 0
 network 11.0.0.0 0.0.0.255 area 0
 network 223.0.0.11 0.0.0.0 area 0
!
```

Verify

Use this section to confirm that your configuration works properly.

The Output Interpreter Tool (registered customers only) (OIT) supports certain **show** commands. Use the OIT to view an analysis of **show** command output.

Show Commands

On a router LSR:

- **show tag-switching forwarding-table**
- **show tag-switching forwarding-table detail**

On an ATM switch:

- **show tag-switching atm-tdp bindings**
- **show atm vc interface<interface> <vci/vpi>**

Use this section to confirm that your configuration works properly.

The Output Interpreter Tool (registered customers only) (OIT) supports certain **show** commands. Use the OIT to view an analysis of **show** command output.

Sample Show Output

In order to check multi-VC on an edge LSR, the traditional **show tag-switching forwarding-table** command can be used. In order to specifically check the virtual circuit descriptor (VCD) or virtual path identifier/virtual channel identifier (VPI/VCI), the command must be specific to a destination and must end with the word **detail**.

```
Alcazaba#show tag-switching forwarding-table
Local  Outgoing  Prefix          Bytes tag  Outgoing  Next Hop
tag    tag or VC  or Tunnel Id   switched   interface
16     Untagged  7.7.7.0/24     0          Et1/1     150.150.0.2
17     Untagged  10.0.0.0/16    0          Et1/1     150.150.0.2
18     Untagged  158.0.0.0/8    0          Et1/1     150.150.0.2
19     Untagged  223.0.0.12/32  0          Et1/1     150.150.0.2
20     Untagged  7.7.7.7/32     570       Et1/1     150.150.0.2
21     Multi-VC  10.0.0.8/30    0          AT4/0.1   point2point
25     Multi-VC  2.2.2.2/32     0          AT4/0.1   point2point
32     Multi-VC  223.0.0.2/32  0          AT4/0.1   point2point
34     Multi-VC  223.0.0.6/32  0          AT4/0.1   point2point
36     Multi-VC  11.0.0.0/30    0          AT4/0.1   point2point
37     Multi-VC  223.0.0.11/32  0          AT4/0.1   point2point

Alcazaba#show tag-switching forwarding-table 2.2.2.2 32 detail
Local  Outgoing  Prefix          Bytes tag  Outgoing  Next Hop
tag    tag or VC  or Tunnel Id   switched   interface
25     Multi-VC  2.2.2.2/32     0          AT4/0.1   point2point
      available 2/61(882), standard 2/62(883), premium 2/63(884), control 2/64(885),
      MAC/Encaps=4/8, MTU=4470, Tag Stack{Multi-VC}
      04F48847 004F4000
      Per-packet load-sharing
```

On any ATM LSR, you can also map the different VCs from one interface to another (with the **show tag-switching atm-tdp bindings** command) with their respective service classes (the **show atm vc interface<ATM interface> <vpi> <vci>** command).

```
Capri#show tag-switching atm-tdp bindings
Destination: 2.2.2.2/32
  Transit ATM3/0/2 2/61 Active -> ATM3/1/2 2/69 Active, CoS=available
  Transit ATM3/0/2 2/62 Active -> ATM3/1/2 2/70 Active, CoS=standard
  Transit ATM3/0/2 2/63 Active -> ATM3/1/2 2/71 Active, CoS=premium
  Transit ATM3/0/2 2/64 Active -> ATM3/1/2 2/72 Active, CoS=control
Destination: 10.0.0.8/30
  Tailend Switch ATM3/0/2 2/97 Active -> Terminating Active, CoS=available
  Tailend Switch ATM3/0/2 2/98 Active -> Terminating Active, CoS=standard
  Tailend Switch ATM3/0/2 2/99 Active -> Terminating Active, CoS=premium
  Tailend Switch ATM3/0/2 2/100 Active -> Terminating Active, CoS=control
[...]
Capri#show atm vc interface atm3/0/2 2 63

Interface: ATM3/0/2, Type: oc3suni
VPI = 2  VCI = 63
Status: UP
Time-since-last-status-change: 02:07:24
Connection-type: TVC(0)
Cast-type: multipoint-to-point-output
Packet-discard-option: enabled
Usage-Parameter-Control (UPC): pass
Wrr weight: 2
Number of OAM-configured connections: 0
OAM-configuration: disabled
OAM-states: Not-applicable
Cross-connect-interface: ATM3/1/2, Type: oc3suni
Cross-connect-VPI = 2
```

```

Cross-connect-VCI = 147
Cross-connect-UPC: pass
Cross-connect OAM-configuration: disabled
Cross-connect OAM-state: Not-applicable
Threshold Group: 9, Cells queued: 0
Rx cells: 0, Tx cells: 0
Tx Clp0:0, Tx Clp1: 0
Rx Clp0:0, Rx Clp1: 0
Rx Upc Violations:0, Rx cell drops:0
Rx pkts:0, Rx pkt drops:0
Rx connection-traffic-table-index: 63998
Rx service-category: WRR_3 (WRR Bit Rate)
Rx pcr-clp01: none
Rx scr-clp01: none
Rx mcr-clp01: none
Rx      cdvt: 0 (from default for interface)
Rx      mbs: none
Tx connection-traffic-table-index: 63998
Tx service-category: WRR_3 (WRR Bit Rate)
Tx pcr-clp01: none
Tx scr-clp01: none
Tx mcr-clp01: none
Tx      cdvt: none
Tx      mbs: none

```

In the sample configurations, all packets that conform are sent by the premium LVC. All packets that exceed the CAR rule are sent by the standard LVC. In these first outputs, a standard ping is done and repeated 158 times:

```

rapid#ping
Protocol [ip]:
Target IP address: 2.2.2.2
Repeat count [5]: 158
Datagram size [100]:
Timeout in seconds [2]:
Extended commands [n]:
Sweep range of sizes [n]:
Type escape sequence to abort.
Sending 158, 100-byte ICMP Echos to 2.2.2.2, timeout is 2 seconds:
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
!!!!!!!!!!!!!!!!!!!!!!!!!!!!
Success rate is 100 percent (158/158), round-trip min/avg/max = 1/1/5 ms

```

You can check whether all packets go through the premium LVC with the **show atm vc** command on the edge LSR as in the sample output. In this sample, the premium output VCD is 884.

```

Alcazaba#show atm vc 884
ATM4/0.1: VCD: 884, VPI: 2, VCI: 63
UBR, PeakRate: 155000
AAL5-MUX, etype:0x8847, Flags: 0x40C84, VCmode: 0x0
OAM frequency: 0 second(s)
InARP DISABLED
InPkts: 0, OutPkts: 158, InBytes: 0, OutBytes: 17064
InPRoc: 0, OutPRoc: 0
InFast: 0, OutFast: 158, InAS: 0, OutAS: 0
Giants: 0
OAM cells received: 0
OAM cells sent: 0
Status: UP
Tag VC: local tag: 0

```

You can also check on any ATM switch with the **show atm vc traffic interface <interface> <vpi/vci>** command. In this sample, each ping packet is transported in three cells: 158*3 = 474 cells.

```
Capri#show atm vc traffic interface atm 3/0/2 2 63
Interface      VPI      VCI      Type      rx-cell-cnts      tx-cell-cnts
ATM3/0/2       2        63       TVC(O)     0                  0
ATM3/0/2       2        63       TVC(I)     474                0
```

Related Information

- [Cisco MPLS Controller Software Configuration Guide](#)
 - [CAR Documentation](#)
 - [Technical Support & Documentation – Cisco Systems](#)
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