

差分服务MPLS网络的隧道模式

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简介

本文描述差异化服务(DiffServ)多协议标签交换(MPLS)基于网络环境的建立隧道可用模式的实施。

先决条件

要求

本文档的读者应掌握以下这些主题的相关知识：

- MPLS和MPLS虚拟私有网络(VPN)的
- 与IP优先级、服务类型(ToS)和DiffServ相关的概念
- 服务质量(QoS)数据包标记和分类使用模块化QoS命令行界面CLI (MQC)

使用的组件

本文档中的信息基于以下软件和硬件版本：

- Cisco IOS软件新的QoS功能的[®]版本12.2(13)T。版本12.1(5)T包括原始QoS功能。
- 从3600系列的任何Cisco路由器或以上，例如支持MPLS供应商核心(p)路由器/服务商边缘路由器功能的Cisco 3660或7206。

本文档中的信息都是基于特定实验室环境中的设备编写的。本文档中使用的所有设备最初均采用原

始（默认）配置。如果您使用的是真实网络，请确保您已经了解所有命令的潜在影响。

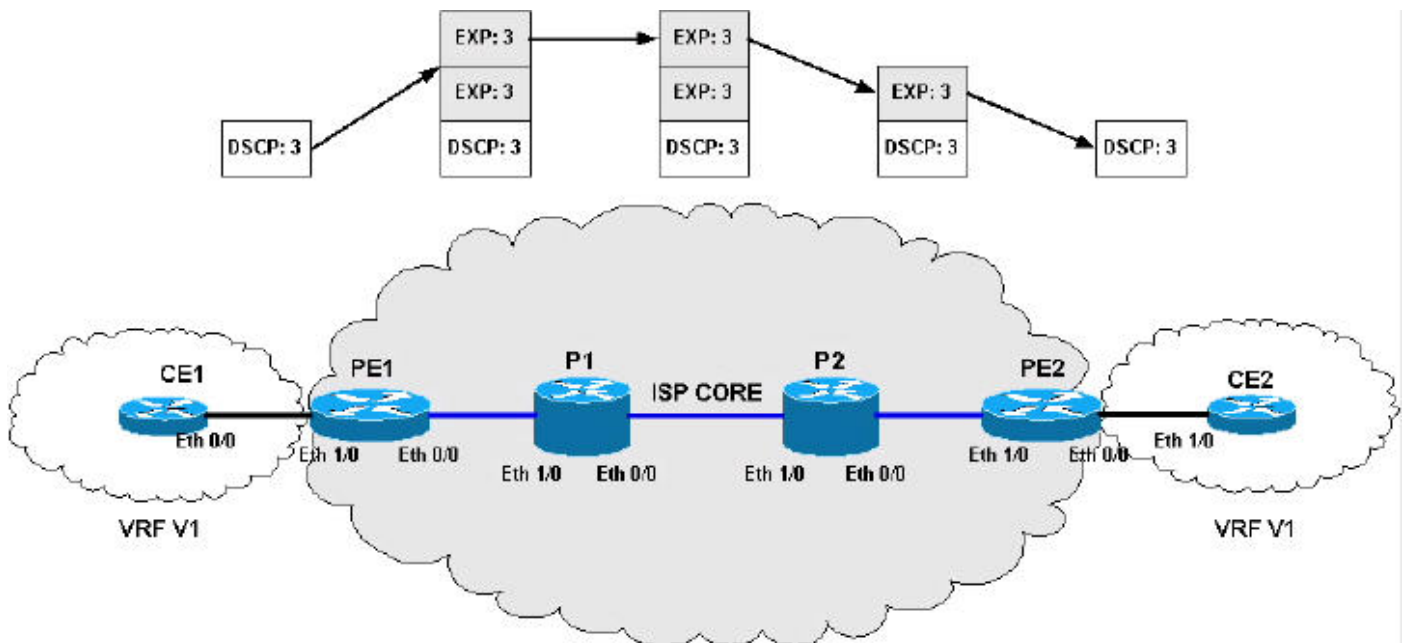
规则

有关文档规则的详细信息，请参阅 [Cisco 技术提示规则](#)。

背景信息

默认行为

此图表描述试验差分服务代码点(DSCP)的/MPLS的默认行为(EXP)位，数据包从一个用户边缘(CE)路由器移动到在MPLS核心间的另一个CE路由器：



此部分此剩余描述在默认行为图表内的活动。

标签(IP的税收- >标签)：

- 流入的IP数据包的IP优先级复制到MPLS EXP位所有被压入的标签。
- DSCP位的第1个三个位复制到MPLS EXP位所有被压入的标签。
- 亦称此技术是Tos反射。

MPLS转发(标签- >标签)：

- EXP复制到在转发或税收时被交换/被压入的新的标签。
- 在标签强制，基础标签没有修改与被添加到当前标签栈的新的标签的值。
- 在标签处理，EXP位没有复制下来到最近显示的标签EXP位。

标签(标签的处理- > IP)：

- 在标签处理EXP位没有复制下来到最近显示的IP数据包的IP precedence/DSCP字段。

前Cisco IOS软件12.2(13)T Usage命令和行为

在IOS版本12.2(13)T前，[set mpls experimental命令](#)是修改MPLS EXP位的方法联机。

发表物Cisco IOS软件12.2(13)T Usage命令和行为

使用IOS版本12.2(13)T和以后， `set mpls experimental`命令修改允许这些选项：

- [设置最上面的MPLS实验](#) `{mpls-exp-value/Qos类别[table table-map-name]}`
- [set mpls experimental imposition](#) `{mpls-exp-value/Qos类别[table table-map-name]}`

注意：新`set mpls experimental topmost`命令与旧有`set mpls imposition`命令是等同的。

在标签推送、交换和弹出操作期间，这两命令，与一些new命令交换机的组合，允许MPLS EXP二进制处理更加好的控制。这两命令允许您使用DiffServ隧道模式。

DiffServ隧道模式

DiffServ隧道模式引入新的每跳行为(PHB)，允许在提供商网络的被区分的QoS。隧道模式在网络的边缘定义，通常在PE标签交换路由器(LSRs) (入口和出口)。您可能需要做P路由器的变动;您也必须考虑什么发生，当最上面的标签从数据包删除由于Penultimate Hop Popping (PHP)时。复制从弹出到最近显示的标签的顶部标签的MPLS EXP值可能是必要的;这总是不适用于所有隧道模式。

有时(例如，无格式Non-VPN MPLS网络)，在最终P路由器的PHP操作能显示一无格式IP数据包，当一数据包用一个标签只接收时。当此IP数据包由出口LSR (PE)接收，分类根据MPLS EXP位的数据包是不可能的，因为当前没有标签。在这些情况下，您必须配置出口PE路由器通告**明确NULL标签**。当PHP操作在P路由器时进行，有值的一个标签为零发送，并且用此特殊标签您能通常标记EXP位作为标记的信息包，允许在出口PE路由器的正确分类。

DiffServ规格MPLS网络支持定义了这些隧道模式：

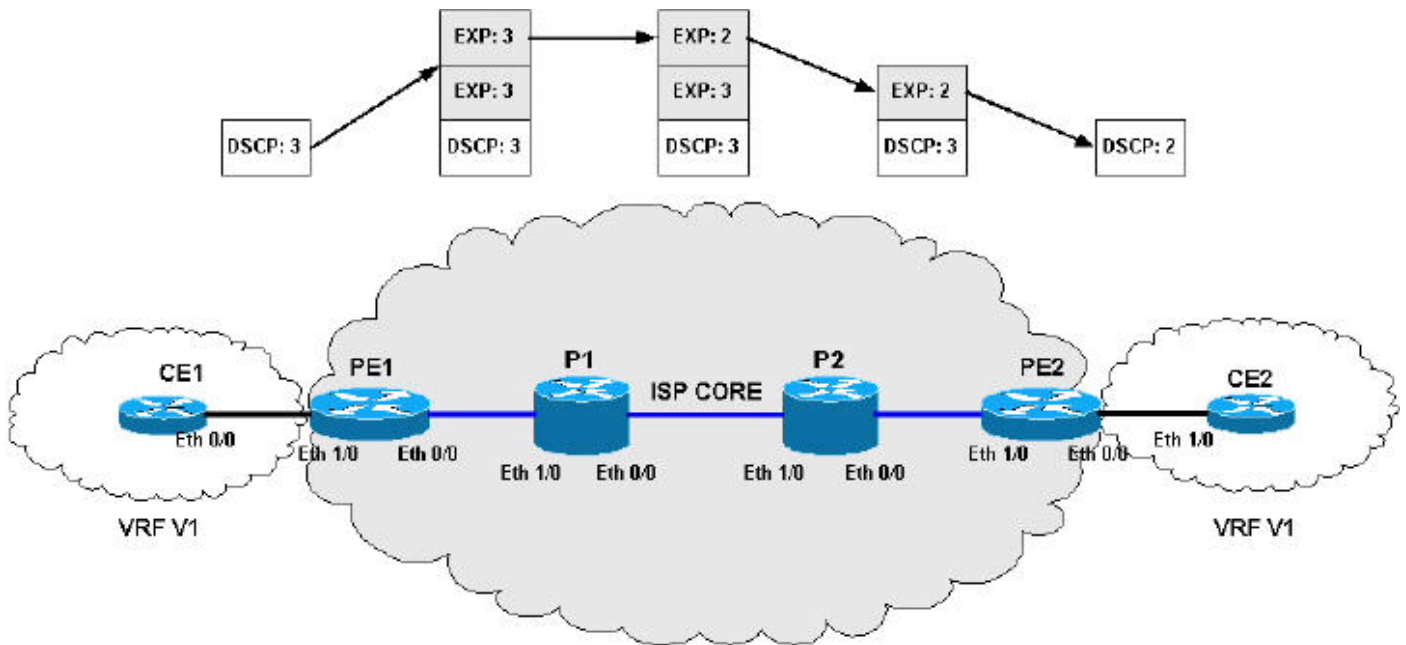
- [统一](#)
- [管道](#)
- [短管道](#)

以下部分分开检查每个隧道模式，并且提供示例显示每个隧道模式如何可以配置。示例包括IP优先级—全双工映射到MPLS EXP位。有一定数量不同的QoS参数和隧道模式每客户的是可能的。

注意：配置示例为MPLS VPN不是特定，并且为无格式MPLS网络和载波支持的载波(Csc)网络是可适用的。也很可能，您的网络能从另一网络变化—可以使用许多不同的QoS参数和隧道模式。

统一模式

建立隧道统一模式的DiffServ只有QoS一块层，到达端到端。入口PE路由器(PE1)复制从流入的IP数据包的DSCP到被强加的标签的MPLS EXP位。当EXP位游遍核心，他们可以或不可以由半成品P路由器修改。在本例中，P路由器P1修改顶部标签的EXP位。在出口P路由器(P2)我们复制EXP位到最近显示的标签的EXP位在PHP (Penultimate-Hop-Pop)以后。最终在出口PE路由器(PE2)我们然后复制EXP位到最近显示的IP数据包的DSCP位。



统一模式配置：

PE1

```

!--- This configuration maps the IP Precedence !--- of
the incoming IP packets to the MPLS EXP bits. class-map
match-all IP-AF11 match ip precedence 0 class-map match-
all IP-AF12 match ip precedence 1 class-map match-all
IP-AF21 match ip precedence 2 class-map match-all IP-
AF22 match ip precedence 3 class-map match-all IP-
AF31 match ip precedence 4 class-map match-all IP-AF32 match
ip precedence 5 class-map match-all MPLS-AF11 match mpls
experimental topmost 0 class-map match-all MPLS-AF12
match mpls experimental topmost 1 class-map match-all
MPLS-AF21 match mpls experimental topmost 2 class-map
match-all MPLS-AF22 match mpls experimental topmost 3
class-map match-all MPLS-AF31 match mpls experimental
topmost 4 class-map match-all MPLS-AF32 match mpls
experimental topmost 5 policy-map set-MPLS-PHB
  class IP-AF11
    police 8000 conform-action set-mpls-exp-imposition-
transmit
                                0 exceed-
action drop
  class IP-AF12
    police 10000 conform-action set-mpls-exp-imposition-
transmit
                                1 exceed-action set-mpls-exp-imposition-
transmit 0
  class IP-AF21
    police 12000 conform-action set-mpls-exp-imposition-
transmit
                                2 exceed-action set-mpls-exp-imposition-
transmit 1
  class IP-AF22
    police 12000 conform-action set-mpls-exp-imposition-
transmit
                                3 exceed-action set-mpls-exp-imposition-
transmit 2
  class IP-AF31

```

```

police 12000 conform-action set-mpls-exp-imposition-
transmit
    4 exceed-action set-mpls-exp-imposition-
transmit 3
class IP-AF32
    police 12000 conform-action set-mpls-exp-imposition-
transmit
    5 exceed-action set-mpls-exp-imposition-
transmit 4

policy-map output-qos
class MPLS-AF11
    bandwidth percent 5
    random-detect
class MPLS-AF12
    bandwidth percent 10
    random-detect
class MPLS-AF21
    bandwidth percent 10
    random-detect
class MPLS-AF22
    bandwidth percent 15
    random-detect
class MPLS-AF31
    bandwidth percent 20
    random-detect
class MPLS-AF32
    bandwidth percent 30
    random-detect

interface Ethernet0/0
ip address 192.168.0.1 255.255.255.0
max-reserved-bandwidth 90
service-policy output output-qos
tag-switching ip
!
interface Ethernet1/0
ip vrf forwarding v1
ip address 10.0.0.2 255.255.255.0
service-policy input set-MPLS-PHB
!

```

P1

```

!--- This configuration swaps the top label from 3 to 2,
!--- which does not need to occur to follow the previous
configuration. class-map match-all mpls-in match mpls
experimental topmost 3 ! policy-map mpls-in
class mpls-in
    set mpls experimental topmost 2
!
interface Ethernet0/0
ip address 192.168.1.1 255.255.255.0
tag-switching ip
!
interface Ethernet1/0
ip address 192.168.0.2 255.255.255.0
service-policy input mpls-in
tag-switching ip
!

```

P2

```
!--- Remember to copy down the MPLS EXP value !--- from
the newly exposed label after the PHP. class-map match-
all MPLS-AF11 match mpls experimental topmost 0 class-
map match-all MPLS-AF12 match mpls experimental topmost
1 class-map match-all MPLS-AF21 match mpls experimental
topmost 2 class-map match-all MPLS-AF22 match mpls
experimental topmost 3 class-map match-all MPLS-AF31
match mpls experimental topmost 4 class-map match-all
MPLS-AF32 match mpls experimental topmost 5 ! class-map
match-all qos-group-AF11 match qos-group 0 class-map
match-all qos-group-AF12 match qos-group 1 class-map
match-all qos-group-AF21 match qos-group 2 class-map
match-all qos-group-AF22 match qos-group 3 class-map
match-all qos-group-AF31 match qos-group 4 class-map
match-all qos-group-AF32 match qos-group 5 ! policy-map
qos-group-in
  class MPLS-AF11
    set qos-group mpls experimental topmost
  class MPLS-AF12
    set qos-group mpls experimental topmost
  class MPLS-AF21
    set qos-group mpls experimental topmost
  class MPLS-AF22
    set qos-group mpls experimental topmost
  class MPLS-AF31
    set qos-group mpls experimental topmost
  class MPLS-AF32
    set qos-group mpls experimental topmost
!
policy-map qos-group-out
  class qos-group-AF11
    bandwidth percent 5
    random-detect
    set mpls experimental topmost qos-group
  class qos-group-AF12
    bandwidth percent 10
    random-detect
    set mpls experimental topmost qos-group
  class qos-group-AF21
    bandwidth percent 10
    random-detect
    set mpls experimental topmost qos-group
  class qos-group-AF22
    bandwidth percent 15
    random-detect
    set mpls experimental topmost qos-group
  class qos-group-AF31
    bandwidth percent 20
    random-detect
    set mpls experimental topmost qos-group
  class qos-group-AF32
    bandwidth percent 30
    random-detect
    set mpls experimental topmost qos-group
!
interface Ethernet0/0
  ip address 192.168.2.1 255.255.255.0
  max-reserved-bandwidth 90
  service-policy output qos-group-out
  tag-switching ip
!
```

```
interface Ethernet1/0
 ip address 192.168.1.2 255.255.255.0
 service-policy input qos-group-in
 tag-switching ip
!
```

PE2

```
!--- Remember to copy down the MPLS EXP bits to the IP
Precedence !--- of the newly exposed IP packet. class-
map match-all MPLS-AF11 match mpls experimental topmost
0 class-map match-all MPLS-AF12 match mpls experimental
topmost 1 class-map match-all MPLS-AF21 match mpls
experimental topmost 2 class-map match-all MPLS-AF22
match mpls experimental topmost 3 class-map match-all
MPLS-AF31 match mpls experimental topmost 4 class-map
match-all MPLS-AF32 match mpls experimental topmost 5 !
class-map match-all qos-group-AF11 match qos-group 0
class-map match-all qos-group-AF12 match qos-group 1
class-map match-all qos-group-AF21 match qos-group 2
class-map match-all qos-group-AF22 match qos-group 3
class-map match-all qos-group-AF31 match qos-group 4
class-map match-all qos-group-AF32 match qos-group 5 !
policy-map qos-group-in
 class MPLS-AF11
   set qos-group mpls experimental topmost
 class MPLS-AF12
   set qos-group mpls experimental topmost
 class MPLS-AF21
   set qos-group mpls experimental topmost
 class MPLS-AF22
   set qos-group mpls experimental topmost
 class MPLS-AF31
   set qos-group mpls experimental topmost
 class MPLS-AF32
   set qos-group mpls experimental topmost
!
policy-map qos-group-out
 class qos-group-AF11
   bandwidth percent 5
   random-detect
   set precedence qos-group
 class qos-group-AF12
   bandwidth percent 10
   random-detect
   set precedence qos-group
 class qos-group-AF21
   bandwidth percent 10
   random-detect
   set precedence qos-group
 class qos-group-AF22
   bandwidth percent 15
   random-detect
   set precedence qos-group
 class qos-group-AF31
   bandwidth percent 20
   random-detect
   set precedence qos-group
 class qos-group-AF32
   bandwidth percent 30
   random-detect
   set precedence qos-group
```

```

!
interface Ethernet0/0
 ip vrf forwarding v1
 ip address 10.0.1.1 255.255.255.0
 max-reserved-bandwidth 90
 service-policy output qos-group-out
!
interface Ethernet1/0
 ip address 192.168.2.2 255.255.255.0
 service-policy input qos-group-in
 tag-switching ip
!

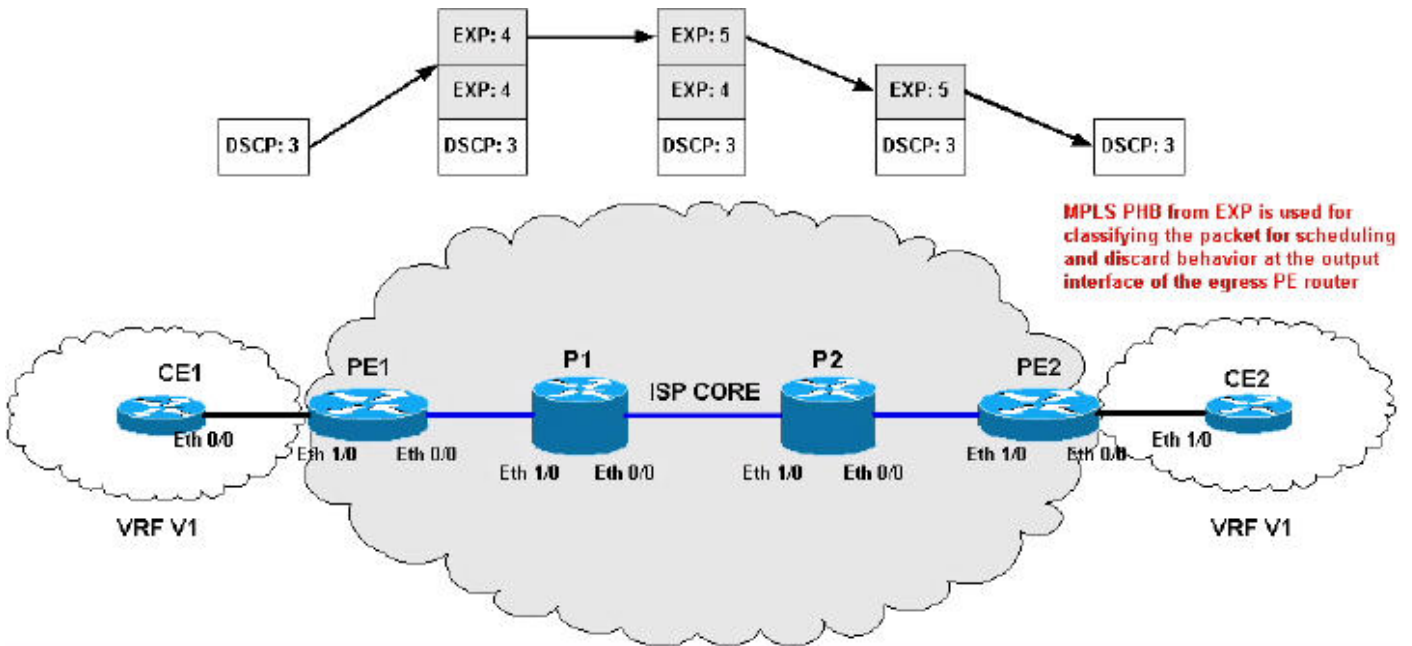
```

管道模式

DiffServ隧道管道模式使用QoS两块层：

1. 数据的基础QoS，依然是不可更改，当横断核心时。
2. 每个核心QoS，是分别于那基础IP信息包。此每个核心QoS PHB保持透明对最终用户。

当数据包到达MPLS核心的边缘时，出口PE路由器(PE2)分类根据从最近已经删除标签的EXP位的MPLS PHB的出站队列的最近显示的IP信息包。



管道模式配置：

PE1

```

!--- On input, the IP Precedence is copied to the MPLS
EXP !--- on label imposition and when leaving the
router, the !--- MPLS EXP bits are used to classify the
traffic into three !--- traffic classes-gold, silver,
and bronze (the topmost). class-map match-all IP-AF22
match ip precedence 0 1 class-map match-all IP-AF31
match ip precedence 2 3 class-map match-all IP-AF32
match ip precedence 4 5 ! class-map match-all bronze
match mpls experimental topmost 2 3 class-map match-all
silver match mpls experimental topmost 4 class-map
match-all gold match mpls experimental topmost 5 !

```



```

policy-map set-MPLS-PHB
  class IP-AF22
    police 12000 conform-action set-mpls-exp-imposition-
transmit
      3 exceed-action set-mpls-exp-imposition-
transmit 2
    class IP-AF31
      police 12000 conform-action set-mpls-exp-imposition-
transmit
        4 exceed-action set-mpls-exp-imposition-
transmit 3
    class IP-AF32
      police 12000 conform-action set-mpls-exp-imposition-
transmit
        5 exceed-action set-mpls-exp-imposition-
transmit 4
  !
policy-map output-qos
  class gold
    bandwidth 40
    random-detect
  class silver
    bandwidth 30
    random-detect
  class bronze
    bandwidth 20
    random-detect
  !
interface Ethernet0/0
  ip address 192.168.0.1 255.255.255.0
  max-reserved-bandwidth 90
  service-policy output output-qos
  tag-switching ip
  !
interface Ethernet1/0
  ip vrf forwarding v1
  ip address 10.0.0.2 255.255.255.0
  service-policy input set-MPLS-PHB
  !

```

P1

```

!--- This configuration swaps the top label from 4 to 5,
!--- which does not need to occur to follow the previous
configuration. class-map match-all mpls-in match mpls
experimental topmost 4 ! policy-map mpls-in
  class mpls-in
    set mpls experimental topmost 5
  !
interface Ethernet0/0
  ip address 192.168.1.1 255.255.255.0
  tag-switching ip
  !
interface Ethernet1/0
  ip address 192.168.0.2 255.255.255.0
  service-policy input mpls-in
  tag-switching ip
  !

```

P2

```

!--- Remember to copy down the MPLS EXP value from !---
the newly exposed label after the PHP. class-map match-
all MPLS-AF11 match mpls experimental topmost 0 class-
map match-all MPLS-AF12 match mpls experimental topmost
1 class-map match-all MPLS-AF21 match mpls experimental
topmost 2 class-map match-all MPLS-AF22 match mpls
experimental topmost 3 class-map match-all MPLS-AF31
match mpls experimental topmost 4 class-map match-all
MPLS-AF32 match mpls experimental topmost 5 ! class-map
match-all gold match qos-group 5 class-map match-all
silver match qos-group 4 class-map match-all bronze
match qos-group 3 match qos-group 2 ! policy-map qos-
group-in
  class MPLS-AF11
    set qos-group mpls experimental topmost
  class MPLS-AF12
    set qos-group mpls experimental topmost
  class MPLS-AF21
    set qos-group mpls experimental topmost
  class MPLS-AF22
    set qos-group mpls experimental topmost
  class MPLS-AF31
    set qos-group mpls experimental topmost
  class MPLS-AF32
    set qos-group mpls experimental topmost
!
policy-map qos-group-out
  class gold
    bandwidth 40
    random-detect
    set mpls experimental topmost qos-group
  class silver
    bandwidth 30
    random-detect
    set mpls experimental topmost qos-group
  class bronze
    bandwidth 20
    random-detect
    set mpls experimental topmost qos-group
!
interface Ethernet0/0
  ip address 192.168.2.1 255.255.255.0
  max-reserved-bandwidth 90
  service-policy output qos-group-out
  tag-switching ip
!
interface Ethernet1/0
  ip address 192.168.1.2 255.255.255.0
  service-policy input qos-group-in
  tag-switching ip
!

```

PE2

!--- Remember to queue the newly exposed IP packet based in !--- the MPLS EXP bits of the label we just removed. Use !--- qos-groups to keep track of this value.

```

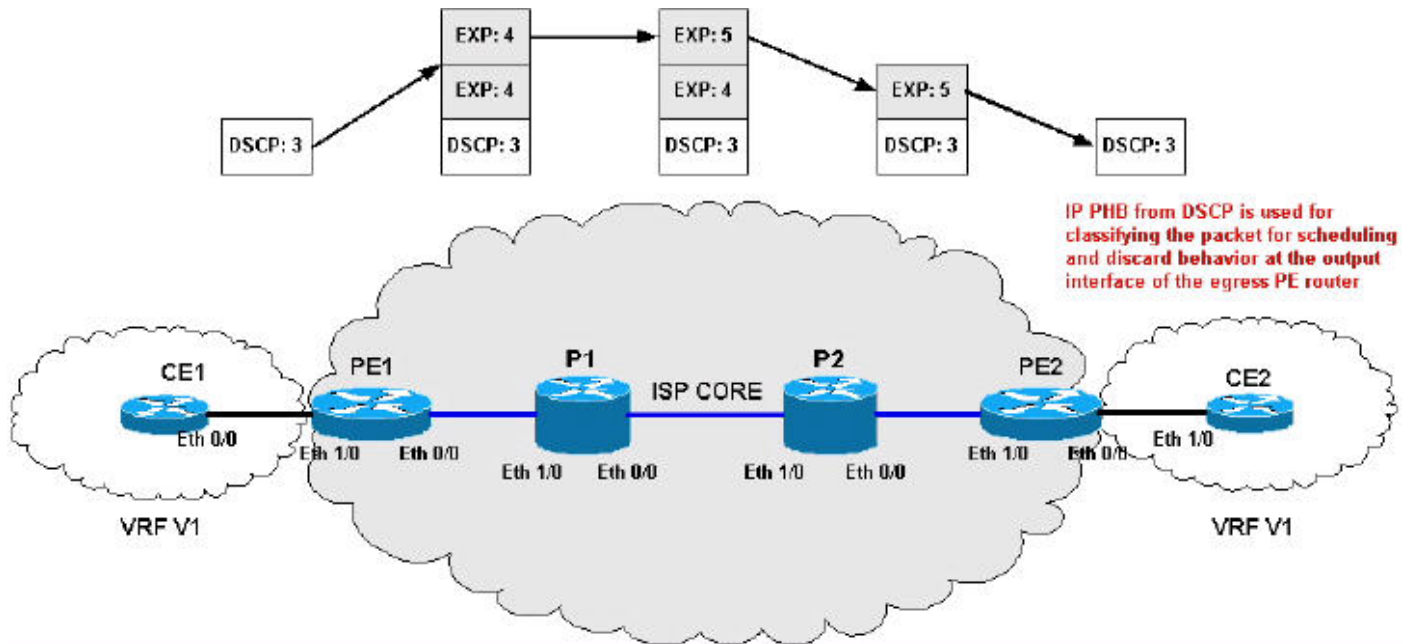
class-map match-all MPLS-AF11
  match mpls experimental topmost 0
class-map match-all MPLS-AF12
  match mpls experimental topmost 1

```

```
class-map match-all MPLS-AF21
  match mpls experimental topmost 2
class-map match-all MPLS-AF22
  match mpls experimental topmost 3
class-map match-all MPLS-AF31
  match mpls experimental topmost 4
class-map match-all MPLS-AF32
  match mpls experimental topmost 5
!
class-map match-all gold
  match qos-group 5
class-map match-all silver
  match qos-group 4
class-map match-all bronze
  match qos-group 3
  match qos-group 2
!
policy-map qos-group-in
  class MPLS-AF11
    set qos-group mpls experimental topmost
    set discard-class 0
  class MPLS-AF12
    set qos-group mpls experimental topmost
    set discard-class 1
  class MPLS-AF21
    set qos-group mpls experimental topmost
    set discard-class 2
  class MPLS-AF22
    set qos-group mpls experimental topmost
    set discard-class 3
  class MPLS-AF31
    set qos-group mpls experimental topmost
    set discard-class 4
  class MPLS-AF32
    set qos-group mpls experimental topmost
    set discard-class 5
!
policy-map qos-group-out
  class gold
    bandwidth 40
    random-detect discard-class-based
  class silver
    bandwidth 30
    random-detect discard-class-based
  class bronze
    bandwidth 20
    random-detect discard-class-based
!
interface Ethernet0/0
  ip vrf forwarding v1
  ip address 10.0.1.1 255.255.255.0
  max-reserved-bandwidth 90
  service-policy output qos-group-out
!
interface Ethernet1/0
  ip address 192.168.2.2 255.255.255.0
  service-policy input qos-group-in
  tag-switching ip
!
```

短管道模式

建立隧道短管道模式的DiffServ使用同样规则和技术在核心间。差异在出口PE路由器(PE2) —您分类根据从DSCP值的IP PHB的出站队列的最近显示的IP信息包此IP数据包。



短管道模式配置：

```

PE1

!--- On input, the IP Precedent is copied to the MPLS
EXP !--- on label imposition. When leaving the router,
the !--- MPLS EXP bits are used to classify the traffic
into three !--- traffic classes-gold, silver and bronze
(the topmost). class-map match-all IP-AF22 match ip
precedence 0 1 class-map match-all IP-AF31 match ip
precedence 2 3 class-map match-all IP-AF32 match ip
precedence 4 5 ! class-map match-all bronze match mpls
experimental topmost 2 3 class-map match-all silver
match mpls experimental topmost 4 class-map match-all
gold match mpls experimental topmost 5 ! policy-map set-
MPLS-PHB
  class IP-AF22
    police 12000 conform-action set-mpls-exp-imposition-
transmit
                3 exceed-action set-mpls-exp-imposition-
transmit 2
  class IP-AF31
    police 12000 conform-action set-mpls-exp-imposition-
transmit
                4 exceed-action set-mpls-exp-imposition-
transmit 3
  class IP-AF32
    police 12000 conform-action set-mpls-exp-imposition-
transmit
                5 exceed-action set-mpls-exp-imposition-
transmit 4
!
policy-map output-qos
  class gold
    bandwidth 40
    random-detect
  class silver

```

```

bandwidth 30
random-detect
class bronze
bandwidth 20
random-detect
!
interface Ethernet0/0
ip address 192.168.0.1 255.255.255.0
max-reserved-bandwidth 90
service-policy output output-qos
tag-switching ip
!
interface Ethernet1/0
ip vrf forwarding v1
ip address 10.0.0.2 255.255.255.0
service-policy input set-MPLS-PHB
!

```

P1

```

!--- This configuration swaps the top label from 4 to 5,
!--- which does not need to occur to follow the previous
configuration. class-map match-all mpls-in match mpls
experimental topmost 4 ! policy-map mpls-in
class mpls-in
set mpls experimental topmost 5
!
interface Ethernet0/0
ip address 192.168.1.1 255.255.255.0
tag-switching ip
!
interface Ethernet1/0
ip address 192.168.0.2 255.255.255.0
service-policy input mpls-in
tag-switching ip
!

```

P2

```

!--- Remember to copy down the MPLS EXP value from !---
the newly exposed label after the PHP. class-map match-
all MPLS-AF11 match mpls experimental topmost 0 class-
map match-all MPLS-AF12 match mpls experimental topmost
1 class-map match-all MPLS-AF21 match mpls experimental
topmost 2 class-map match-all MPLS-AF22 match mpls
experimental topmost 3 class-map match-all MPLS-AF31
match mpls experimental topmost 4 class-map match-all
MPLS-AF32 match mpls experimental topmost 5 ! class-map
match-all gold match qos-group 5 class-map match-all
silver match qos-group 4 class-map match-all bronze
match qos-group 3 match qos-group 2 ! policy-map qos-
group-in
class MPLS-AF11
set qos-group mpls experimental topmost
class MPLS-AF12
set qos-group mpls experimental topmost
class MPLS-AF21
set qos-group mpls experimental topmost
class MPLS-AF22
set qos-group mpls experimental topmost
class MPLS-AF31

```

```

    set qos-group mpls experimental topmost
class MPLS-AF32
    set qos-group mpls experimental topmost
!
policy-map qos-group-out
class gold
    bandwidth 40
    random-detect
    set mpls experimental topmost qos-group
class silver
    bandwidth 30
    random-detect
    set mpls experimental topmost qos-group
class bronze
    bandwidth 20
    random-detect
    set mpls experimental topmost qos-group
!
interface Ethernet0/0
    ip address 192.168.2.1 255.255.255.0
    max-reserved-bandwidth 90
    service-policy output qos-group-out
    tag-switching ip
!
interface Ethernet1/0
    ip address 192.168.1.2 255.255.255.0
    service-policy input qos-group-in
    tag-switching ip
!

```

PE2

```

!--- Remember to queue the newly exposed IP packet !---
based on the value of the IP Precedent. class-map match-
all gold match precedence 4 5 class-map match-all silver
match precedence 2 3 class-map match-all bronze match
precedence 0 1 ! policy-map qos-group-out
class gold
    bandwidth 40
    random-detect prec-based
class silver
    bandwidth 30
    random-detect prec-based
class bronze
    bandwidth 20
    random-detect prec-based
!
interface Ethernet0/0
    ip vrf forwarding v1
    ip address 10.0.1.1 255.255.255.0
    max-reserved-bandwidth 90
    service-policy output qos-group-out
!
interface Ethernet1/0
    ip address 192.168.2.2 255.255.255.0
    tag-switching ip
!

```

隧道模式摘要

此表汇总应用到IP或标记的信息包在网络的多种阶段的多种操作：

隧道模式	IP -> 标签	标签 -> 标签	标签 -> IP
统一	复制IP Prec/DiffServ到 MPLS EXP里 (可以由SP也更改)	MPLS EXP可能由 SP更改	MPLS EXP复制对IP Prec/DiffServ
管道	SP QoS策略设置的MPLS EXP		原始IP保留的 Prec/DiffServ (根据 MPLS EXP)的出口 队列
短管道			原始IP保留的 Prec/DiffServ (在IP Prec/DiffServ根据的 出口队列)

相关信息

- [Cisco IOS软件- MPLS](#)
- [问&A -多协议标签交换网络的服务质量](#)
- [Cisco IOS交换服务命令参考, 版本12.2](#)
- [Cisco IOS服务质量解决方案配置指南, 版本12.2](#)
- [Cisco IOS服务质量解决方案命令参考, 版本12.2](#)
- [MPLS 支持页](#)
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