

第十一章队列和拥塞

11.1. Fast Switching 和 CEF

提问 给路由器配置最有效的包交换算法

回答

Fast Switching 缺省是启用的

```
Router#configure terminal
```

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

```
Router(config)#interface FastEthernet0/0
```

```
Router(config-if)#ip route-cache
```

```
Router(config-if)#exit
```

```
Router(config)#end
```

```
Router#
```

如果使用策略，需要下面的命令

```
Router#configure terminal
```

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

```
Router(config)#interface FastEthernet0/0
```

```
Router(config-if)#ip route-cache policy
```

```
Router(config-if)#exit
```

```
Router(config)#end
```

```
Router#
```

CEF 缺省是没有启用的，全局和端口启用

```
Router#configure terminal
```

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

```
Router(config)#ip cef
```

```
Router(config)#interface FastEthernet0/0
```

```
Router(config-if)#ip route-cache cef
```

```
Router(config-if)#exit
```

```
Router(config)#end
```

```
Router#
```

注释 除了上面的 policy 参数以外，还有下面的参数来保证进出是同一物理接口

```
Router(config)#interface Serial0/0
```

```
Router(config-if)#ip route-cache same-interface
```

可以使用下面命令进行验证 show cef interface show cef drop 和 show cef not-cef-switched show ip cef

11.8. 使用 NBAR

提问 使用 NBAR (Network Based Application Recognition) 在应用层对数据进行识别和分类

回答

```
Router1#configure terminal
```

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

```
Router1(config)#ip cef
```

```
Router1(config)#class-map INTERACTIVE
```

```
Router1(config-cmap)#match protocol citrix
```

```
Router1(config-cmap)#match protocol telnet
```

```
Router1(config-cmap)#exit
```

```
Router1(config)#policy-map QoSPolicy
```

```
Router1(config-pmap)#class INTERACTIVE
```

```
Router1(config-pmap-c)#bandwidth percent 50
```

```
Router1(config-pmap-c)#set dscp ef
```

```
Router1(config-pmap-c)#exit
```

```
Router1(config-pmap)#class class-default
```

```
Router1(config-pmap-c)#bandwidth percent 20
```

```
Router1(config-pmap-c)#random-detect dscp-based
```

```
Router1(config-pmap-c)#exit
```

```
Router1(config-pmap)#exit
```

```
Router1(config)#interface FastEthernet0/0
```

```
Router1(config-fi)#service-policy inbound QoSPolicy
```

```
Router1(config-if)#exit
```

```
Router1(config)#end
```

```
Router1#
```

思科支持在网上下载 PDLM (Packet Description Language Module) 来激活 NBAR 分类

```
Router1#show flash
```

System flash directory:

File	Length	Name/status
------	--------	-------------

1	23169076	c2600-ipvoice-mz.124-10.bin
---	----------	-----------------------------

2	3100	bittorrent.pdlm
---	------	-----------------

[23172304 bytes used, 9857836 available, 33030140 total]

32768K bytes of processor board System flash (Read/Write)

```
Router1#Router1#configure terminal
```

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

```
Router1(config)#ip nbar pdlm flash://bittorrent.pdlm
```

```
Router1(config)#class-map BITTORRENT
```

```
Router1(config-cmap)#match protocol bittorrent
```

```
Router1(config-cmap)#exit
```

```
Router1(config)#end
```

```
Router1#
```

也可以使用 NBAR 来自动对网络协议进行分类统计

```
Router1#configure terminal
```

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

```
>Router1(config)#interface FastEthernet0/0
```

```
Router1(config-if)#ip nbar protocol-discovery
```

```
Router1(config-if)#exit
```

```
Router1(config)#end
```

```
Router1#
```

注释 NBAR 会增加 CPU 利用率。Router1#show ip nbar protocol-discovery top-n 5 可以显示出 NBAR 所识别各个协议数据统计

```
<!--[if !supportLists]-->11.9. <!--[endif]-->使用 WRED 来控制拥塞
```

提问

回答

```
Router#configure terminal
```

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

```
Router(config)#class-map Prec5
```

```
Router(config-cmap)#description Critical
```

```
Router(config-cmap)#match ip precedence 5
```

```
Router(config-cmap)#exit
```

```
Router(config)#policy-map cb_wred

Router(config-pmap)#class Prec5

Router(config-pmap-c)#random-detect dscp-based

Router(config-pmap-c)#exit

Router(config-pmap)#class class-default

Router(config-pmap-c)#fair-queue 512

Router(config-pmap-c)#queue-limit 96

Router(config-pmap-c)#random-detect dscp-based

Router(config-pmap-c)#exit

Router(config-pmap)#exit

Router(config)#interface HSSI0/1

Router(config-if)#service-policy output cb_wred

Router(config-if)#exit

Router(config)#end

Router#
```

注释

11.10. 使用 RSVP

提问 在网络中启用 RSVP

回答

```
Router#configure terminal

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

Router(config)#access-list 15 permit ip 192.168.1.0 0.0.0.255

Router(config)#interface FastEthernet0/0
```

```
Router(config-if)#ip rsvp bandwidth 128 56
```

```
Router(config-if)#ip rsvp neighbor 15
```

```
Router(config-if)#exit
```

```
Router(config)#end
```

```
Router#
```

注释 配置 RSVP 之前，接口要配置 WFQ, CBWFQ, 或者 WRED

11.11. Manual RSVP Reservations

提问

回答

Sender 主机 (192.168.100.202) 连接 R1

```
Router1#configure terminal
```

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

```
Router1(config)#interface FastEthernet0/0
```

```
Router1(config-if)#ip address 192.168.100.21 255.255.255.0
```

```
Router1(config-if)#ip rsvp bandwidth 128 56
```

```
Router1(config-if)#exit
```

```
Router1(config)#interface Serial0/0
```

```
Router1(config-if)#no ip address
```

```
Router1(config-if)#encapsulation frame-relay
```

```
Router1(config-if)#fair-queue 64 256 37
```

```
Router1(config-if)#ip rsvp bandwidth
```

```
Router1(config-if)#exit
```

```
Router1(config)#interface Serial0/0.1 point-to-point
```

```
Router1(config-subif)#ip address 192.168.55.9 255.255.255.252
```

```
Router1(config-subif)#frame-relay interface-dlci 904
```

```
Router1(config-fr-dlci)#ip rsvp bandwidth 128 56
```

```
Router1(config-subif)#exit
```

```
Router1(config)#ip rsvp sender 192.168.9.100 192.168.100.202 UDP 1300 1300 192.168.100.202  
FastEthernet0/0 55 1
```

```
Router1(config)#end
```

```
Router1#
```

Receiver 主机 (192.168.9.100) 连接 R4

```
Router4# configure terminal
```

```
Router4(config)#interface Ethernet0/0
```

```
Router4(config-if)#ip address 192.168.9.3 255.255.255.0
```

```
Router4(config-if)#ip rsvp bandwidth 128 56
```

```
Router4(config-if)#exit
```

```
Router4(config)#interface Serial0/0  
s="MsoNormal">Router4(config-if)#no ip address
```

```
Router4(config-if)#encapsulation frame-relay
```

```
Router4(config-if)#fair-queue 64 256 37
```

```
Router4(config-if)#ip rsvp bandwidth
```

```
Router4(config-if)#exit
```

```
Router4(config)#interface Serial0/0.1 point-to-point
```

```
Router4(config-subif)#ip address 192.168.56.5 255.255.255.252
```

```
Router4(config-subif)#frame-relay interface-dlci 107
```

```
Router4(config-fr-dlci)#ip rsvp bandwidth 128 56
```

```
Router4(config-subif)#exit
```

```
Router4(config)#ip rsvp reservation 192.168.9.100 192.168.100.202 UDP 1300 1300 192.168.9.100  
Ethernet0/0 FF RATE 55 1
```

```
Router4(config)#end
```

```
Router4#
```

注释

11.12. 聚合 RSVP 的预留 (Aggregating RSVP Reservations)

提问 聚合多个 RSVP 这样核心网络不需要对每个数据流进行追踪

回答

```
Router2#configure terminal
```

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

```
Router2(config)#interface FastEthernet0/0
```

```
Router2(config-if)#ip address 192.168.101.1 255.255.255.0
```

```
Router2(config-if)#ip rsvp bandwidth 128 56
```

```
Router2(config-if)#ip rsvp data-packet classification none
```

```
Router2(config-if)#ip rsvp resource-provider none
```

```
Router2(config-if)#exit
```

```
Router2(config)#interface Serial0/0.1 point-to-point
```

```
Router2(config-subif)#ip address 192.168.55.10 255.255.255.252
```

```
Router2(config-subif)#frame-relay interface-dlci 409
```

```
Router2(config-fr-dlci)#ip rsvp bandwidth 128 56
```

```
Router2(config-subif)#ip rsvp data-packet classification none
```

```
Router2(config-subif)#ip rsvp resource-provider none
```

```
Router2(config-subif)#exit
```

```
Router2(config)#end
```


Router2#

注释 RSVP 扩展性不强，对于核心网络还是使用传统的 DSCP 标记方式，12.2(2)T 的 IOS 引入了新的办法来解决此问题，核心路由器配置 RSVP 来支持 RSVP Requests，但是队列的时候不需要使用 RSVP 的信息

11.13. Using Generic Traffic Shaping

提问

回答

注释

11.14. Using Frame-Relay Traffic Shaping

提问

回答

注释

11.15. Using Committed Access Rate

提问

回答

注释

11.16. 部署基于标准的 PHB (Per-Hop Behavior)

提问 配置基于规范的根据 DSCP 位的 PHB

回答

```
Router#configure terminal
```

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

```
Router(config)#class-map EF
```

```
Router(config-cmap)#description Real-time application traffic
```

```
Router(config-cmap)#match ip precedence 5
```

```
Router(config-cmap)#exit

Router(config)#class-map AF1x

Router(config-cmap)#description Priority Class 1

Router(config-cmap)#match ip precedence 1

Router(config-cmap)#exit

Router(config)#class-map AF2x

Router(config-cmap)#description Priority Class 2

Router(config-cmap)#match ip precedence 2

Router(config-cmap)#exit

Router(config)#class-map AF3x

Router(config-cmap)#description Priority Class 3

Router(config-cmap)#match ip precedence 3

Router(config-cmap)#exit

Router(config)#class-map AF4x

Router(config-cmap)#description Priority Class 4

Router(config-cmap)#match ip precedence 4

Router(config-cmap)#exit

Router(config)#policy-map cbwfq_pq

Router(config-pmap)#class EF

Router(config-pmap-c)#priority 58 800

Router(config-pmap-c)#exit

Router(config-pmap)#class AF1x

Router(config-pmap-c)#bandwidth percent 15

Router(config-pmap-c)#random-detect dscp-based
```

```
Router(config-pmap-c)#exit

Router(config-pmap)#class AF2x

Router(config-pmap-c)#bandwidth percent 15

Router(config-pmap-c)#random-detect dscp-based

Router(config-pmap-c)#exit

Router(config-pmap)#class AF3x

Router(config-pmap-c)#bandwidth percent 15

Router(config-pmap-c)#random-detect dscp-based

Router(config-pmap-c)#exit

Router(config-pmap)#class AF4x

Router(config-pmap-c)#bandwidth percent 15

Router(config-pmap-c)#random-detect dscp-based

Router(config-pmap-c)#exit

Router(config-pmap)#class class-default

Router(config-pmap-c)#fair-queue 512

Router(config-pmap-c)#queue-limit 96

Router(config-pmap-c)#exit

Router(config-pmap)#exit

Router(config)#interface HSSI0/1

Router(config-if)#service-policy output cbwfpolicy

Router(config-if)#exit

Router(config)#end

Router#
```

注释

11.17. AutoQoS

提问 配置路由器自动生成 Voip 或者一般数据包的 QoS 策略配置

回答

一种是针对 VoIP 数据的

```
Router1#configure terminal
```

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

```
Router1(config)#ip cef
```

```
Router1(config)#interface Serial0/0
```

```
Router1(config-if)#no ip address
```

```
Router1(config-if)#encapsulation frame-relay
```

```
Router1(config-if)#exit
```

```
Router1(config)#interface Serial0/0.1 point-to-point
```

```
Router1(config-subif)#ip address 192.168.55.9 255.255.255.252
```

```
Router1(config-subif)#frame-relay interface-dlci 904
```

```
Router1(config-fr-dlci)#auto qos voip
```

```
%Creating new map-class.
```

```
Router1(config-fr-dlci)#exit
```

```
Router1(config-subif)#exit
```

```
Router1(config)#end
```

```
Router1#
```

```
*Mar 1 01:32:55.031: %RMON-5-FALLINGTRAP: Falling trap is generated because the
```

```
value of cbQosCMDropBitRate.1169.1171 has fallen below the falling-threshold va
```

```
lue 0
```

```
Router1#
```

针对一般的 IP 数据包，第一步是流量模式的收集

```
Router1#configure terminal
```

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

```
Router1(config)#ip cef
```

```
Router1(config)#interface Serial0/0
```

```
Router1(config-if)#no ip address
```

```
Router1(config-if)#encapsulation frame-relay
```

```
Router1(config-if)#exit
```

```
Router1(config)#interface Serial0/0.1 point-to-point
```

```
Router1(config-subif)#ip address 192.168.55.9 255.255.255.252
```

```
Router1(config-subif)#frame-relay interface-dlci 904
```

```
Router1(config-fr-dlci)#auto discovery qos
```

```
Router1(config-fr-dlci)#exit
```

```
Router1(config-subif)#exit
```

```
Router1(config)#end
```

```
Router1#
```

第二步是生成策略

```
Router1#configure terminal
```

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

```
Router1(config)#interface Serial0/0.1 point-to-point
```

```
Router1(config-subif)#frame-relay interface-dlci 904
```

```
Router1(config-fr-dlci)#auto qos
```

```
%Creating new map-class.
```

```
Router1(config-fr-dlci)#no auto discovery qos
```

```
Router1(config-fr-dlci)#exit
```

```
Router1(config-subif)#exit
```

```
Router1(config)#end
```

```
Router1#
```

注释 AutoQoS 很好，但是有下面几个限制：只能针对点对点的链路，不能和 frame map 或者 virtual templates 一起使用，不能用于 SVC，两端必须同时配置，必须禁止掉所有的服务策略或者 access-groups 即使用于其他的端口，要启用 CEF

针对 VoIP 的 AutoQoS 引自 12.2(15)T，通过一个宏来生成配置，可以用 show auto qos 来查看。针对通用 IP 数据流的引自 12.3(7)T，自动针对数据流分类至十个不同类别，要先用 auto qos 然后再 no 掉原来的 discovery。注意的是你如果后来想不用 auto qos 了，虽然可以 no auto qos 但是还是有很多配置是没法自动清除的，记得要保存之前的 show auto qos 的输出。AutoQoS 不是万能的，要慎用

```
<!--[if !supportLists]-->11.18. <!--[endif]-->查看队列参数
```

提问 查看当前端口的队列配置

回答

```
Router#show queue FastEthernet0/0
```

```
Router#show queuing
```

注释 配置优先级队列或者自定义队列的时候 show queue 命令没有相应的输出

11.2. 设置 DSCP 或者 TOS 位

提问 路由器标记特定数据包的 DSCP 或者 TOS 位

回答

```
Router#configure terminal
```

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

```
Router(config)#access-list 101 permit any eq ftp any
```

```
Router(config)#access-list 101 permit any any eq ftp
```

```
Router(config)#access-list 102 permit any eq ftp-data any
```

```
Router(config)#access-list 102 permit any any eq ftp-data
```

```
Router(config)#class-map match-all ser00-ftpcontrol

Router(config-cmap)#description branch ftp control traffic

Router(config-cmap)#match input-interface serial0/0

Router(config-cmap)#match access-group 101

Router(config-cmap)#exit

Router(config)#class-map match-all ser00-ftpdata

Router(config-cmap)#description branch ftp data traffic

Router(config-cmap)#match input-interface serial0/0

Router(config-cmap)#match access-group 102

Router(config-cmap)#exit

Router(config)#policy-map serialftppolicy

Router(config-pmap)#description branch ftp traffic policy

Router(config-pmap)#class ser00-ftpcontrol

Router(config-pmap-c)#set ip precedence immediate

Router(config-pmap-c)#exit

Router(config-pmap)#class ser00-ftpdata

Router(config-pmap-c)#set ip precedence priority

Router(config-pmap-c)#exit

Router(config-pmap)#exit

Router(config)#interface serial0/0

Router(config-if)#ip route-cache policy

Router(config-if)#service-policy input serialftppolicy

Router(config-if)#exit

Router(config)#end
```

Router#

注释 先使用 classmap 来定义特殊的数据流，然后使用 policymap 来对 TOS 位进行标记

11.3. 使用优先级队列(Priority Queuing)

提问 使用优先级队列这种严格的方式来保证高优先级的数据先被处理

回答

```
Router#configure terminal
```

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

```
Router(config)#access-list 101 permit ip any any precedence 5 tos 12
```

```
Router(config)#access-list 102 permit ip any any precedence 4
```

```
Router(config)#access-list 103 permit ip any any precedence 3
```

```
Router(config)#priority-list 1 protocol ip high list 101
```

```
Router(config)#priority-list 1 protocol ip medium list 102
```

```
Router(config)#priority-list 1 protocol ip normal list 103
```

```
Router(config)#priority-list 1 default low
```

```
Router(config)#interface Ethernet0
```

```
Router(config-if)#priority-group 1
```

```
Router(config-if)#exit
```

```
Router(config)#end
```

Router#

注释 单纯使用优先级队列可能会导致高优先级的数据占用掉所有的带宽。precedence 5 tos 12 等同于 dscp ef

缺省情况下会被不匹配的数据包归入到 normal 优先级队列，本例中特别配置其归入了 low 优先级队列。Show interface 命令可以看到缺省各个队列大小（high 优先级为 20 个，medium 为 40 个，依次递增）

Output queue (queue priority: size/max/drops):

high: 0/20/0, medium: 0/40/0, normal 0/60/0, low 0/80/0

可以使用 Router(config)#priority-list 1 queue-limit 10 15 25 35 命令来修改。建议使用 LLQ 或者 CBWFQ 来替代单纯的优先级队列

11.4. 使用自定义队列 (Custom Queuing)

提问 根据数据流中 IP 优先级的不同来自定义队列共享带宽

回答

```
Router#configure terminal
```

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

```
Router(config)#access-list 103 permit ip any any precedence 5
```

```
Router(config)#access-list 104 permit ip any any precedence 4
```

```
Router(config)#access-list 105 permit ip any any precedence 3
```

```
Router(config)#access-list 106 permit ip any any precedence 2
```

```
Router(config)#access-list 107 permit ip any any precedence 1
```

```
Router(config)#queue-list 1 protocol ip 3 list 103
```

```
Router(config)#queue-list 1 protocol ip 4 list 104
```

```
Router(config)#queue-list 1 protocol ip 5 list 105
```

```
Router(config)#queue-list 1 queue 5 byte-count 3000 limit 55
```

```
Router(config)#queue-list 1 protocol ip 6 list 106
```

```
Router(config)#queue-list 1 protocol ip 7 list 107
```

```
Router(config)#queue-list 1 default 8
```

```
Router(config)#interface HSSI0/0
```

```
Router(config-if)#custom-queue-list 1
```

```
Router(config-if)#exit
```

```
Router(config)#end
```

```
Router#
```

注释 通过配置自定义队列可以生成 16 个应用队列和 1 个系统队列。

```
Queuing strategy: custom-list 1
```

```
Output queues: (queue #: size/max/drops)
```

```
0: 0/20/0 1: 0/20/0 2: 0/20/0 3: 0/20/0 4: 0/20/0
```

```
5: 0/55/3 6: 5/20/0 7: 0/20/0 8: 0/20/0 9: 0/20/0
```

```
10: 0/20/0 11: 0/20/0 12: 0/20/0 13: 0/20/0 14: 0/20/0
```

```
15: 0/20/0 16: 0/20/0
```

缺省情况下自定义队列不会对无分类的数据流进行队列归属，所以需要配置一个缺省队列。缺省情况下每个队列会读取 1500 字节，每个队列可最多保存 20 个数据包，可以通过 `queue-list 1 queue 5 byte-count 3000 limit 55` 命令来修改。

对于这种队列方式需要注意的是队列是基于字节的不是基于数据包的，所以对于字节下的数据流会发送相对多的数据包，但是总体来说流量是平均的。此种方式也是比较老的方案，推荐使用 CBWFQ

11.5. 自定义队列混和优先级队列

提问 高优先级数据优先处理，低优先级数据共享带宽

回答

```
Router#configure terminal
```

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

```
Router(config)#access-list 101 permit ip any any precedence 7
```

```
Router(config)#access-list 102 permit ip any any precedence 6
```

```
Router(config)#access-list 103 permit ip any any precedence 5
```

```
Router(config)#access-list 104 permit ip any any precedence 4
```

```
Router(config)#access-list 105 permit ip any any precedence 3
```

```
Router(config)#access-list 106 permit ip any any precedence 2
```

```
Router(config)#access-list 107 permit ip any any precedence 1
```

```
Router(config)#queue-list 1 protocol ip 1 list 101
```

```
Router(config)#queue-list 1 protocol ip 2 list 102
```

```
Router(config)#queue-list 1 protocol ip 3 list 103
```

```
Router(config)#queue-list 1 protocol ip 4 list 104
```

```
Router(config)#queue-list 1 protocol ip 5 list 105
```

```
Router(config)#queue-list 1 protocol ip 6 list 106
```

```
Router(config)#queue-list 1 protocol ip 7 list 107
```

```
Router(config)#queue-list 1 lowest-custom 4
```

```
Router(config)#interface HSSI0/0
```

```
Router(config-if)#custom-queue-list 1
```

```
Router(config-if)#exit
```

```
Router(config)#end
```

```
Router#
```

多了一个 queue-list 1 lowest-custom 4 , 这样 123. 被定义为优先级队列

11.6. 使用加权公平队列 (Weighted Fair Queuing)

提问 根据 TOS/DSCP 位来转发数据包

回答

缺省情况下 WFQ 会自动在小于 2M 速率的接口启用

```
Router#configure terminal
```

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

```
Router(config)#interface Serial0/0
```

```
Router(config-if)#fair-queue 64 512 10
```

```
Router(config-if)#exit
```

```
Router(config)#end
```

```
Router#
```

注释 WFQ 在没有 TOS/DSCP 标记的情况下依然可以工作。命令后面的参数分为三个，第一个为丢弃阈值，某个队列如果超过 64 个数据包，以后的数据包就会被 丢弃，第二个为动态队列数目，是 16 的倍数，如果端口有很多的数据流建议增加，第三个为 RSVP 预留队列，缺省为 0。

11.7. 使用基于类的加权公平队列 (Using Class-Based Weighted Fair Queuing)

提问 在端口上配置基于类的加权公平队列

回答

```
Router#configure terminal
```

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

```
Router(config)#class-map highprec
```

```
Router(config-cmap)#description Highest priority Prec=5
```

```
Router(config-cmap)#match ip precedence 5
```

```
Router(config-cmap)#exit
```

```
Router(config)#class-map medhiprec
```

```
Router(config-cmap)#description Medium-high priority Prec=4
```

```
Router(config-cmap)#match ip precedence 4
```

```
Router(config-cmap)#exit
```

```
Router(config)#class-map medloprec
```

```
Router(config-cmap)#description Medium-low priority Prec=2,3
```

```
Router(config-cmap)#match ip precedence 2 3
```

```
Router(config-cmap)#exit
```

```
Router(config)#policy-map cbwfqpolicy
```

```
Router(config-pmap)#class highprec
```

```
Router(config-pmap-c)#bandwidth percent 25
```

```
Router(config-pmap-c)#exit
```

```
Router(config-pmap)#class medhiprec
```

```
Router(config-pmap-c)#bandwidth percent 25

Router(config-pmap-c)#exit

Router(config-pmap)#class medloprec

Router(config-pmap-c)#bandwidth percent 25

Router(config-pmap-c)#exit

Router(config-pmap)#class class-default

Router(config-pmap-c)#fair-queue 512

Router(config-pmap-c)#queue-limit 96

Router(config-pmap-c)#exit

Router(config-pmap)#exit

Router(config)#interface serial0/1

Router(config-if)#service-policy output cbwfqpolicy

Router(config-if)#exit

Router(config)#end

Router#
```