



Implementing DiffServ for End-to-End Quality of Service

About Differentiated Services

Differentiated Services (DiffServ) describes a set of end-to-end quality of service (QoS) capabilities. End-to-end QoS is the ability of the network to deliver service required by specific network traffic from one end of the network to another. Cisco IOS QoS software supports three types of service models: best-effort services, Integrated Services (IntServ), and Differentiated Services. For more information about the best-effort services and IntServ, see the *Cisco IOS Quality of Service Solutions Configuration Guide*, Release 12.1.

Differentiated Services is a multiple service model that can satisfy differing QoS requirements. With Differentiated Services, the network tries to deliver a particular kind of service based on the QoS specified by each packet. This specification can occur in different ways, for example, using the 6-bit Differentiated Services Code Point (DSCP) setting in IP packets or source and destination addresses. The network uses the QoS specification to classify, mark, shape, and police traffic, and to perform intelligent queueing.

Differentiated Services is used for several mission-critical applications and for providing end-to-end QoS. Typically, Differentiated Services is appropriate for aggregate flows because it performs a relatively coarse level of traffic classification.

For more information about the specific Cisco IOS components and features related to DiffServ, see the “Differentiated Services Components” and “Feature Sets” sections later in this document.

DS Field Definition

A replacement header field, called the DS field, is defined by Differentiated Services. The DS field supersedes the existing definitions of the IPv4 type of service (ToS) octet (RFC 791) and the IPv6 traffic class octet. Six bits of the DS field are used as the DSCP to select the Per Hop Behavior (PHB) at each interface. A currently unused (CU) 2-bit field is reserved for explicit congestion notification (ECN). The value of the CU bits is ignored by DS-compliant interfaces when determining the PHB to apply to a received packet.

Per-Hop Behaviors

RFC 2475 defines PHB as the externally observable forwarding behavior applied at a DiffServ-compliant node to a DiffServ Behavior Aggregate (BA).

With the ability of the system to mark packets according to DSCP setting, collections of packets with the same DSCP setting and sent in a particular direction can be grouped into a BA. Packets from multiple sources or applications can belong to the same BA.

In other words, a PHB refers to the packet scheduling, queueing, policing, or shaping behavior of a node on any given packet belonging to a BA, as configured by a service level agreement (SLA) or a policy map.

The following sections describe the four available standard PHBs:

- Default PHB (as defined in RFC 2474)
- Class-Selector PHB (as defined in RFC 2474)
- Assured Forwarding (AFny) PHB (as defined in RFC 2597)
- Expedited Forwarding (EF) PHB (as defined in RFC 2598)

Default PHB

The default PHB essentially specifies that a packet marked with a DSCP value of 000000 (recommended) receives the traditional best-effort service from a DS-compliant node (that is, a network node that complies with all of the core DiffServ requirements). Also, if a packet arrives at a DS-compliant node, and the DSCP value is not mapped to any other PHB, the packet will get mapped to the default PHB.

For more information about default PHB, refer to RFC 2474, *Definition of the Differentiated Services Field in IPv4 and IPv6 Headers*.

Class-Selector PHB

To preserve backward-compatibility with any IP Precedence scheme currently in use on the network, DiffServ has defined a DSCP value in the form xxx000, where x is either 0 or 1. These DSCP values are called Class-Selector Code Points. (The DSCP value for a packet with default PHB 000000 is also called the Class-Selector Code Point.)

The PHB associated with a Class-Selector Code Point is a Class-Selector PHB. These Class-Selector PHBs retain most of the forwarding behavior as nodes that implement IP Precedence-based classification and forwarding.

For example, packets with a DSCP value of 110000 (the equivalent of the IP Precedence-based value of 110) have preferential forwarding treatment (for scheduling, queueing, and so on), as compared to packets with a DSCP value of 100000 (the equivalent of the IP Precedence-based value of 100). These Class-Selector PHBs ensure that DS-compliant nodes can coexist with IP Precedence-based nodes.

For more information about class-selector PHB, refer to RFC 2474, *Definition of the Differentiated Services Field in IPv4 and IPv6 Headers*.

Assured Forwarding PHB

Assured Forwarding PHB is nearly equivalent to Controlled Load Service available in the integrated services model. AFny PHB defines a method by which BAs can be given different forwarding assurances.

For example, network traffic can be divided into the following classes:

- Gold: Traffic in this category is allocated 50 percent of the available bandwidth.
- Silver: Traffic in this category is allocated 30 percent of the available bandwidth.
- Bronze: Traffic in this category is allocated 20 percent of the available bandwidth.

Further, the AFny PHB defines four AF classes: AF1, AF2, AF3, and AF4. Each class is assigned a specific amount of buffer space and interface bandwidth, according to the SLA with the service provider or policy map.

Within each AF class, you can specify three drop precedence (dP) values: 1, 2, and 3.

Assured Forwarding PHB can be expressed as shown in the following example:

AFny

In this example, n represents the AF class number (1, 2, or 3) and y represents the dP value (1, 2, or 3) within the AFn class.

In instances of network traffic congestion, if packets in a particular AF class (for example, AF1) need to be dropped, packets in the AF1 class will be dropped according to the following guideline:

$$dP(AFny) \geq dP(AFnz) \geq dP(AFnx)$$

where dP (AFny) is the probability that packets of the AFny class will be dropped. In other words, y denotes the dP within an AFn class.

In the following example, packets in the AF13 class will be dropped before packets in the AF12 class, which in turn will be dropped before packets in the AF11 class:

$$dP(AF13) \geq dP(AF12) \geq dP(AF11)$$

The dP method penalizes traffic flows within a particular BA that exceed the assigned bandwidth. Packets on these offending flows could be re-marked by a policer to a higher drop precedence.

An AFx class can be denoted by the DSCP value, xyzab0, where xyz can be 001, 010, 011, or 100, and ab represents the dP value.

Table 1 lists the DSCP value and corresponding dP value for each AF PHB class.

Table 1 DSCP Values and Corresponding Drop Precedence Values for Each AF PHB Class

Drop Precedence	Class 1	Class 2	Class 3	Class 4
Low drop precedence	001010	010010	011010	100010
Medium drop precedence	001100	010100	011100	100100
High drop precedence	001110	010110	011110	100110

Expedited Forwarding PHB

Resource Reservation Protocol (RSVP), a component of the integrated services model, provides a Guaranteed Bandwidth Service. Applications such as Voice over IP (VoIP), video, and online trading programs require this kind of robust service. The EF PHB, a key ingredient of DiffServ, supplies this kind of robust service by providing low loss, low latency, low jitter, and assured bandwidth service.

EF can be implemented using priority queueing (PQ), along with rate-limiting on the class (or BA). When implemented in a DiffServ network, EF PHB provides a virtual leased line, or premium service. For optimal efficiency, however, EF PHB should be reserved for only the most critical applications because, in instances of traffic congestion, it is not feasible to treat all or most traffic as high priority.

EF PHB is ideally suited for applications such as VoIP that require low bandwidth, guaranteed bandwidth, low delay, and low jitter.

The recommended DSCP value for EF PHB is 101110.

For more information about EF PHB, refer to RFC 2598, *An Expedited Forwarding PHB*.

Benefits

Use the Implementing DiffServ for End-to-End Quality of Service feature set to implement the Differentiated Services architecture. The benefits of implementing Differentiated Services include the following:

- Reduces the burden on network devices and easily scales as the network grows
- Allows customers to keep any existing Layer 3 ToS prioritization scheme that may be in use
- Allows customers to mix DiffServ-compliant devices with any existing ToS-enabled equipment in use
- Alleviates bottlenecks through efficient management of current corporate network resources

Differentiated Services Components

The following components make up the foundation of a Cisco Differentiated Services implementation:

- Traffic conditioning (traffic policing and traffic shaping)

Traffic conditioning is performed at the edges of a DiffServ domain. Traffic conditioners perform traffic shaping and policing functions to ensure that traffic entering the DiffServ domain conforms to the rules specified by the Traffic Conditioning Agreement (TCA), and comply with the service provisioning policy of the domain. Traffic conditioning may range from simple code point re-marking to complex policing and shaping operations.

- Packet classification

Packet classification uses a traffic descriptor (for example, the DSCP) to categorize a packet within a specific group in order to define that packet. After the packet has been defined (that is, classified), the packet is then accessible for QoS handling on the network.

Using packet classification, you can partition network traffic into multiple priority levels or classes of service. When traffic descriptors are used to classify traffic, the source agrees to adhere to the contracted terms and the network promises a quality of service. Traffic policers and traffic shapers use the traffic descriptor of the packet (that is, the classification of the packet) to ensure adherence to that agreement.

- Packet marking

Packet marking is related to packet classification. Packet marking allows you to classify a packet based on a specific traffic descriptor (such as the DSCP value). This classification can then be used to apply user-defined differentiated services to the packet and to associate a packet with a local QoS group.

Associating a packet with a local QoS group allows users to associate a group ID with a packet. The group ID can be used to classify packets into QoS groups based on prefix, autonomous system, and community string. A user can set up to 64 DSCP values and 100 QoS group markings.

- Congestion management

Congestion management (or scheduling) is achieved through traffic scheduling and traffic queueing. When there is network congestion, a scheduling mechanism such as class-based weighted fair queueing (CBWFQ) is used to provide guaranteed bandwidth to the different classes of traffic.

- Congestion avoidance

Congestion avoidance techniques monitor network traffic loads in an effort to anticipate and avoid congestion at common network bottlenecks. Congestion avoidance is achieved through packet dropping. Among the more commonly used congestion avoidance mechanisms is Weighted Random Early Detection (WRED).

With WRED and Differentiated Services, you have the option of allowing WRED to use the DSCP value when WRED calculates the drop probability of a packet.

Feature Sets

This section lists the feature sets that correspond to the Differentiated Services components listed earlier. These feature sets provide the necessary functionality that allows you to implement Differentiated Services.

This feature set includes the following features:

- **Modular Quality of Service Command-Line Interface**—This feature provides a command-line interface (CLI) structure that allows users to configure class-based QoS features.
- **Class-Based Packet Marking**—This feature provides a user-friendly command-line interface for efficient packet marking by which users can differentiate packets by designating them different identifying values. For example, this feature allows users to mark packets by setting the IP Precedence bits or the IP DSCP in the ToS byte.
- **Traffic Policing**—This feature allows you to limit the input or output transmission rate of a class of traffic based on user-defined criteria. It also enables the system to mark packets by setting the IP Precedence value, the QoS group, or the DSCP value.
- **Class-Based Shaping**—This feature allows you to configure Generic Traffic Shaping (GTS) on a traffic class, specify average rate or peak rate traffic shaping, and configure CBWFQ inside GTS.
- **CBWFQ**—This feature is a scheduling mechanism used to provide a minimum bandwidth guarantee to traffic classes during times of network congestion at an interface.
- **DiffServ Compliant Weighted Random Early Detection**—This feature provides support for the DiffServ standard. It enables WRED to use either the DSCP or the IP Precedence value when calculating the drop probability for a packet. This feature should be used in conjunction with CBWFQ.
- **Enhanced `show policy-map interface` Command Enhancements for Class-Based Accounting**—The `show policy-map interface` command now displays information such as the incoming traffic rate, the dropped packet rate, the number of matched packets, and the number of matched bytes for traffic classes that are attached to the specified interface. This feature collects and displays common statistics that are used for billing and accounting purposes.

- Multiprotocol Label Switching (MPLS) Class of Service Enhancements—This feature allows the service provider to set the MPLS experimental field instead of overwriting the value in the customer’s IP precedence field (the first three bits of the DSCP field in the header of an IP packet).

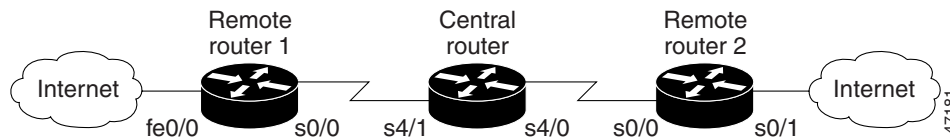
Constructing Services Using DiffServ

The following section provides a sample DiffServ implementation. It includes sample configurations and troubleshooting logs, which can be used for monitoring system performance.

Sample DiffServ Implementation

Figure 1 shows a sample DiffServ implementation with three routers: Remote router 1, central router, and remote router 2.

Figure 1 Sample Network Implementing DiffServ



In this example, we want to give end-to-end QoS to several different types of traffic classes using the Cisco IOS Differentiated Services feature set.

Traffic classes along with the SLAs for each traffic class in use on the sample DiffServ implementation are described as follows:

- Voice is considered premium class. The gold class of traffic consists of TACACS sessions, along with traffic marked with DSCP values 12 and 14. The silver traffic class consists of Telnet, Simple Mail Transfer Protocol (SMTP), and File Transfer Protocol (FTP) sessions. The bronze traffic class consists of web traffic and traffic marked with DSCP values 28 and 30. Anything else is considered as belonging to “best-effort” traffic class.
- The premium class should be forwarded with the lowest delay possible up to a maximum of 500 kbps during periods of congestion. The gold class should be treated preferentially over the silver class, which in turn should be treated preferentially over the bronze class. The gold, silver, and bronze classes should have 35 percent, 25 percent, and 15 percent, respectively, of the interface bandwidth as the minimum bandwidth guarantees. Bronze class should be shaped to 320 kbps, and the best-effort class should be policed to 56 kbps.
- To provision for the various traffic classes, the traffic needs to be classified based on DSCP values in a DiffServ domain. So that traffic can be classified based on DSCP values, the traffic should be premarked with the appropriate DSCP values at the time of entering the network.

In Figure 1, the correct place to do this kind of traffic marking is in the incoming direction of Fast Ethernet interface 0/0 of remote router 1 and the incoming direction of Serial interface 0/1 of remote router 2. This marking can be achieved through an input service policy.

Table 2 lists the DSCP values used to mark different classes of traffic entering into the sample network.

Table 2 DSCP Values for Traffic Classes and Traffic Types

Traffic Class	Traffic Type	DSCP Value
Premium	Voice	46
Gold	TACACS	10
Silver	Telnet	18
	SMTP	20
	FTP	22
Bronze	HTTP	26

The following policy map, SETDSCP, can be used in the input direction of fe0/0 of remote router 1 to achieve the marking scheme noted in Table 2:

SETDSCP Policy Map

```
class-map match-all EF
  match access-group 101

class-map match-all AF1
  match access-group 102

class-map match-all AF21
  match access-group 108
class-map match-all AF22
  match access-group 109
class-map match-all AF23
  match access-group 110

class-map match-all AF3
  match access-group 104

policy-map SETDSCP
  class EF
    set ip dscp 46
  class AF1
    set ip dscp 10
  class AF21
    set ip dscp 18
  class AF22
    set ip dscp 20
  class AF23
    set ip dscp 22
  class AF3
    set ip dscp 26
```

Once the traffic classes are marked with the appropriate DSCP values using the SETDSCP policy map, the different behavior aggregate requirements for each of the traffic classes can be met by using the following policy map, VOIP, in the output direction:

VOIP Policy Map

```
class-map match-all premium
  match ip dscp 46
class-map match-all gold
  match ip dscp 10 12 14
class-map match-all silver
```

```

match ip dscp 18 20 22
class-map match-all bronze
  match ip dscp 26 28 30
class-map best-effort
  match access-group 105

policy-map VOIP
  class premium
    priority 500
  class gold
    bandwidth percent 35
  class silver
    shape average 320000
    bandwidth percent 25
  class bronze
    bandwidth percent 15
  class best-effort
    police 56000 1750 1750 conform-action set-dscp-transmit 0

```

Sample Configurations

This section contains the configurations for each of the routers shown in Figure 1.

The examples demonstrate how marking, shaping, policing, and monitoring is done through the Modular QoS Command-Line Interface (MQC).

Remote Router 1 Configuration

Current configuration:

```

Remotel# show running-config

Building configuration...
!
version 12.1
no service single-slot-reload-enable
service timestamps debug uptime
service timestamps log uptime
no service password-encryption
!
hostname Remotel
!
logging rate-limit console 10 except errors
no logging console
!
ip subnet-zero
!
ip dhcp smart-relay
!
ip cef
!
class-map match-all gold
  match ip dscp 10 12 14
class-map match-all EF
  match access-group 101
class-map match-all AF21
  match access-group 108
class-map match-all AF23
  match access-group 110
class-map match-all AF22
  match access-group 109
class-map match-all bronze
  match ip dscp 26 28 30

```

```
class-map match-all platinum
  match ip dscp 46
class-map match-all silver
  match ip dscp 18 20 22
class-map match-all best-effort
  match access-group 105
class-map match-all AF3
  match access-group 104
class-map match-all AF1
  match access-group 102
!
policy-map VOIP
  class platinum
    priority 50
  class gold
    bandwidth percent 50
  class bronze
    shape average 320000
    bandwidth percent 15
  class silver
    bandwidth percent 35
  class best-effort
    police 56000 1750 1750 conform-action set-dscp-transmit 0 exceed-action drop
violate-action drop
policy-map SETDSCP
  class EF
    set ip dscp 46
  class AF1
    set ip dscp 10
  class AF3
    set ip dscp 26
  class AF21
    set ip dscp 18
  class AF22
    set ip dscp 20
  class AF23
    set ip dscp 22
!
call rsvp-sync
cns event-service server
!
interface FastEthernet0/0
  ip address 4.1.1.1 255.255.255.0
  load-interval 60
  speed auto
  half-duplex
  service-policy input SETDSCP
!
interface Serial0/0
  bandwidth 2000
  ip address 2.1.1.1 255.255.255.0
  load-interval 60
  service-policy output VOIP
!
interface Serial0/1
  no ip address
  shutdown
!
ip classless
ip route 1.1.1.0 255.255.255.0 2.1.1.2
ip route 3.1.1.0 255.255.255.0 2.1.1.2
!
access-list 101 permit udp any any range 16384 32768
access-list 102 permit tcp any any eq tacacs
```

```

access-list 104 permit tcp any any eq www
access-list 105 permit ip any any
access-list 108 permit tcp any any eq telnet
access-list 109 permit tcp any any eq smtp
access-list 110 permit tcp any any eq ftp
!
voice-port 1/0/0
!
voice-port 1/0/1
!
dial-peer cor custom
!
dial-peer voice 11 pots
  destination-pattern 2220
  port 1/0/0
!
dial-peer voice 1 voip
  destination-pattern 1110
  session target ipv4:1.1.1.2
  ip precedence 5
!
line con 0
  transport input none
line aux 0
line vty 0 4
  login
!
no scheduler allocate
end

```

Central Router Configuration

Current configuration:

```

Central# show running-config

Building configuration...

Current configuration:
!
version 12.1
no service single-slot-reload-enable
service timestamps debug uptime
service timestamps log uptime
no service password-encryption
!
hostname Central
!
logging rate-limit console 10 except errors
no logging console

ip dhcp smart-relay
!
ip cef
!
class-map match-all gold
  match ip dscp 10 12 14
class-map match-all bronze
  match ip dscp 26 28 30
class-map match-all platinum
  match ip dscp 46
class-map match-all silver
  match ip dscp 18 20 22

```

```
class-map match-all best-effort
  match ip dscp 0
!
policy-map AVVID
  class silver
    bandwidth percent 35
    random-detect dscp-based
    random-detect dscp 18 20 40 10
    random-detect dscp 20 20 40 30
    random-detect dscp 22 2 3 3
  class gold
    bandwidth percent 50
    random-detect dscp-based
    random-detect dscp 10 20 40 10
    random-detect dscp 12 20 40 15
    random-detect dscp 14 20 40 20
  class bronze
    bandwidth percent 15
    random-detect dscp-based
    random-detect dscp 26 20 40 10
    random-detect dscp 28 20 40 20
    random-detect dscp 30 20 40 30
  class platinum
    priority 500
!
cns event-service server
!
interface Serial4/0
  bandwidth 2000
  ip address 3.1.1.1 255.255.255.0
  no ip mroute-cache
  load-interval 60
  service-policy output AVVID
!
interface Serial4/1
  ip address 2.1.1.2 255.255.255.0
  no ip mroute-cache
  service-policy output AVVID
  clockrate 2015232
!
interface Serial4/2
  no ip address
  no ip mroute-cache
  shutdown
!
interface Serial4/3
  no ip address
  no ip mroute-cache
  shutdown
!
ip classless
ip route 0.0.0.0 0.0.0.0 10.0.153.1
ip route 1.1.1.0 255.255.255.0 3.1.1.2
ip route 4.1.1.0 255.255.255.0 2.1.1.1
ip http server
!
line con 0
  exec-timeout 0 0
  transport input none
line aux 0
line vty 0 4
line vty 5 15

end
```

Remote Router 2 Configuration

Current configuration:

Remote2# **show running-config**

Building configuration...

Current configuration:

```

!
version 12.1
no service single-slot-reload-enable
service timestamps debug uptime
service timestamps log uptime
no service password-encryption
!
hostname Remote2
!
logging rate-limit console 10 except errors
no logging console
!
ip dhcp smart-relay
!
ip cef
!
class-map match-all gold
  match ip dscp 10 12 14
class-map match-all EF
  match access-group 101
class-map match-all AF21
  match access-group 108
class-map match-all AF23
  match access-group 110
class-map match-all AF22
  match access-group 109
class-map match-all bronze
  match ip dscp 26 28 30
class-map match-all platinum
  match ip dscp 46
class-map match-all silver
  match ip dscp 18 20 22
class-map match-all best-effort
  match access-group 105
class-map match-all AF3
  match access-group 104
class-map match-all AF1
  match access-group 102
!
!
policy-map VOIP
  class platinum
    priority 500
  class gold
    bandwidth percent 35
  class bronze
    shape average 320000
    bandwidth percent 15
  class silver
    bandwidth percent 25
  class best-effort
    police 56000 1750 1750 conform-action set-dscp-transmit 0 exceed-action drop
  violate-action drop
policy-map SETDSCP
  class EF

```

```
    set ip dscp 46
class AF1
    set ip dscp 10
class AF3
    set ip dscp 26
class AF21
    set ip dscp 18
class AF22
    set ip dscp 20
class AF23
    set ip dscp 22
!

interface Serial0/0
bandwidth 2000
ip address 3.1.1.2 255.255.255.0
load-interval 60
service-policy output VOIP
clockrate 2000000
!
interface Serial0/1
ip address 1.1.1.1 255.255.255.0
load-interval 60
no keepalive
service-policy input SETDSCP
clockrate 2000000
!
ip kerberos source-interface any
ip classless
ip route 2.1.1.0 255.255.255.0 3.1.1.1
ip route 4.1.1.0 255.255.255.0 3.1.1.1
no ip http server
!
access-list 101 permit udp any any range 16384 32768
access-list 102 permit tcp any any eq tacacs
access-list 104 permit tcp any any eq www
access-list 105 permit ip any any
access-list 108 permit tcp any any eq telnet
access-list 109 permit tcp any any eq smtp
access-list 110 permit tcp any any eq ftp
!
voice-port 1/0/0
!
voice-port 1/0/1
!
dial-peer cor custom
!
dial-peer voice 1 voip
destination-pattern 2220
session target ipv4:2.1.1.1
ip precedence 5
!
dial-peer voice 11 pots
destination-pattern 1110
port 1/0/0
!
!
line con 0
transport input none
line aux 0
line vty 0 4
login
!
no scheduler allocate
```

```
end
```

Troubleshooting Logs

This section contains sample troubleshooting logs for remote router 1 and the central router. These logs can be used for monitoring and maintaining the DiffServ implementation.

Remote Router 1

```
Remotel1# show policy-map SETDSCP
```

```
Policy Map SETDSCP
Class EF
  set ip dscp 46
Class AF1
  set ip dscp 10
Class AF3
  set ip dscp 26
Class AF21
  set ip dscp 18
Class AF22
  set ip dscp 20
Class AF23
  set ip dscp 22
```

```
Remotel1# show policy-map VOIP
```

```
Policy Map VOIP
Class platinum
  Weighted Fair Queueing
  Strict Priority
  Bandwidth 500 (kbps) Burst 12500 (Bytes)
Class gold
  Weighted Fair Queueing
  Bandwidth 35 (%) Max Threshold 64 (packets)
Class bronze
  Traffic Shaping
  Average Rate Traffic Shaping
  CIR 320000 (bps) Max. Buffers Limit 1000 (Packets)
  Weighted Fair Queueing
  Bandwidth 15 (%) Max Threshold 64 (packets)
Class silver
  Weighted Fair Queueing
  Bandwidth 25 (%) Max Threshold 64 (packets)
Class best-effort
  police 56000 1750 1750 conform-action set-dscp-transmit 0 exceed-action drop
violate-action drop
```

```
Remotel1# show policy-map interface f0/0
```

```
FastEthernet0/0
```

```
Service-policy input: SETDSCP (1611)
```

```
Class-map: EF (match-all) (1612/3)
  2154221 packets, 176646532 bytes
  1 minute offered rate 642000 bps, drop rate 0 bps
Match: access-group 101 (1614)
QoS Set
  ip dscp 46
  Packets marked 2154256
```

```
Class-map: AF1 (match-all) (1616/12)
 46351 packets, 69711904 bytes
 1 minute offered rate 254000 bps, drop rate 0 bps
Match: access-group 102 (1618)
QoS Set
  ip dscp 10
    Packets marked 46352

Class-map: AF3 (match-all) (1620/11)
 81757 packets, 122962528 bytes
 1 minute offered rate 483000 bps, drop rate 0 bps
Match: access-group 104 (1622)
QoS Set
  ip dscp 26
    Packets marked 81951

Class-map: AF21 (match-all) (1624/4)
 84585 packets, 127215840 bytes
 1 minute offered rate 484000 bps, drop rate 0 bps
Match: access-group 108 (1626)
QoS Set
  ip dscp 18
    Packets marked 84780

Class-map: AF22 (match-all) (1628/6)
 75440 packets, 113461760 bytes
 1 minute offered rate 423000 bps, drop rate 0 bps
Match: access-group 109 (1630)
QoS Set
  ip dscp 20
    Packets marked 75612

Class-map: AF23 (match-all) (1632/5)
 66212 packets, 99582848 bytes
 1 minute offered rate 362000 bps, drop rate 0 bps
Match: access-group 110 (1634)
QoS Set
  ip dscp 22
    Packets marked 66428

Class-map: class-default (match-any) (1636/0)
 2555349 packets, 778812687 bytes
 1 minute offered rate 2896000 bps, drop rate 0 bps
Match: any (1638)
 2555358 packets, 778810855 bytes
 1 minute rate 2896000 bps
```

```
Remotel1# show policy-map interface s0/0
```

```
Serial10/0
```

```
Service-policy output: VOIP (1558)
```

```
Class-map: platinum (match-all) (1559/8)
 2988402 packets, 215165016 bytes
 1 minute offered rate 564000 bps, drop rate 0 bps
Match: ip dscp 46 (1561)
Weighted Fair Queueing
  Strict Priority
  Output Queue: Conversation 264
    Bandwidth 500 (kbps)
    (pkts matched/bytes matched) 2988422/215166384
    (total drops/bytes drops) 330478/23794416
```

```

Class-map: gold (match-all) (1563/2)
  64300 packets, 96064200 bytes
  1 minute offered rate 252000 bps, drop rate 0 bps
  Match: ip dscp 10 12 14 (1565)
  Weighted Fair Queueing
    Output Queue: Conversation 265
      Bandwidth 35 (%) Max Threshold 64 (packets)
      (pkts matched/bytes matched) 64300/96064200
      (depth/total drops/no-buffer drops) 0/0/0

Class-map: bronze (match-all) (1567/7)
  115945 packets, 173221830 bytes
  1 minute offered rate 479000 bps, drop rate 56000 bps
  Match: ip dscp 26 28 30 (1569)
  Traffic Shaping
    Target      Byte      Sustain    Excess     Interval  Increment Adapt
    Rate        Limit    bits/int   bits/int   (ms)      (bytes)   Active
    320000      2000    8000      8000      25        1000     -

    Queue      Packets   Bytes      Packets   Bytes
    Depth                                     Delayed   Delayed   Active
    64          80006    119528964 72784    108739296 yes

  Weighted Fair Queueing
    Output Queue: Conversation 266
      Bandwidth 15 (%) Max Threshold 64 (packets)
      (pkts matched/bytes matched) 80006/119528964
      (depth/total drops/no-buffer drops) 0/12749/0

Class-map: silver (match-all) (1572/9)
  315979 packets, 472072626 bytes
  1 minute offered rate 1258000 bps, drop rate 646000 bps
  Match: ip dscp 18 20 22 (1574)
  Weighted Fair Queueing
    Output Queue: Conversation 267
      Bandwidth 25 (%) Max Threshold 64 (packets)
      (pkts matched/bytes matched) 316253/472481982
      (depth/total drops/no-buffer drops) 0/158914/0

Class-map: best-effort (match-all) (1576/10)
  3548921 packets, 1051813080 bytes
  1 minute offered rate 2801000 bps, drop rate 0 bps
  Match: access-group 105 (1578)
  police:
    56000 bps, 1750 limit, 1750 extended limit
    conformed 0 packets, 0 bytes; action: set-dscp-transmit 0
    exceeded 0 packets, 0 bytes; action: drop
    violated 0 packets, 0 bytes; action: drop

Class-map: class-default (match-any) (1580/0)
  3549281 packets, 1051837716 bytes
  1 minute offered rate 2801000 bps, drop rate 0 bps
  Match: any (1582)
    3549281 packets, 1051837644 bytes
    1 minute rate 2801000 bps

Remotel# show queue serial 0/0

Input queue: 0/75/0/0 (size/max/drops/flushes); Total output drops: 631823
Queueing strategy: weighted fair
Output queue: 101/1000/64/593935 (size/max total/threshold/drops)
  Conversations 4/7/256 (active/max active/max total)
  Reserved Conversations 3/3 (allocated/max allocated)
  Available Bandwidth 1000 kilobits/sec

```

```
(depth/weight/total drops/no-buffer drops/interleaves) 5/0/346494/0/0
Conversation 264, linktype: ip, length: 72
source: 0.0.0.0, destination: 1.1.1.2, id: 0x0000, ttl: 59,
TOS: 184 prot: 17, source port 0, destination port 16384

(depth/weight/total drops/no-buffer drops/interleaves) 63/45/166791/0/0
Conversation 267, linktype: ip, length: 1494
source: 0.0.0.0, destination: 1.1.1.2, id: 0x0000, ttl: 59,
TOS: 72 prot: 6, source port 0, destination port 23

(depth/weight/total drops/no-buffer drops/interleaves) 35/104/13461/0/0
Conversation 266, linktype: ip, length: 1494
source: 0.0.0.0, destination: 1.1.1.2, id: 0x0000, ttl: 59,
TOS: 104 prot: 6, source port 0, destination port 80

(depth/weight/total drops/no-buffer drops/interleaves) 1/32384/67216/0/0
Conversation 89, linktype: ip, length: 1482
source: 0.0.0.0, destination: 1.1.1.2, id: 0x0000, ttl: 59,
TOS: 0 prot: 17, source port 0, destination port 67
```

```
Remotel# show interface serial 0/0
```

```
Serial0/0 is up, line protocol is up
```

```
Hardware is PowerQUICC Serial
Internet address is 2.1.1.1/24
MTU 1500 bytes, BW 2000 Kbit, DLY 20000 usec,
    reliability 255/255, txload 207/255, rxload 1/255
Encapsulation HDLC, loopback not set
Keepalive set (10 sec)
Last input 00:00:03, output 00:00:00, output hang never
Last clearing of "show interface" counters 00:50:30
Input queue: 0/75/0/0 (size/max/drops/flushes); Total output drops: 595699
Queueing strategy: weighted fair
Output queue: 114/1000/64/560199 (size/max total/threshold/drops)
    Conversations 4/7/256 (active/max active/max total)
    Reserved Conversations 3/3 (allocated/max allocated)
    Available Bandwidth 1000 kilobits/sec
1 minute input rate 0 bits/sec, 0 packets/sec
1 minute output rate 1624000 bits/sec, 962 packets/sec
    354 packets input, 22827 bytes, 0 no buffer
    Received 354 broadcasts, 0 runts, 0 giants, 0 throttles
    0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
    2918044 packets output, 616834104 bytes, 0 underruns
    0 output errors, 0 collisions, 0 interface resets
    0 output buffer failures, 0 output buffers swapped out
    0 carrier transitions
    DCD=up DSR=up DTR=up RTS=up CTS=up
```

Central Router

```
Central# show policy-map interface serial 4/0
```

```
Serial4/0
```

```
Service-policy output: AVVID (2022)
```

```
Class-map: silver (match-all) (2023/2)
    251162 packets, 375236028 bytes
    1 minute offered rate 612000 bps, drop rate 0 bps
Match: ip dscp 18 20 22 (2025)
```

```

Weighted Fair Queueing
Output Queue: Conversation 265
Bandwidth 25 (%)
(pkts matched/bytes matched) 3/4482
(depth/total drops/no-buffer drops) 0/0/0
mean queue depth: 0
    
```

Dscp (Prec)	Random drop pkts/bytes	Tail drop pkts/bytes	Minimum threshold	Maximum threshold	Mark probability
0(0)	0/0	0/0	20	40	1/10
1	0/0	0/0	22	40	1/10
2	0/0	0/0	24	40	1/10
3	0/0	0/0	26	40	1/10
4	0/0	0/0	28	40	1/10

(...up to DSCP 63.....)

61	0/0	0/0	30	40	1/10
62	0/0	0/0	32	40	1/10
63	0/0	0/0	34	40	1/10
rsvp	0/0	0/0	36	40	1/10

```

Class-map: gold (match-all) (2027/3)
102479 packets, 153103626 bytes
1 minute offered rate 250000 bps, drop rate 0 bps
Match: ip dscp 10 12 14 (2029)
Weighted Fair Queueing
Output Queue: Conversation 266
Bandwidth 35 (%)
(pkts matched/bytes matched) 0/0
(depth/total drops/no-buffer drops) 0/0/0
mean queue depth: 0
    
```

Dscp (Prec)	Random drop pkts/bytes	Tail drop pkts/bytes	Minimum threshold	Maximum threshold	Mark probability
0(0)	0/0	0/0	20	40	1/10
1	0/0	0/0	22	40	1/10
2	0/0	0/0	24	40	1/10
3	0/0	0/0	26	40	1/10

...up to DSCP 63.....)

61	0/0	0/0	30	40	1/10
62	0/0	0/0	32	40	1/10
63	0/0	0/0	34	40	1/10
rsvp	0/0	0/0	36	40	1/10

```

Class-map: bronze (match-all) (2031/4)
106605 packets, 159267870 bytes
1 minute offered rate 262000 bps, drop rate 0 bps
Match: ip dscp 26 28 30 (2033)
Weighted Fair Queueing
Output Queue: Conversation 267
Bandwidth 15 (%)
(pkts matched/bytes matched) 0/0
(depth/total drops/no-buffer drops) 0/0/0
mean queue depth: 0
    
```

Dscp (Prec)	Random drop pkts/bytes	Tail drop pkts/bytes	Minimum threshold	Maximum threshold	Mark probability
0(0)	0/0	0/0	20	40	1/10
1	0/0	0/0	22	40	1/10
2	0/0	0/0	24	40	1/10
3	0/0	0/0	26	40	1/10
4	0/0	0/0	28	40	1/10
5	0/0	0/0	30	40	1/10
6	0/0	0/0	32	40	1/10
(...up to DSCP 63.....)					
61	0/0	0/0	30	40	1/10
62	0/0	0/0	32	40	1/10
63	0/0	0/0	34	40	1/10
rsvp	0/0	0/0	36	40	1/10

```

Class-map: platinum (match-all) (2035/5)
  4253851 packets, 306277272 bytes
  1 minute offered rate 499000 bps, drop rate 0 bps
  Match: ip dscp 46 (2037)
  Weighted Fair Queueing
  Strict Priority
  Output Queue: Conversation 264
    Bandwidth 500 (kbps)
    (pkts matched/bytes matched) 4248148/305866656
    (total drops/bytes drops) 5/360

```

```

Class-map: class-default (match-any) (2039/0)
  4719109 packets, 1000522466 bytes
  1 minute offered rate 1625000 bps, drop rate 0 bps
  Match: any (2041)
    4719109 packets, 1000522466 bytes
    1 minute rate 1625000 bps

```

Central# **show queue serial 4/0**

```

Input queue: 0/75/0/0 (size/max/drops/flushes); Total output drops: 5
Queueing strategy: weighted fair
Output queue: 0/1000/64/5 (size/max total/threshold/drops)
  Conversations 0/2/256 (active/max active/max total)
  Reserved Conversations 3/3 (allocated/max allocated)
  Available Bandwidth 1000 kilobits/sec

```

Central# **show queue serial 4/1**

```

Input queue: 0/75/0/0 (size/max/drops/flushes); Total output drops: 0
Queueing strategy: weighted fair
Output queue: 0/1000/64/0 (size/max total/threshold/drops)
  Conversations 0/1/256 (active/max active/max total)
  Reserved Conversations 3/3 (allocated/max allocated)
  Available Bandwidth 1011 kilobits/sec

```

Class-Based Management

The accounting functionality of DiffServ allows you to collect and display service policy statistics on a per-class basis. The **show policy-map interface** command has been enhanced to include additional information related to traffic classes on a particular interface. The **show policy-map interface** command now displays information including the incoming traffic rate, the dropped packet rate, the number of matched packets, and the number of matched bytes, for traffic classes that are attached to the specified interface. These details can be used for billing and accounting purposes, and for managing projects, as appropriate.

Supported Platforms

This feature runs on the following platforms:

- Cisco 2500 series
- Cisco 2600 series
- Cisco 3600 series
- Cisco 4500 series
- Cisco 7200 series
- Cisco 7500 RSP series

Supported Standards, MIBs, and RFCs

Standards

The Differentiated Services, Assured Forwarding, and Expedited Forwarding standards are supported by this feature.

MIBs

No new or modified MIBs are supported by this feature.

To obtain lists of supported MIBs by platform and Cisco IOS release, and to download MIB modules, go to the Cisco MIB web site on Cisco Connection Online (CCO) at <http://www.cisco.com/public/sw-center/netmgmt/cmtk/mibs.shtml>.

RFCs

- RFC 2474, *Definition of the Differentiated Services Field in IPv4 and IPv6 Headers*
- RFC 2475, *An Architecture for Differentiated Services Framework*
- RFC 2597, *Assured Forwarding PHB*
- RFC 2598, *An Expedited Forwarding PHB*
- RFC 2697, *A Single Rate Three Color Marker*

What to Do Next

To configure the features of the Differentiated Services feature set, refer to the following feature modules available on *Cisco.com* or on the Documentation CD:

- Modular Quality of Service Command-Line Interface (Cisco IOS Release 12.0(5)XE)
- Class-Based Packet Marking (Cisco IOS Release 12.1(5)T)
- Traffic Policing (Cisco IOS Release 12.1(5)T)
- Class-Based Shaping (Cisco IOS Release 12.1(2)T)
- DiffServ Compliant Weighted Random Early Detection (Cisco IOS Release 12.1(5)T)
- MPLS Class of Service Enhancements (Cisco IOS Release 12.1(5)T)

