Understand QoS Fundamentals and Class-Default Behavior in SD-WAN

Contents

Introduction

This document describes the Quality of Service (QoS) class-default behavior on the Cisco Catalyst SD-WAN Manager GUI.

Prerequisites

Cisco recommends that you have knowledge of these topics:

- Cisco Catalyst Software-Defined Wide Area Network (SD-WAN)
- Quality of Service (QoS)

Components Used

The information in this document is based on:

- Cisco IOS® XE Catalyst SD-WAN Edges version 17.9.5a.
- Cisco Catalyst SD-WAN Manager version 20.12.4.

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

Background Information

QoS Fundamentals

QoS is the mechanism that provides preference to specific traffic flows over others when packets must be dropped due to congestion. Not all traffic flows are equal for the business.

Due to the fact that all traffic flows are not equally important for the business, QoS is necessary to prioritize

the traffic.

QoS is a feature that accomplishes the Quality-Of-Service objective based on:

- Classification and Marking **-** Match and mark interested traffic. The matching process in QoS happens when a router classifies packets bases on packet headers or deep packet inspection via NBAR based on the criteria set in the policy sequence match. Then, the marking take place based on the policy sequence action. If a packet is already mark with a DSCP value, it can be re-marked.

Note: An SD-WAN router has a distinct service and transport VRF, the classification process happens on the service side and is destined to transport side.

- Forwarding Class (FC) **-** match egress interface queues in one-to-one relation. FC is a logic use by the router to map egress queues.

For example: Forwarding Class: CS6 maps to Queue 1, Forwarding Class: AF4X maps to Queue 3, and so on.

```
<#root>
policy
 access-list QoS-Classification

     sequence 11


 match
       dscp 48      <--- Match the traffic with dscp 48 to CS6



   action accept
        class CS6   <--- Classify this traffic to CS6

     sequence 21
      match
       dscp 26

<--- Match the traffic with dscp 26


      action accept
       class AF31

<--- Classify this traffic to AF31



!---Output is supressed

class-map


class AF21 queue 5<--- Assign the Forwarding Class to Queue 5

class AF31 queue 4 <--- Assign the Forwarding Class to Queue 4
class AF41 queue 3 <--- Assign the Forwarding Class to Queue 3


class CS6 queue 1 <--- Assign the Forwarding Class to Queue 1
```

```
class AF43 queue 2 <--- Assign the Forwarding Class to Queue 2
class Queue0 queue 0
```

- Rate Limit: Refers to a configured maximum bandwidth allowed on a network interface, essentially controlling the rate at which traffic can flow by dropping packets that exceed the specified limit, preventing congestion and prioritizing certain types of traffic based on their allowed rate.

- Shaping and Policing: Refers to controlling the traffic rate entering or leaving the network. Shaping delays excess traffic, while policing drops or re-marks.

- Drops: Refers to the intentional discarding of packets as a method to manage congestion and ensure network performance.

- Congestion Management - Queue and Schedule Techniques. The router places packets into different egress queues, and the scheduler decides the packet order. This allows the scheduler to treat each traffic inside a queue differently.

Note: Without QoS enable, Cisco IOS® XE routers use Queue2 as the default queue and treat all traffic equally. On SD-WAN environment Queue0 is used for control traffic.

- Congestion Avoidance: Refers to manage network traffic to prevent congestion, ensuring efficient data transmission and maintaining optimal performance.

- Tail Drops: Is a method where incoming packets are automatically discarded when a queue in a network device, like a router or switch, reaches its maximum capacity. When the queue is full, any additional packets arriving are dropped starting from the "tail" end of the queue. This means the newest packets are the ones discarded.

- Random Early Discards (RED): Proactively drops packets before a queue becomes full, signaling to the sender to reduce transmission rate, thereby preventing congestion.

Note: RED (Random Early Detection) helps manage TCP throughput by dropping packets before a queue becomes completely full. This early packet dropping signals TCP senders to proactively reduce their congestion window size, effectively throttling back the traffic to better match the available bandwidth.

QoS class-default

The class class-default is automatically created and any traffic that does not match any of the class-map is automatically assign to class-default for best effort delivery. However, a different action can be assigned for it.

QoS Class-Default (not defined) Behavior on Cisco Catalyst SD-WAN Manager

Since class-default is automatically created when QoS is configured and the class is not defined explicitly on the QoS localized policy, Queue 2 is assigned automatically. Therefore, the statistics about forwarding class class-default which is not defined are not shown on Manager GUI.

A separate class needs to be created to mark and classify the traffic that does not match in any class-map previously defined, because Cisco Catalyst SD-WAN Manager does not collect statistics on the class class-default.

QoS Localized Policy example**:**

```
<#root>
policy
 access-list QoS-Classification
     sequence 1
      action accept


class Default <--- Classify the traffic to Forwarding Class Default (match any dscp that is not assigned


     sequence 11
      match


dscp 48

      action accept


 class CS6

     sequence 21
      match


 dscp 26

      action accept


class AF31


   default-action accept

   qos-scheduler QOS-MAP-V01_0
    class Queue0
    bandwidth-percent 42
    buffer-percent 42
    scheduling llq
    drops tail-drop
    burst 15000

   qos-scheduler QOS-MAP-V01_1
    class Queue1
    bandwidth-percent 16
    buffer-percent 16
    scheduling wrr
    drops tail-drop

   qos-scheduler QOS-MAP-V01_3
    class Queue3
    bandwidth-percent 11
    buffer-percent 11
    scheduling wrr
    drops red-drop
```

```
  qos-scheduler QOS-MAP-V01_4
   class Queue4
   bandwidth-percent 9
   buffer-percent 9
   scheduling wrr
   drops red-drop

  qos-scheduler QOS-MAP-V01_5
   class Queue5
   bandwidth-percent 6
   buffer-percent 6
   scheduling wrr
   drops red-drop

  qos-scheduler QOS-MAP-V01_2
   class Queue2
   bandwidth-percent 16
   buffer-percent 16
   scheduling wrr
   drops tail-drop

  qos-map QOS-MAP-V01
   qos-scheduler QOS-MAP-V01_0
   qos-scheduler QOS-MAP-V01_1
   qos-scheduler QOS-MAP-V01_3
   qos-scheduler QOS-MAP-V01_4
   qos-scheduler QOS-MAP-V01_5
   qos-scheduler QOS-MAP-V01_2

  class-map
   class AF2x queue 5
   class AF3x queue 4
   class AF4x queue 3
```

class DEFAULT queue 2

<--- Assign the Forwarding Class Default to Queue 2

```
   class CS6 queue 1
   class Queue0 queue 0
   class Queue1 queue 1
   class Queue2 queue 2
   class Queue3 queue 3
   class Queue4 queue 4
   class Queue5 queue 5
```

From Cisco Edge Router CLI:

In this example, the **DSCP 8** is used and is not classified in any forwarding class:

<#root>

```
Router#
```

ping vrf 4001 10.19.253.1 dscp 8 repeat 4000

```
Type escape sequence to abort.
Sending 4000, 100-byte ICMP Echos to 172.19.253.1, timeout is 2 seconds:
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!!!!!!!!!!
Success rate is 100 percent (4000/4000), round-trip min/avg/max = 1/1/2 ms
```

Use the command **show policy-map interface** to validate that the Class Map configuration.

<#root>

Router#

show policy-map interface GigabitEthernet0/0/0

Service-policy output: QOS-MAP-V01

```
queue stats for all priority classes:
Queueing
priority level 1
queue limit 512 packets
(queue depth/total drops/no-buffer drops) 0/0/0
(pkts output/bytes output) 2355461/1168305717
```

Class-map: Queue0 (match-any)

```
2355461 packets, 1168305717 bytes
30 second offered rate 8000 bps, drop rate 0000 bps
Match: qos-group 0
police:
rate 42 %
rate 420000000 bps, burst 13125000 bytes
conformed 2355461 packets, 1168305717 bytes; actions:
transmit
exceeded 0 packets, 0 bytes; actions:
drop
conformed 8000 bps, exceeded 0000 bps
Priority: Strict, b/w exceed drops: 0

Priority Level: 1
```

Class-map: Queue1 (match-any)

```
0 packets, 0 bytes
30 second offered rate 0000 bps, drop rate 0000 bps
Match: qos-group 1
Queueing
queue limit 1250 packets
(queue depth/total drops/no-buffer drops) 0/0/0
(pkts output/bytes output) 0/0
bandwidth remaining ratio 16
```

Class-map: Queue3 (match-any)

```
0 packets, 0 bytes
30 second offered rate 0000 bps, drop rate 0000 bps
Match: qos-group 3
Queueing
queue limit 1250 packets
```

(queue depth/total drops/no-buffer drops) 0/0/0
(pkts output/bytes output) 0/0
bandwidth remaining ratio 11
Exp-weight-constant: 9 (1/512)
Mean queue depth: 0 packets

class	Transmitted pkts/bytes	Random drop pkts/bytes	Tail drop pkts/bytes	Minimum thresh	Maximum thresh	Mark prob
0	0/0	0/0	0/0	312	625	1/10
1	0/0	0/0	0/0	351	625	1/10
2	0/0	0/0	0/0	390	625	1/10
3	0/0	0/0	0/0	429	625	1/10
4	0/0	0/0	0/0	468	625	1/10
5	0/0	0/0	0/0	507	625	1/10
6	0/0	0/0	0/0	546	625	1/10
7	0/0	0/0	0/0	585	625	1/10

Class-map: Queue4 (match-any)

0 packets, 0 bytes
30 second offered rate 0000 bps, drop rate 0000 bps
Match: qos-group 4
Queueing
queue limit 1250 packets
(queue depth/total drops/no-buffer drops) 0/0/0
(pkts output/bytes output) 0/0
bandwidth remaining ratio 9
Exp-weight-constant: 9 (1/512)
Mean queue depth: 0 packets

class	Transmitted pkts/bytes	Random drop pkts/bytes	Tail drop pkts/bytes	Minimum thresh	Maximum thresh	Mark prob
0	0/0	0/0	0/0	312	625	1/10
1	0/0	0/0	0/0	351	625	1/10
2	0/0	0/0	0/0	390	625	1/10
3	0/0	0/0	0/0	429	625	1/10
4	0/0	0/0	0/0	468	625	1/10
5	0/0	0/0	0/0	507	625	1/10
6	0/0	0/0	0/0	546	625	1/10
7	0/0	0/0	0/0	585	625	1/10

Class-map: Queue5 (match-any)

0 packets, 0 bytes
30 second offered rate 0000 bps, drop rate 0000 bps
Match: qos-group 5
Queueing
queue limit 1250 packets
(queue depth/total drops/no-buffer drops) 0/0/0
(pkts output/bytes output) 0/0
bandwidth remaining ratio 6
Exp-weight-constant: 9 (1/512)
Mean queue depth: 0 packets

class	Transmitted pkts/bytes	Random drop pkts/bytes	Tail drop pkts/bytes	Minimum thresh	Maximum thresh	Mark prob
0	0/0	0/0	0/0	312	625	1/10
1	0/0	0/0	0/0	351	625	1/10
2	0/0	0/0	0/0	390	625	1/10

```
3 0/0 0/0 0/0 429 625 1/10
4 0/0 0/0 0/0 468 625 1/10
5 0/0 0/0 0/0 507 625 1/10
6 0/0 0/0 0/0 546 625 1/10
7 0/0 0/0 0/0 585 625 1/10


Class-map: class-default (match-any)


<<<< Created by default, not defined in the policy


131264 packets, 15640913 bytes


30 second offered rate 0000 bps, drop rate 0000 bps
Match: any
Queueing
queue limit 1250 packets
(queue depth/total drops/no-buffer drops) 0/0/0

(pkts output/bytes output) 120019/11394812


bandwidth remaining ratio 16
```
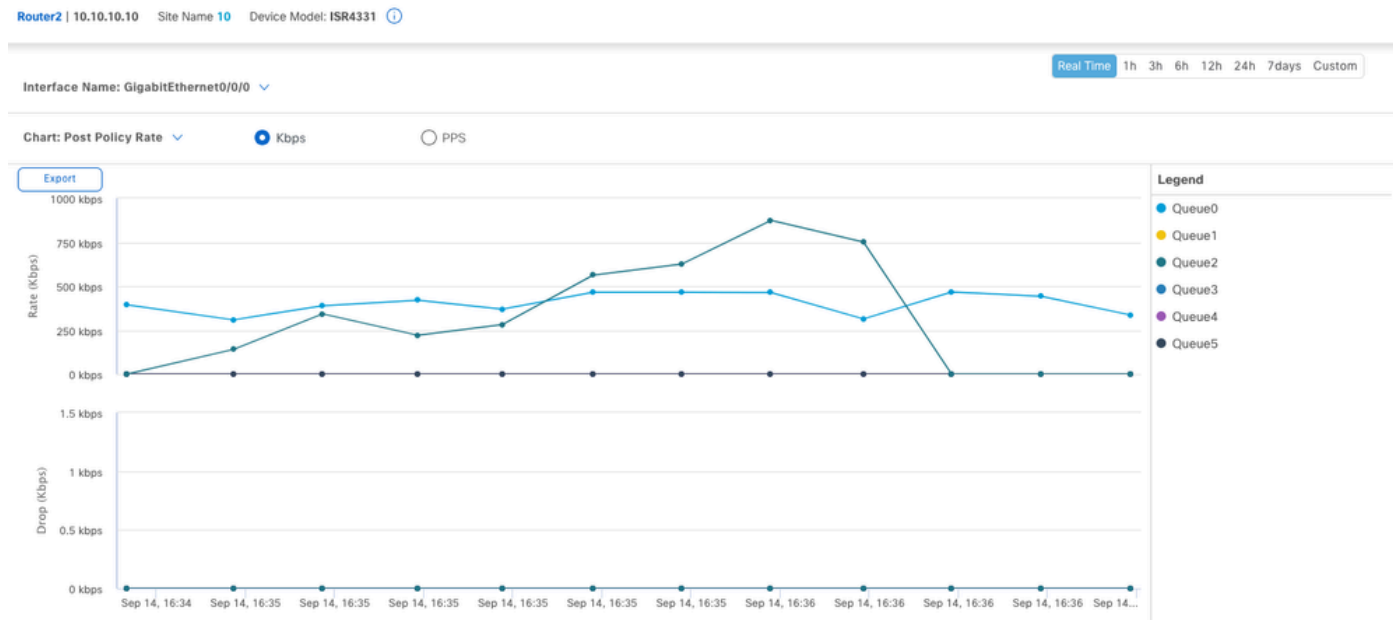
From Cisco Catalyst SD-WAN Manager GUI the traffic matched in the Queue2 is shown in the graphs but is not shown as class-default class:

QoS Monitor Graphs From Cisco Catalyst SD-WAN Manager

Verify

To identify the QoS Queue for the packets, it can validate through the FIA Trace.

Configure the FIA Trace condition on the LAN interface (GigabitEthernet0/0/0) where QoS Classification is

enabled.

<#root>

```
clear platform condition all
debug platform packet-trace packet 2048 fia-trace data-size 2048
```

debug platform condition interface GigabitEthernet0/0/0 both

Run the command **debug platform condition start** to start the FIA Trace.

Run the command **debug platform condition stop** to stop the FIA Trace.

Run the command **show platform packet-trace summary** to display the FIA Trace packets.

<#root>

Router2

#show platform packet-trace packet 0 decode

```
Packet: 0 CBUG ID: 5952
Summary
Input : INJ.2
```

Output : GigabitEthernet0/0/0

State : FWD

```
Timestamp
Start : 1032236067625063 ns (09/14/2024 21:33:39.652978 UTC)
Stop : 1032236067714747 ns (09/14/2024 21:33:39.653068 UTC)

Path Trace
Feature: IPV4(Input)
Input : internal0/0/rp:0
Output : <unknown>
```

Source : 192.168.1.2

Destination : 172.19.253.2

Protocol : 1 (ICMP)

```
Feature: SDWAN Internal Intf
VRF ID : 9
Encap Type : unknown
```

IP DSCP : 8

```
IP Version : 4
IP Protocol : 1
Dst Port : 0
Is Marked High Priority : NO
Is SDWAN Control Tunnel Traffic : NO
Set HIGH_QUEUE : NO (NOT marked high priority, NOT SD-WAN control tunnel traffic)
Skip SDWAN Policy : FALSE


 Feature: SDWAN QoS Output


Fwd Class ID : 0

QoS Queue : 2  <<<<<<< Packet assigned to Queue2 (Output in Egress Transport interface)


DSCP Rewrite : No
CoS Rewrite : No
EXP Rewrite : No
Rewrite Rule : n/a


 Feature: QOS


Direction : Egress
Action : FWD
Pak Priority : FALSE
Priority : FALSE
Queue ID : 127 (0x7f)
PAL Queue ID : 1073741826 (0x40000002)
Queue Limit : 1250
WRED enabled : FALSE
Inst Queue len : 0
Avg Queue len : n/a
Policy name : QOS-MAP-V01

Class name : class-default <<<< Created by default (not defined in the policy)
```

Related Information

[Cisco Catalyst SD-WAN Forwarding and QoS Configuration Guide](#)

[Cisco Catalyst SD-WAN Forwarding and QoS Overview](#)