Catalyst 9000 Switching QoS Deep Dive

Ninad Diwakar, Technical Marketing Engineer (TME)

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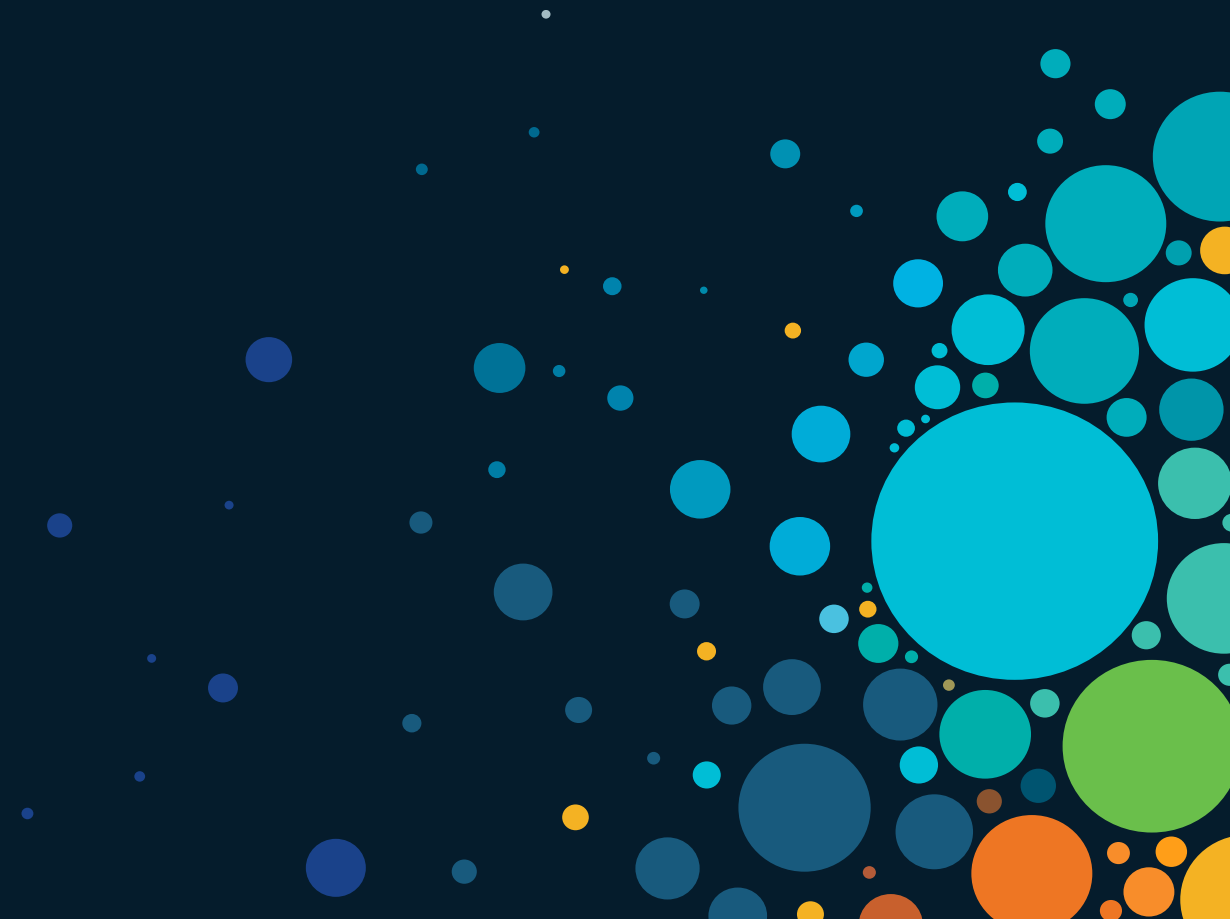## until February 24, 2023.
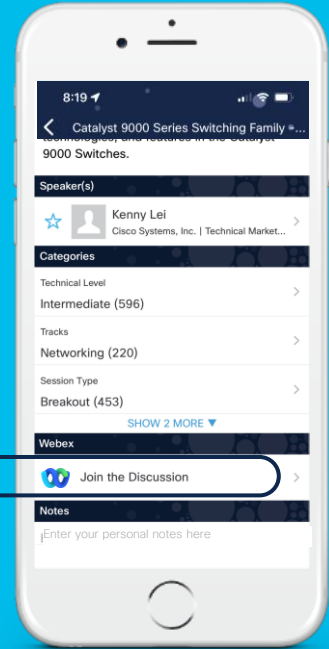
Agenda

- QoS Overview

- UADP QoS Architecture
  - Classification, Marking and Policing
  - Queueing, Shaping and Scheduling
  - Congestion Management and Buffers

- Silicon One Q200 QoS (VoQ) Architecture
  - Classification, Marking and Policing
  - Queueing, Shaping and Scheduling
  - Congestion Management and Buffers

- Config Migration to Catalyst 9K Switches

- Conclusion

Overview

Look familiar?

Why QoS in campus?

User Experience

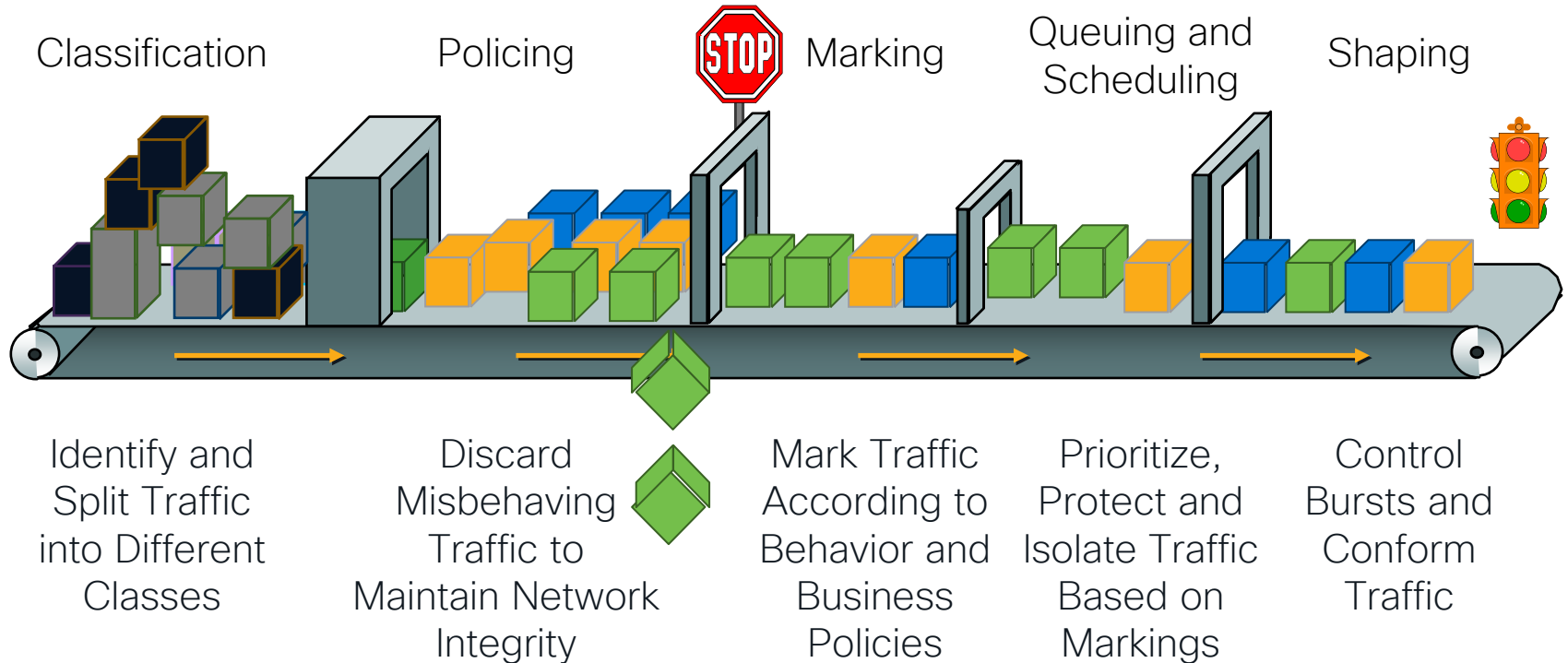|		
Guaranteeing voice quality	Bandwidth Savvy Business Applications	protect network infrastructure to deal with abnormal events
Video Quality	de-prioritizing non-business applications	protecting the control planes

The QoS Toolset

Classification — Identify and Split Traffic into Different Classes

Policing — Discard Misbehaving Traffic to Maintain Network Integrity

Marking — Mark Traffic According to Behavior and Business Policies

Queuing and Scheduling — Prioritize, Protect and Isolate Traffic Based on Markings

Shaping — Control Bursts and Conform Traffic

Modular QoS CLI (MQC)

class-map
    What traffic do we care about?

policy-map
    What actions do we take on the classes?

service-policy
    Where do we apply the policy?

```
class-map match-any Voice
  match dscp ef
class-map match-any Video
  match dscp 34


Policy-map POLICY-QOS
  class Voice
    priority level 1
  class Video
    set dscp 10


interface x/y
  service-policy (input/output) POLICY-QOS
```

UADP QoS

Catalyst 9000 Switches with UADP ASICs

UADP 3.0x

Catalyst 9400X models
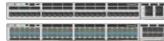
Catalyst 9500 High performance Series

Catalyst 9600 Series with Sup-1

UADP 2.0x

Catalyst® 9200CX Series

Catalyst 9300X models

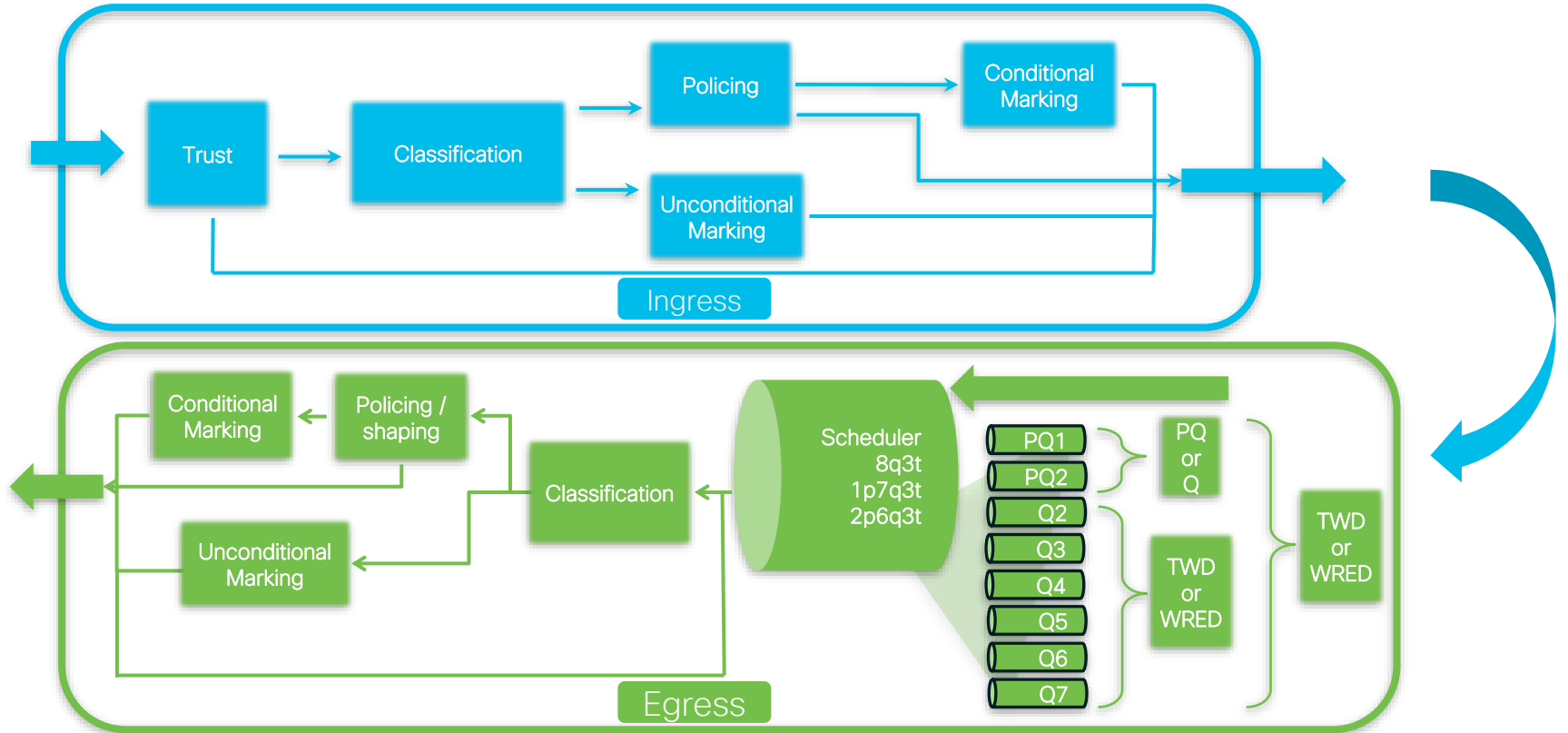Catalyst 9400 Series

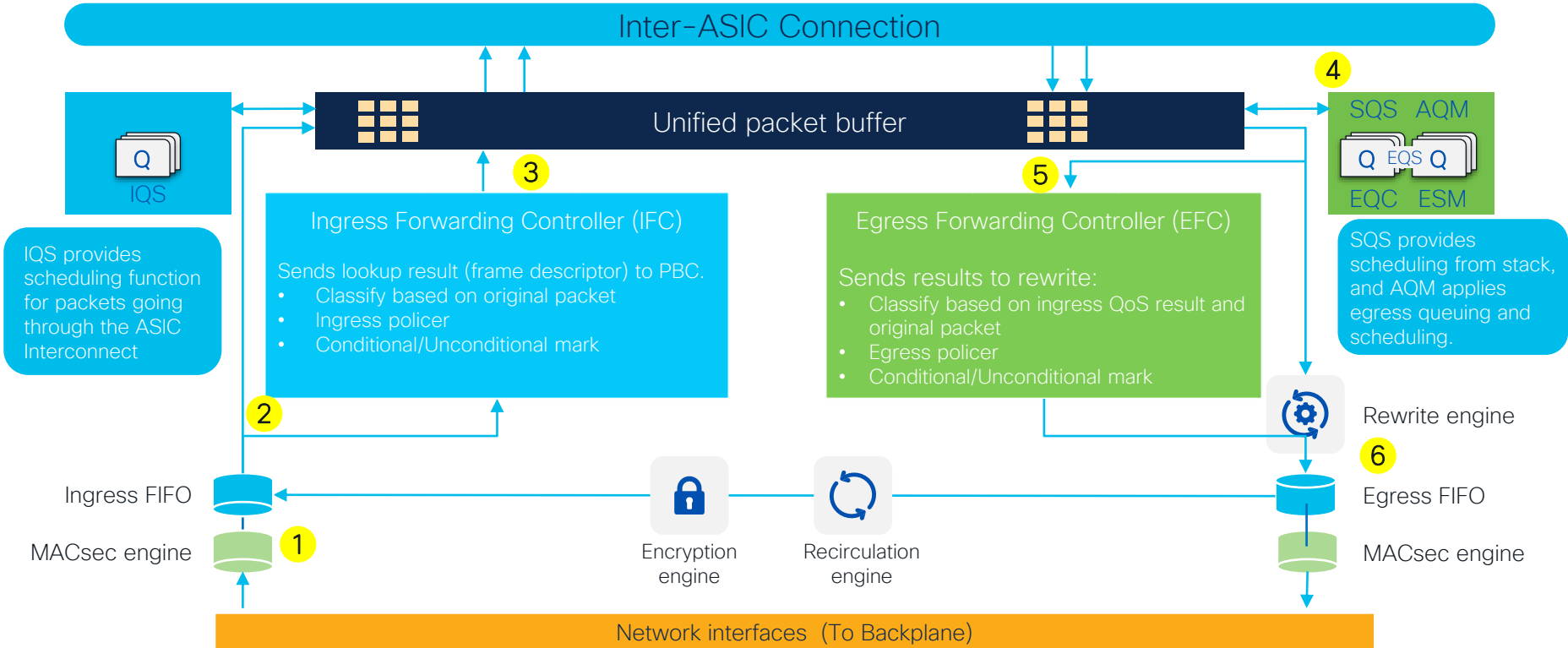Catalyst 9200 Series

Catalyst 9300 Series

Catalyst 9500 Series

QoS Fundamental Actions in UADP

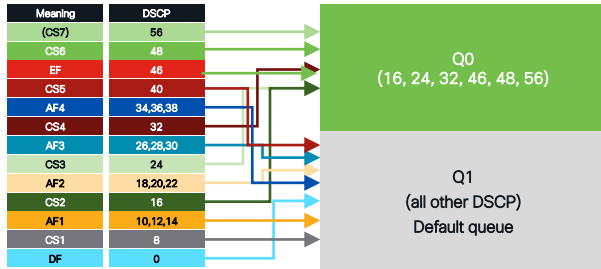WRED: up to 4 queues with UADP 2.0x; up to 8 queues with UADP 3.0x

UADP QoS forwarding
Ingress and egress

Inter–ASIC Connection

Unified packet buffer

IQS

IQS provides scheduling function for packets going through the ASIC Interconnect

3

Ingress Forwarding Controller (IFC)

Sends lookup result (frame descriptor) to PBC.
- Classify based on original packet
- Ingress policer
- Conditional/Unconditional mark

5

Egress Forwarding Controller (EFC)

Sends results to rewrite:
- Classify based on ingress QoS result and original packet
- Egress policer
- Conditional/Unconditional mark

4

SQS AQM

Q EQS Q

EQC ESM

SQS provides scheduling from stack, and AQM applies egress queuing and scheduling.

2

Rewrite engine

6

Ingress FIFO

MACsec engine **1**

Encryption engine

Recirculation engine

Egress FIFO

MACsec engine

Network interfaces (To Backplane)

UADP QoS Default

- Catalyst 9000 Switches with UADP ASICs
  - QoS enabled
  - All ports trust at layer2 and layer3
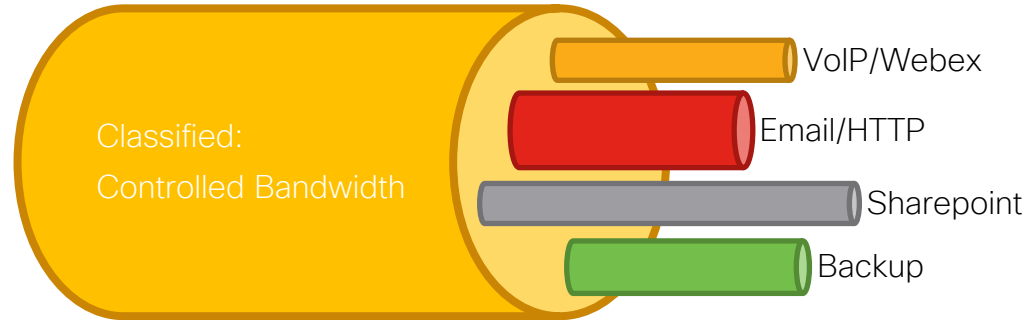 - Two queues (neither set as priority)

Meaning	DSCP
(CS7)	56
CS6	48
EF	46
CS5	40
AF4	34,36,38
CS4	32
AF3	26,28,30
CS3	24
AF2	18,20,22
CS2	16
AF1	10,12,14
CS1	8
DF	0

Q0
(16, 24, 32, 46, 48, 56)

Q1
(all other DSCP)
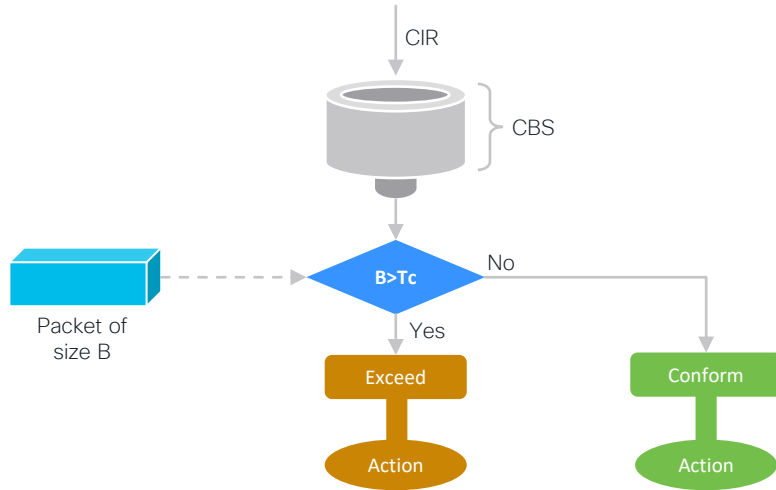Default queue

Classification and Marking

- Identify traffic
  - Access Control Lists (ACLs)
  - DSCP
  - IP precedence
  - CoS
  - QoS Group (local with the switch)
  - EXP (MPLS)
  - Network-Based Application Recognition (NBAR) protocols *
  - VLANs

- Marking
  - Conditional or unconditional
  - Table map (default-class)
  - QoS group (local within switch)

* Access platforms

Unclassified:
Uncontrolled Bandwidth

Webex
mgmt
HTTP
email
Sharepoint
Backup

Classified:
Controlled Bandwidth

VoIP/Webex
Email/HTTP
Sharepoint
Backup

CISCO Live!

Policing – Limit the traffic

1 rate 2 color

CIR

CBS

Packet of size B

B>Tc

No

Yes

Exceed → Action

Conform → Action

```
police cir 1g bc 3125000
    conform-action set-dscp-transmit af41
    exceed-action drop
```

2 rate 3 color

PIR

CIR

PBS

CBS

Packet of size B

B>Tp

No

B>Tc

No

Yes

Yes

Violate → Action

Exceed → Action

Conform → Action

```
police cir percent 10 pir percent 50
    conform-action transmit
    exceed-action set-dscp-transmit dscp table MARKDOWN
    violate-action drop
```

CIR – Committed Information Rate
PIR – Peak Information Rate

PBS- Peak Burst Size
CBS – Committed Burst Size
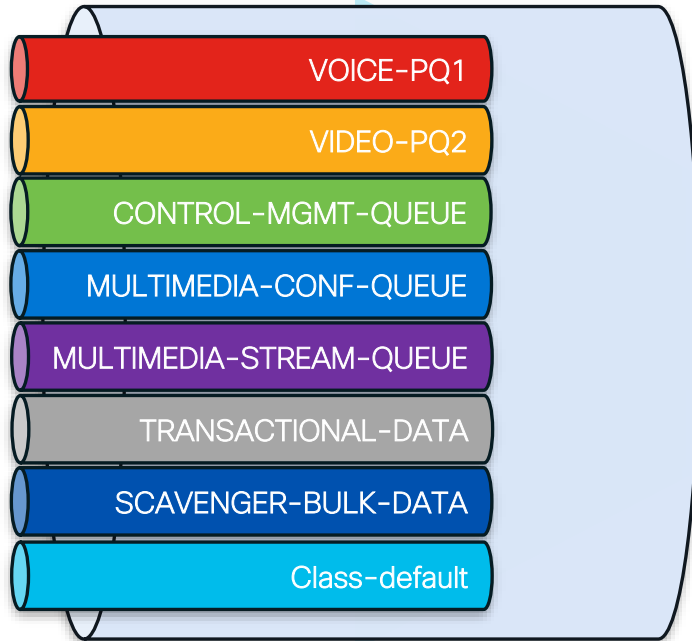
Queueing, Scheduling and Shaping
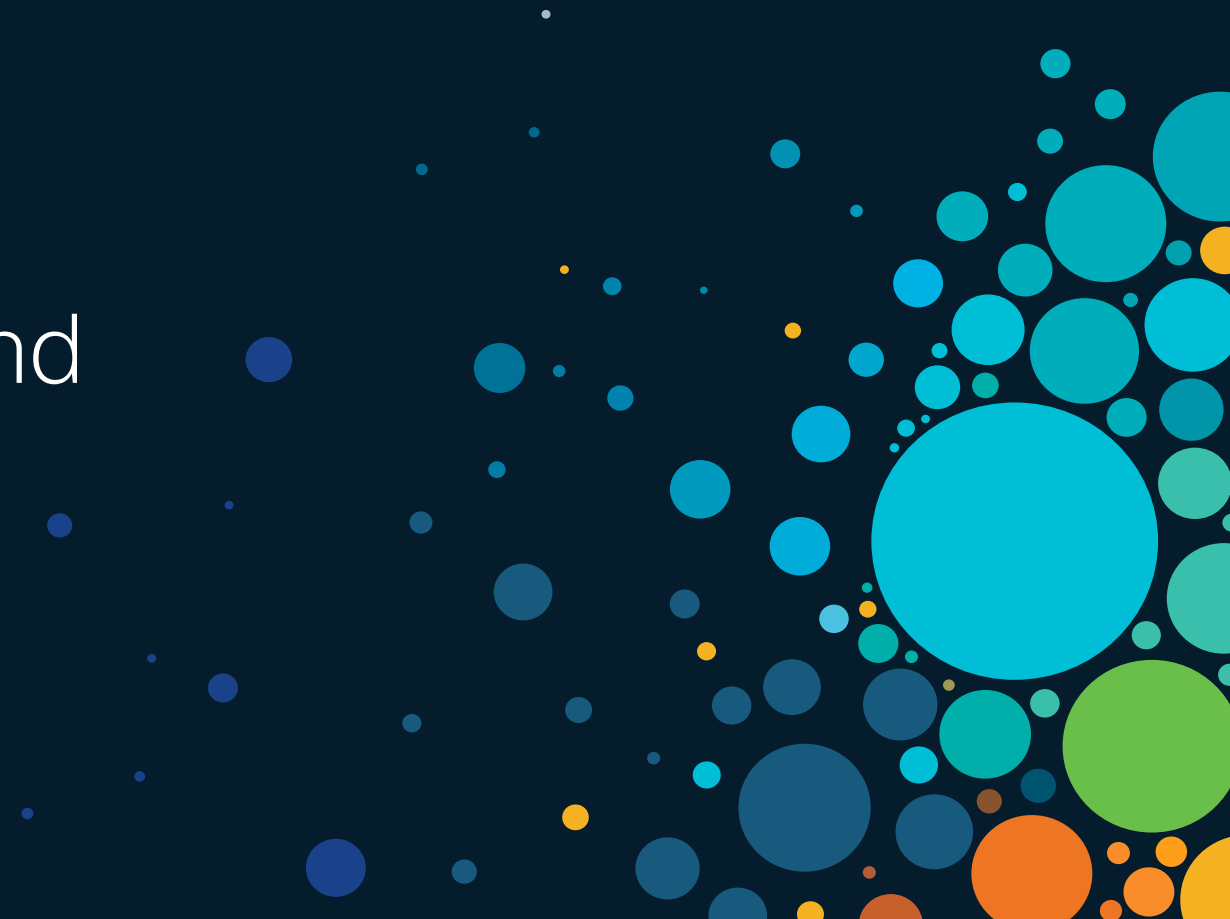
Queueing

- Separate the traffic into the queues

- Traffic in different queue can be treated differently

- Up-to 8 queues per interface, 2 of which can be priority-queues (PQ).

- Both priority-queues are strict priority queues.

- Policer or a shaper on the priority queue will limit the traffic to the configured value regardless of the traffic level on other queues.

Q0
Q1
Q2
Q3
Q4
Q5
Q6
Q7

PQ or Q

Buffer Memory
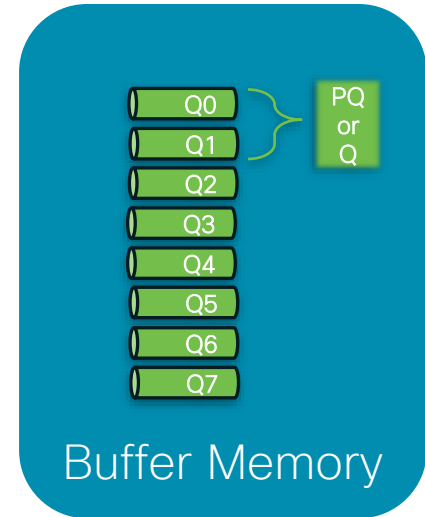
Queueing
2P6Q3T Example

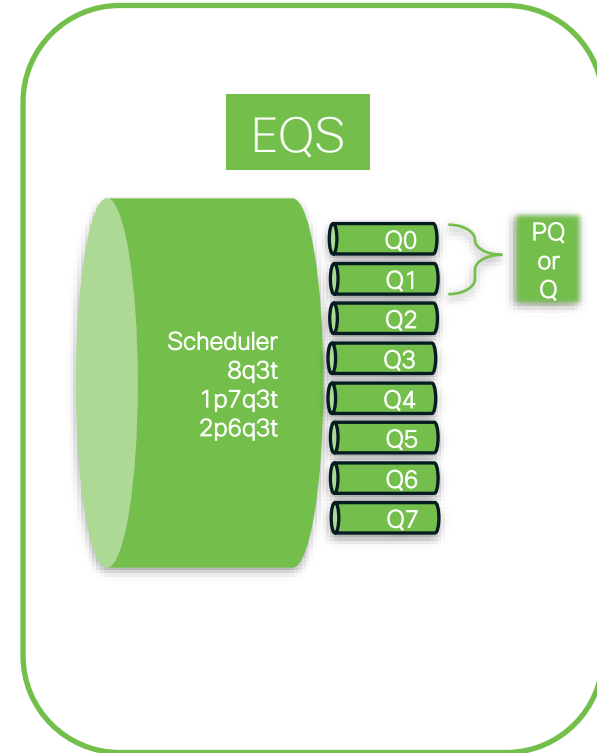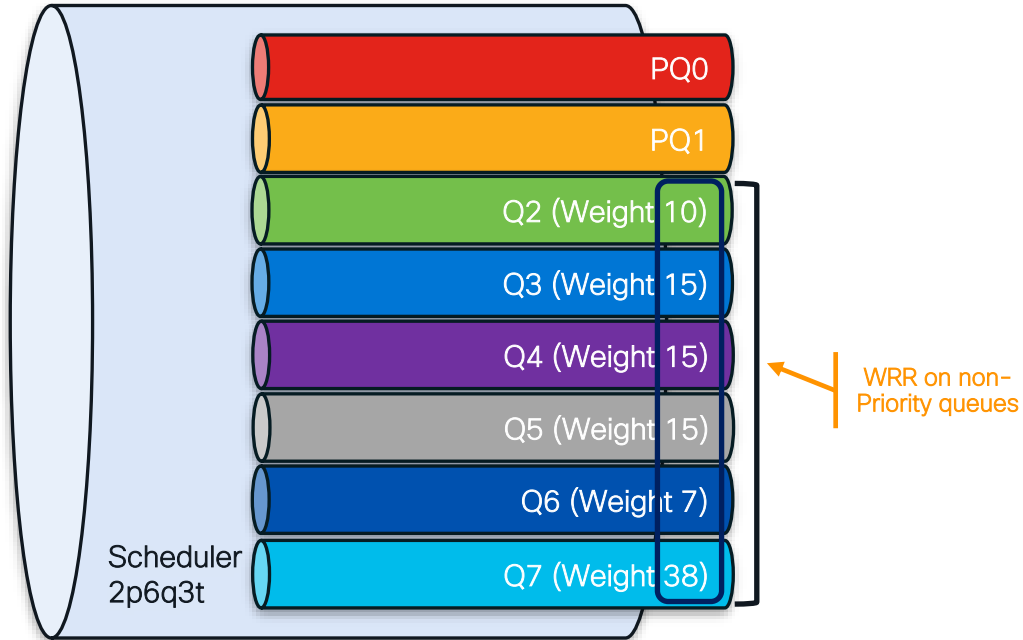| Queue |
|---|
| VOICE-PQ1 |
| VIDEO-PQ2 |
| CONTROL-MGMT-QUEUE |
| MULTIMEDIA-CONF-QUEUE |
| MULTIMEDIA-STREAM-QUEUE |
| TRANSACTIONAL-DATA |
| SCAVENGER-BULK-DATA |
| Class-default |

Policy Map Configuration

```
policy-map 2P6Q3T
class VOICE-PQ1
  priority level 1
class VIDEO-PQ2
  priority level 2
class CONTROL-MGMT-QUEUE
  bandwidth remaining percent 10
class MULTIMEDIA-CONFERENCING-QUEUE
  bandwidth remaining percent 15
class MULTIMEDIA-STREAMING-QUEUE
  bandwidth remaining percent 15
class TRANSACTIONAL-DATA-QUEUE
  bandwidth remaining percent 15
class SCAVENGER-BULK-DATA-QUEUE
  bandwidth remaining percent 7
class class-default
  bandwidth remaining percent 38
```

Scheduling – UADP

- Scheduling defines the order of transmission of traffic out of the queues

- Different type of queues are served differently
  - Strict priority queues
    - Always serviced first
    - With 2 PQs, level1 over level 2
  - Normal queues
    - Served only after priority queues are empty
    - Use Weighted Round Robin (WRR) for scheduling

- WRR servers normal queue based on the weight and packet size

- Egress Queue System (EQS) is the component on the UADP ASIC responsible for the scheduling

Scheduling - Example

Scheduler
2p6q3t

PQ0
PQ1
Q2 (Weight 10)
Q3 (Weight 15)
Q4 (Weight 15)
Q5 (Weight 15)
Q6 (Weight 7)
Q7 (Weight 38)

WRR on non-Priority queues

Policy Map Configuration

```
policy-map 2P6Q3T
  class VOICE-PQ1
    priority level 1
  class VIDEO-PQ2
    priority level 2
  class CONTROL-MGMT-QUEUE
    bandwidth remaining percent 10
  class MULTIMEDIA-CONFERENCING-QUEUE
    bandwidth remaining percent 15
  class MULTIMEDIA-STREAMING-QUEUE
    bandwidth remaining percent 15
  class TRANSACTIONAL-DATA-QUEUE
    bandwidth remaining percent 15
  class SCAVENGER-BULK-DATA-QUEUE
    bandwidth remaining percent 7
  class class-default
    bandwidth remaining percent 38
```

Shaping

- Smooth out traffic peaks, microburst, with preserving traffic

- Control traffic rate to the desired value with buffering.

- Usually in the egress direction

Shaping Example

```
policy-map Shaper
    class Transactions
    shape average percent 30
```
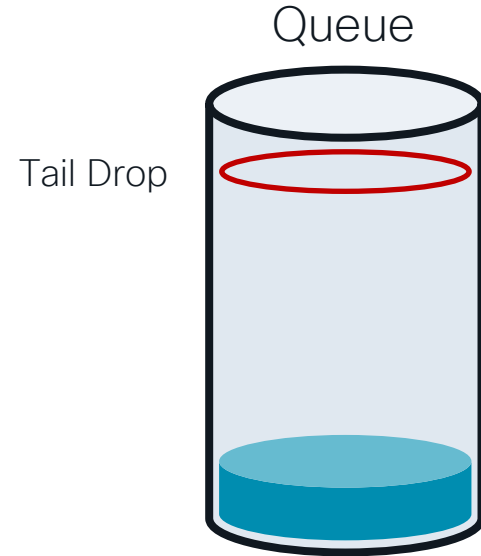
Original traffic

With shaping
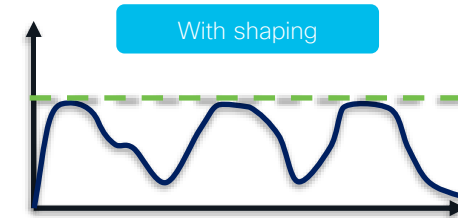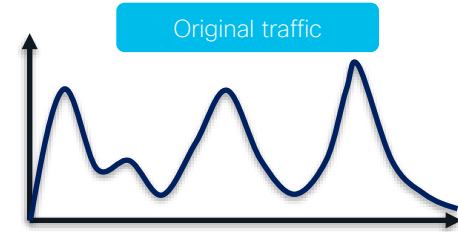
UADP
Congestion
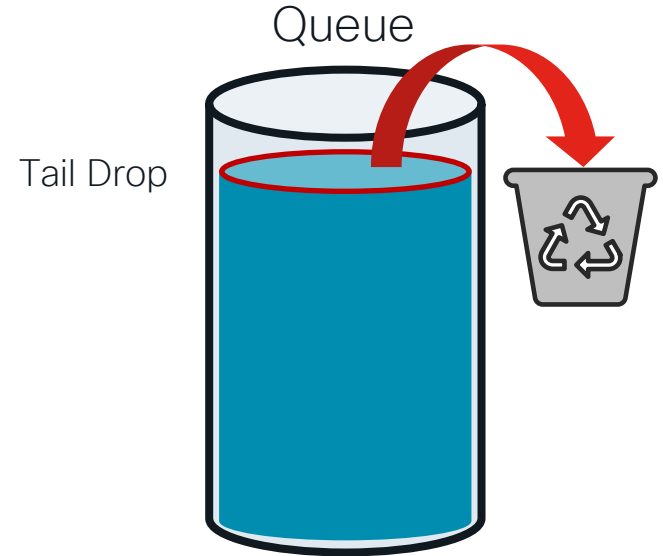# Management

Congestion Management Tools

- Tail Drop (TD)
  - Drop packets at tail of the queue
  - Single threshold per queue
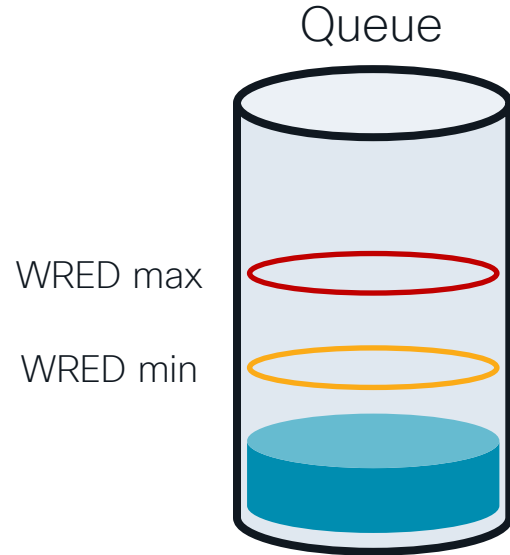
Queue

Tail Drop

Congestion Management Tools

- Tail Drop (TD)
  - Drop packets at tail of the queue
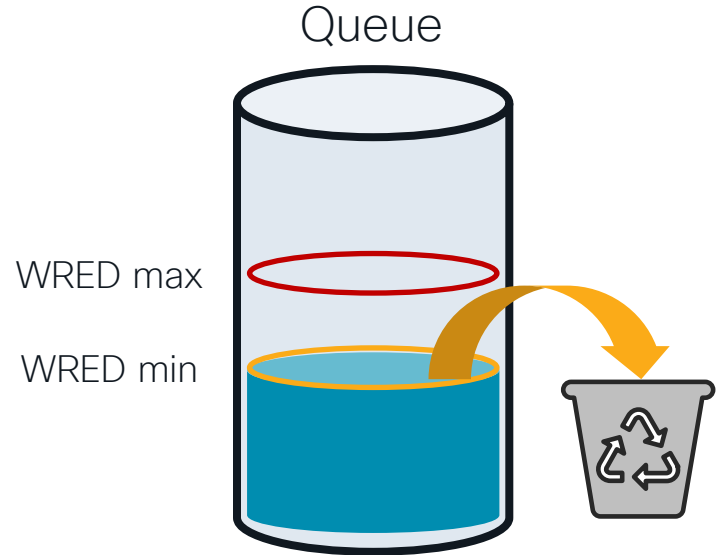 - Single threshold per queue

Queue

Tail Drop

CISCO *Live!*

Congestion Management Tools

- Tail Drop (TD)
  - Drop packets at tail of the queue
  - Single threshold per queue

- Weighted Random Early Drop (WRED)
  - One or more thresholds per queue
  - Threshold associated with priority
  - Buffer usage below threshold no affect

Queue

WRED max

WRED min

Congestion Management Tools

- Tail Drop (TD)
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  - One or more thresholds per queue
  - Threshold associated with priority
 - Buffer usage below threshold no affect
  - Buffer usage over min threshold = random drops

Queue

WRED max

WRED min

Congestion Management Tools

- Tail Drop (TD)
  - Drop packets at tail of the queue
  - Single threshold per queue

- Weighted Random Early Drop (WRED)
  - One or more thresholds per queue
  - Threshold associated with priority
  - Buffer usage below threshold no affect
  - Buffer usage over min threshold = random drops
  - Buffer usage over max threshold = all traffic drop

Queue

WRED max

WRED min
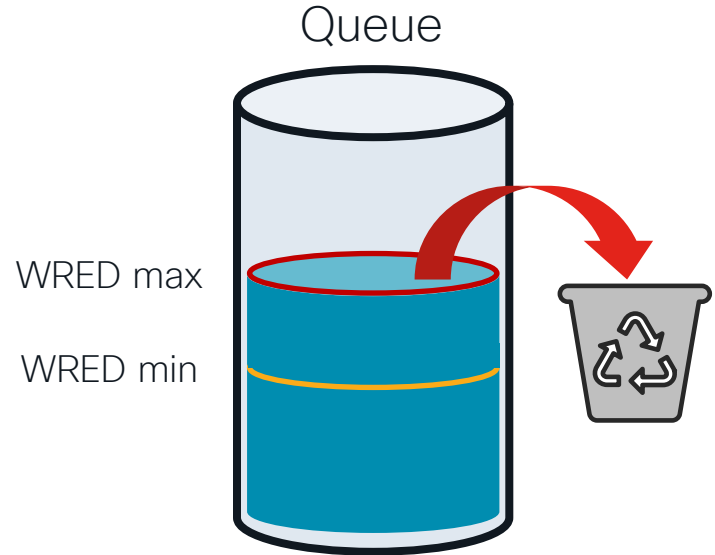
UADP – Congestion Management
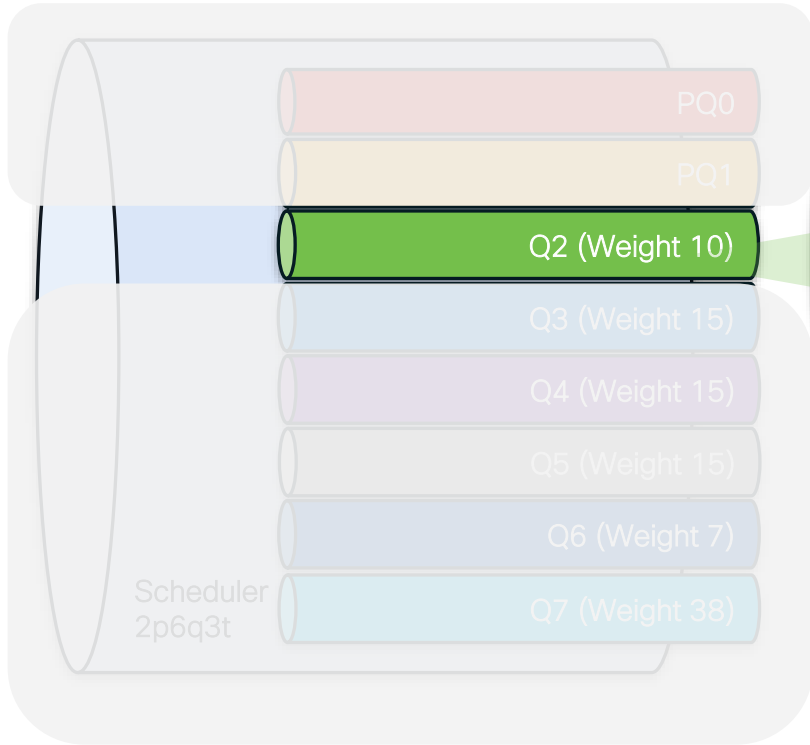
Weighted Tail Drop (WTD)

- Default
- For non-priority queues
- Up to 3 thresholds per queue, one threshold per QoS tag
- Each queue need to use same QoS tag type

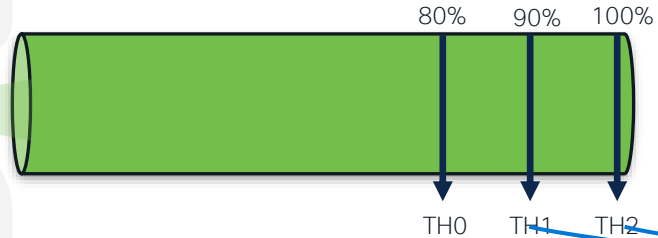## Weighted Random Early Detection (WRED)

- For non-priority queues
- Up to 4 queues with UADP 2.0X and up to 8 queues with UADP 3.0X
- Up to 3 threshold pairs per queue
- Each queue need to same QoS tag type

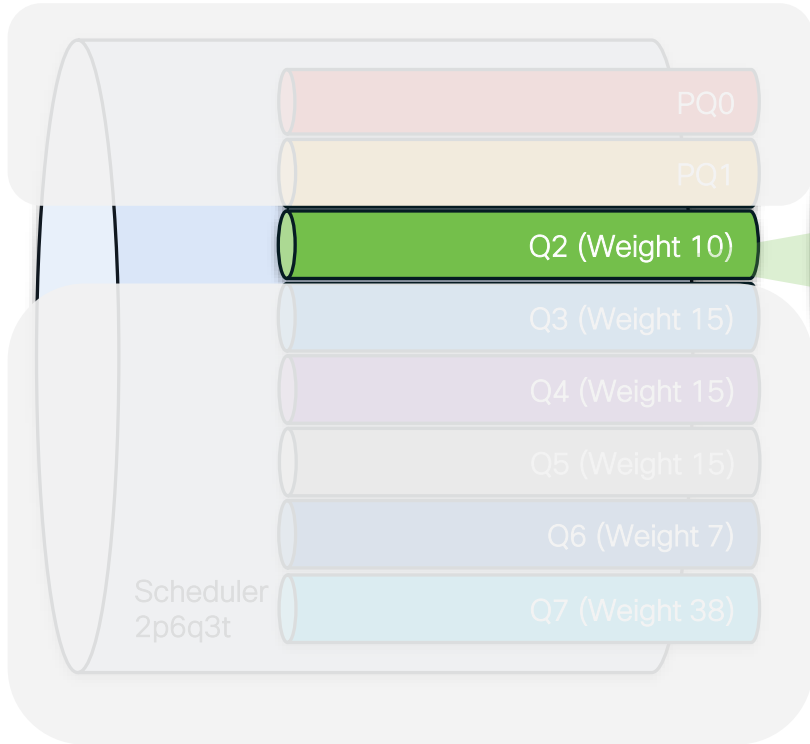Weighted -> Multiple pair of thresholds

WTD – UADP Example

Three thresholds to conditionally drop specific traffic in the event of congestion

PQ0

PQ1

Q2 (Weight 10)

Q3 (Weight 15)

Q4 (Weight 15)

Q5 (Weight 15)

Q6 (Weight 7)

Scheduler 2p6q3t

Q7 (Weight 38)

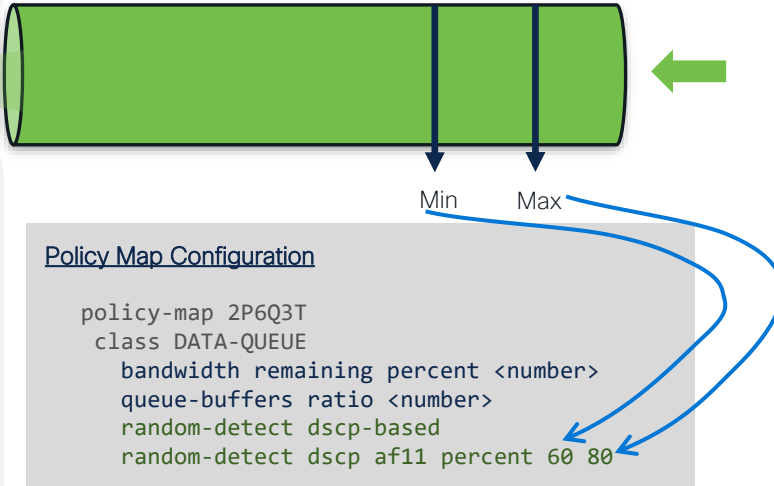80%   90%   100%

TH: threshold

TH0   TH1   TH2

Policy Map Configuration

```
policy-map 2P6Q3T
 class DATA-QUEUE
   queue-limit dscp values af13 cs1 percent
80
   queue-limit dscp values af12 percent 90
   queue-limit dscp values af11 percent 100
```

WRED – UADP Example

- Shown a single pair of WRED thresholds
- UADP supports up to 3 pairs of thresholds

PQ0
PQ1
Q2 (Weight 10)
Q3 (Weight 15)
Q4 (Weight 15)
Q5 (Weight 15)
Q6 (Weight 7)
Q7 (Weight 38)

Scheduler
2p6q3t

Min   Max

Policy Map Configuration

```
policy-map 2P6Q3T
  class DATA-QUEUE
    bandwidth remaining percent <number>
    queue-buffers ratio <number>
    random-detect dscp-based
    random-detect dscp af11 percent 60 80
```
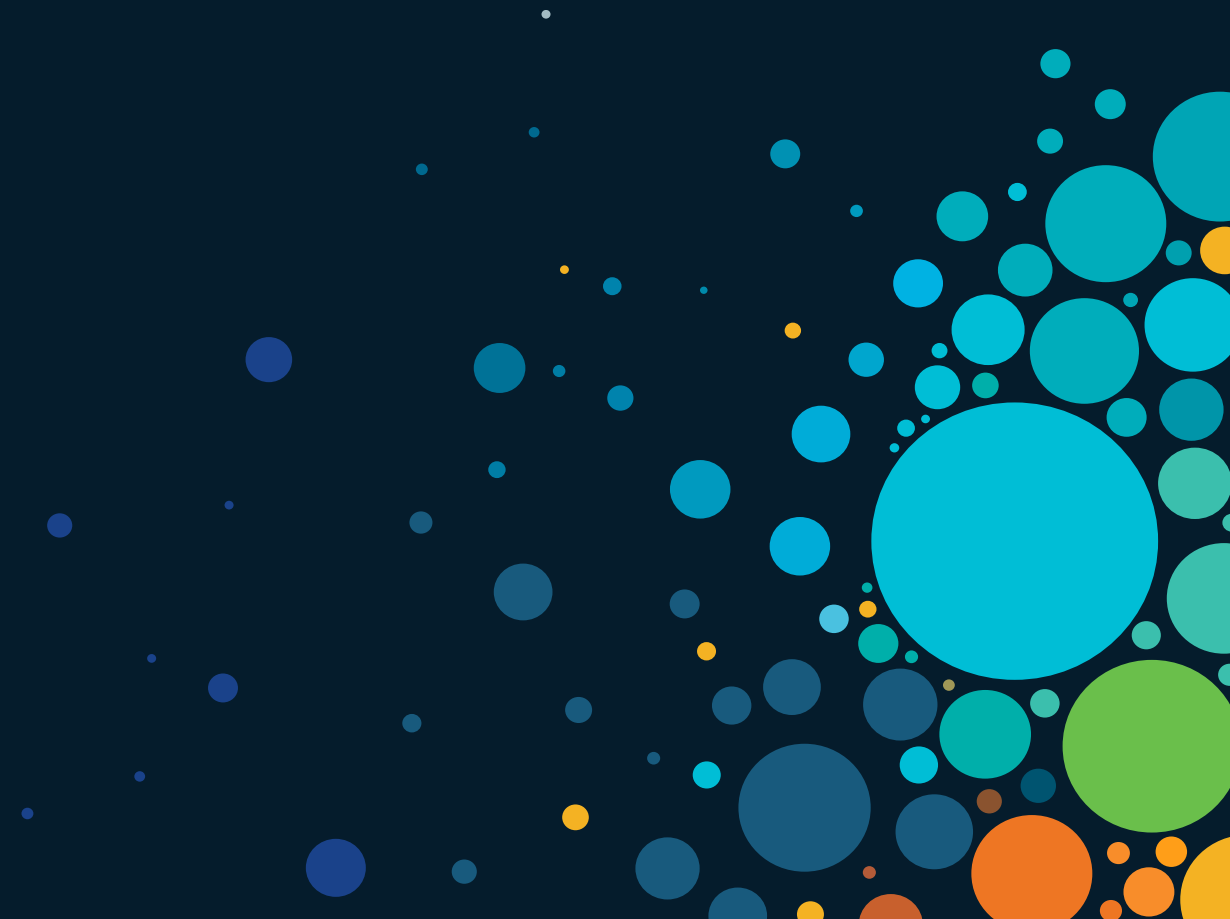
Buffers
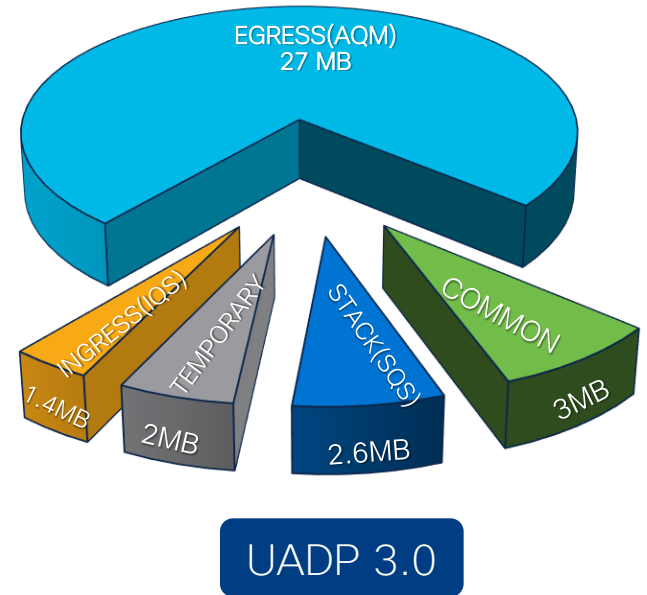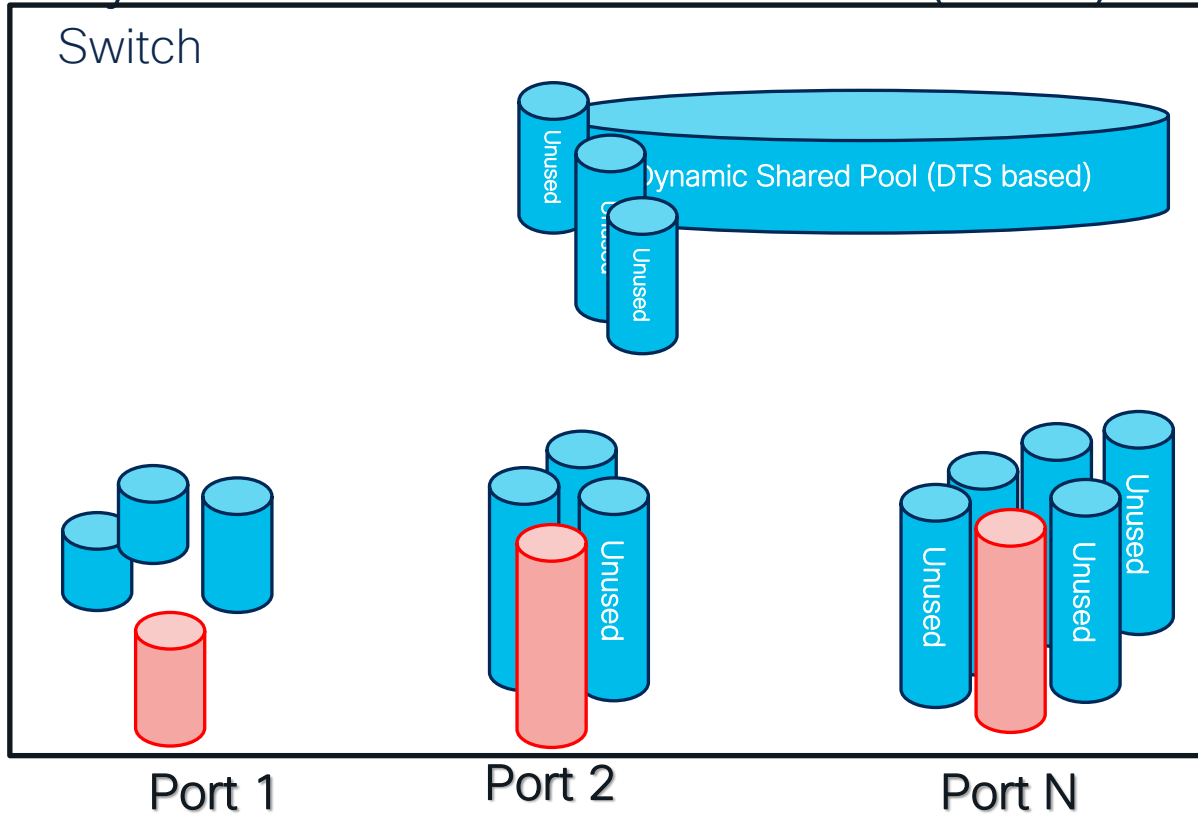
Buffers

- Resources consuming Packet buffer
  - Ingress Buffers (IQS)
  - Egress Stack Buffers(SQS)
  - Egress Port Buffers(AQM)
  - Temporary Buffers (FIFO)
  - Common Buffers (internal)

- Allocation
  - Dedicated and shared: use dedicated first then shared
  - Dynamic Threshold Scale (DTS): Algorithm to managed the shared buffer

- UADP 3.0 specific
  - Buffer can be shared across two cores
 - "qos share-buffer" to enable the unified buffer

EGRESS(AQM)
27 MB

INGRESS(IQS)
1.4MB

TEMPORARY
2MB

STACK(SQS)
2.6MB

COMMON
3MB

UADP 3.0

Dynamic Threshold Scale (DTS)

Switch

Dynamic Shared Pool (DTS based)

Unused

Port 1

Port 2

Port N

- Shared buffer is good for burst absorption.

- Dedicated buffer is good for predicated performance for each port.

- Buffer management is flexible: Dedicated plus shared.

- Configurable dedicated threshold per port/queue

- Configurable global maximum shared threshold

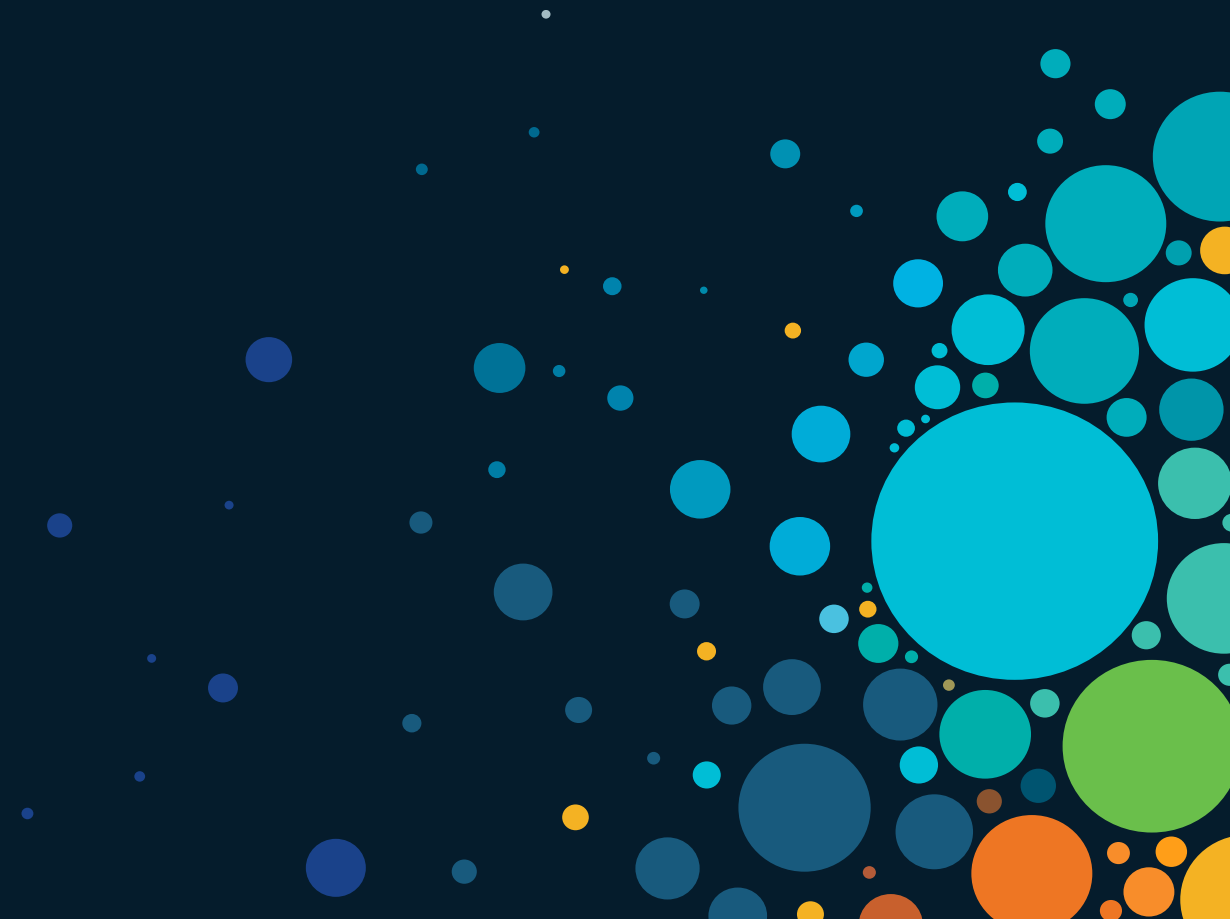- Automatically adjusted depends on the available shared pool

Dynamic Threshold Scale (DTS)
Buffer allocation graph
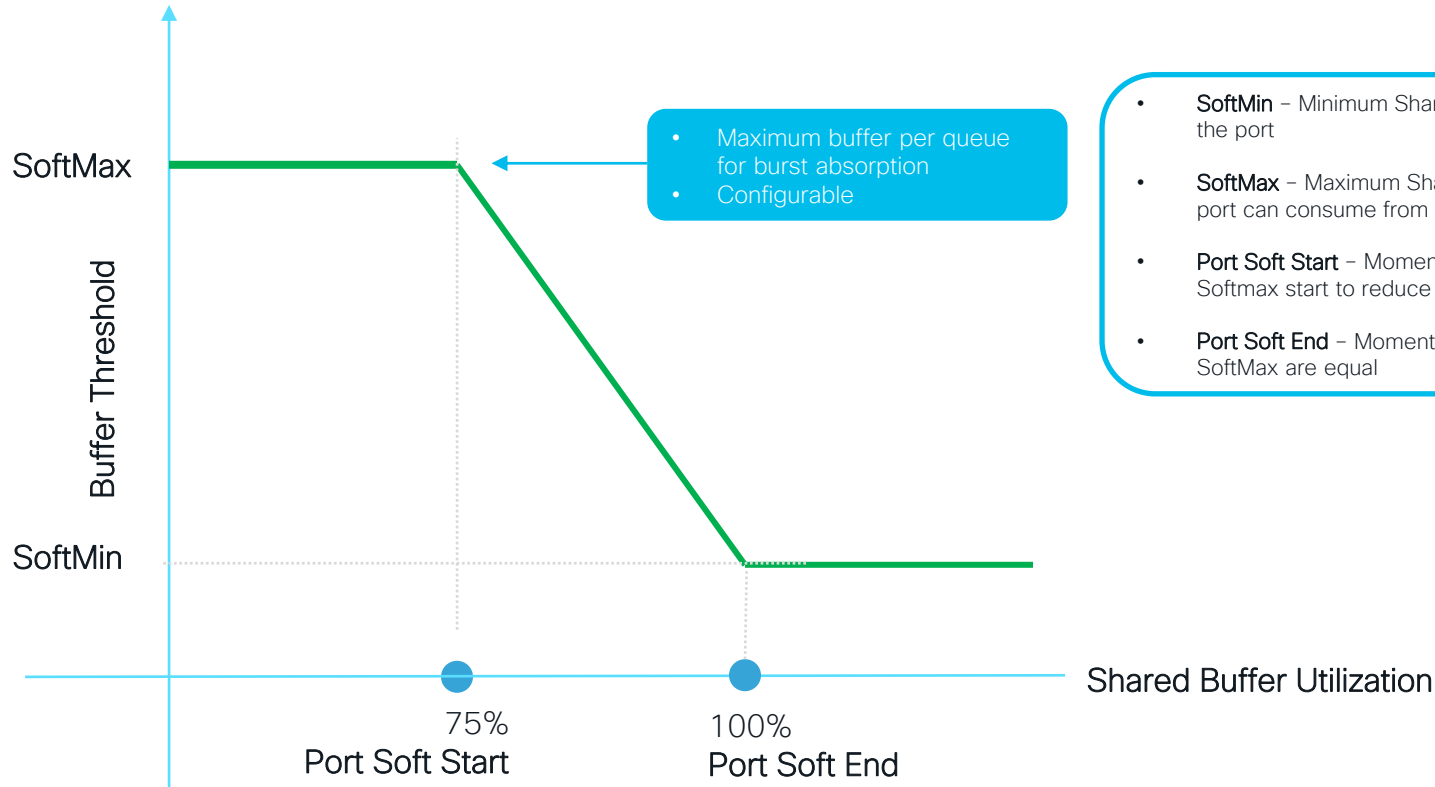
- **SoftMin** – Minimum Shared buffer given to the port
- **SoftMax** – Maximum Shared buffer the port can consume from shared Pool
- **Port Soft Start** – Moment when the Softmax start to reduce with step base
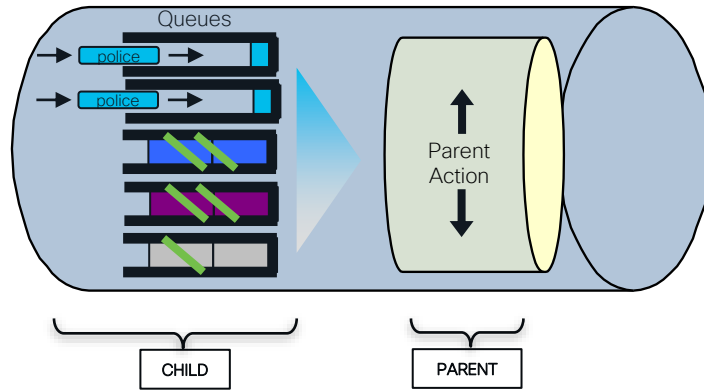- **Port Soft End** – Moment when SoftMin and SoftMax are equal
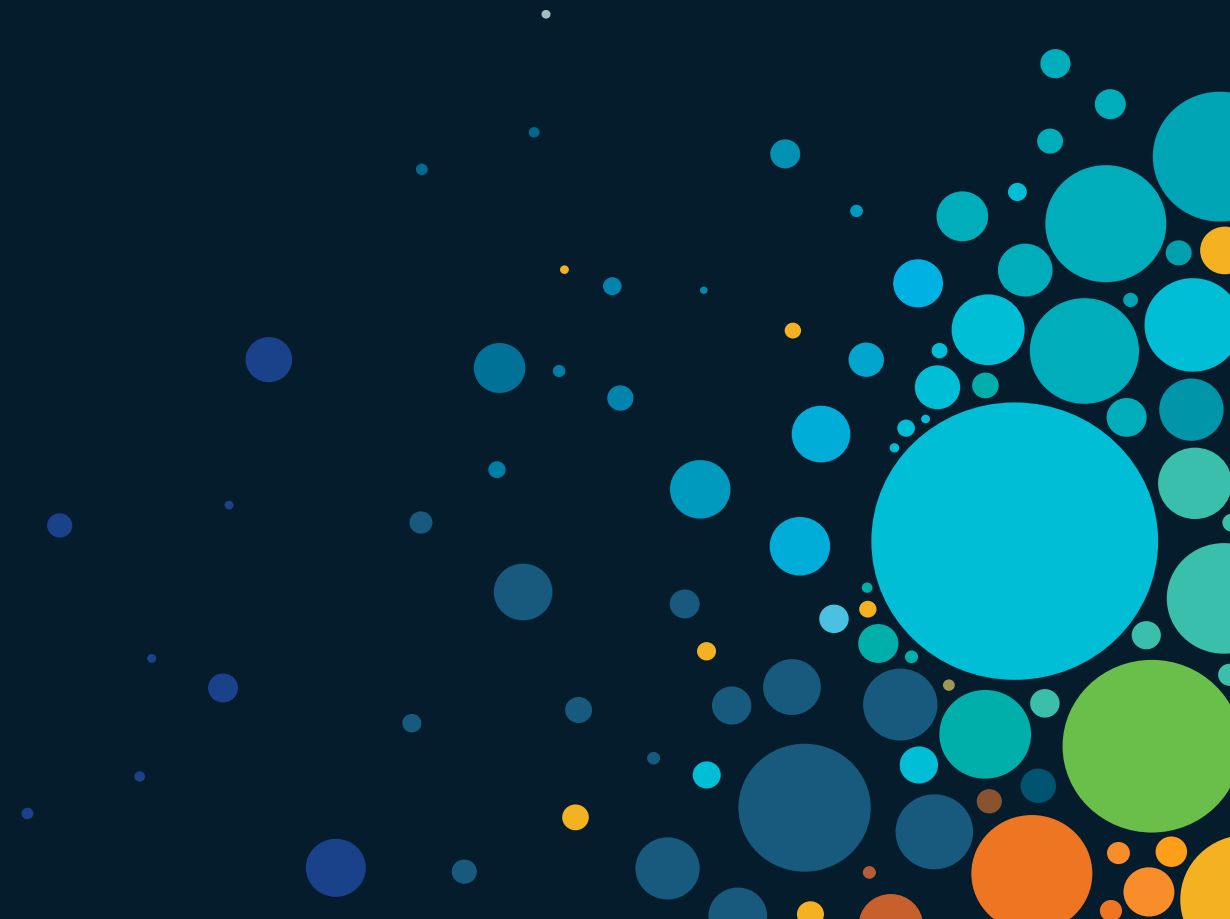
HQoS

UADP Hierarchical QoS (HQoS)

HQoS (two-level hierarchy) allows you to perform the following functions:

- Classification
- Policing
- Shaping

Child Policy	Parent Policy
Classification + Policing	Shaping
	Marking
Classification + Marking	Policing
	Shaping

Silicon One Q200 QoS

Silicon One QoS Terminology

Term	Explanation
VoQ	Virtual Output Queues between Ingress and Egress
Packet Color	Used for congestion management to prioritize packets to be dropped
Traffic-Class	Internal tag used by the Silicon One ASIC to differentiate packet priority
Traffic Manager	The block in Q200 responsible for scheduling
Traffic/Transmit Scheduler	When the OQ can send traffic out to the wire
Credit Scheduler	When the VoQ can send traffic to the Output queue
SMS	Shared Memory Sub-system – Primary Buffering system
HBM	High Bandwidth Memory – Secondary deep Buffering system used during congestion

VoQ and Head of Line Blocking (HoL)

Buffer types – Head of Line Blocking
What is the Problem?
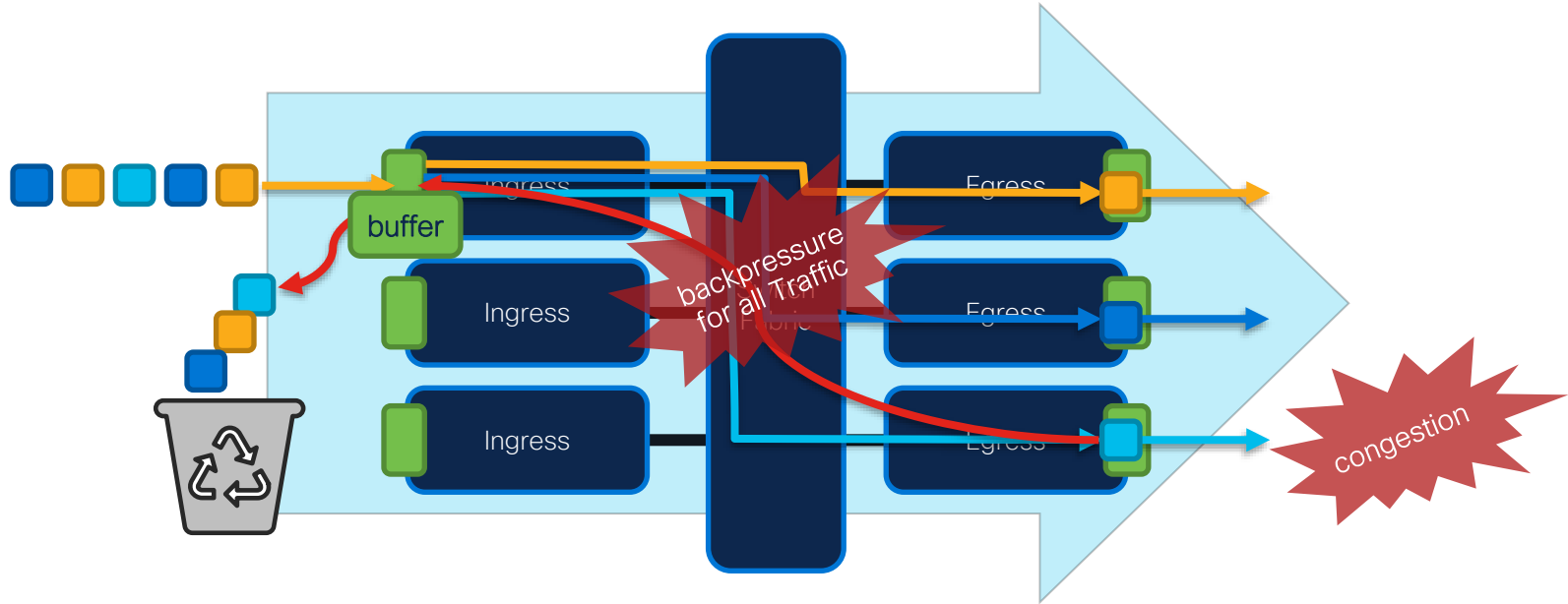
Virtual Output Queuing – Silicon One ASIC

Avoid Head of Line block

VoQ Buffer

Credit

Ingress

buffer

Ingress

Switch Fabric

Ingress

Egress

Egress

Egress

congestion
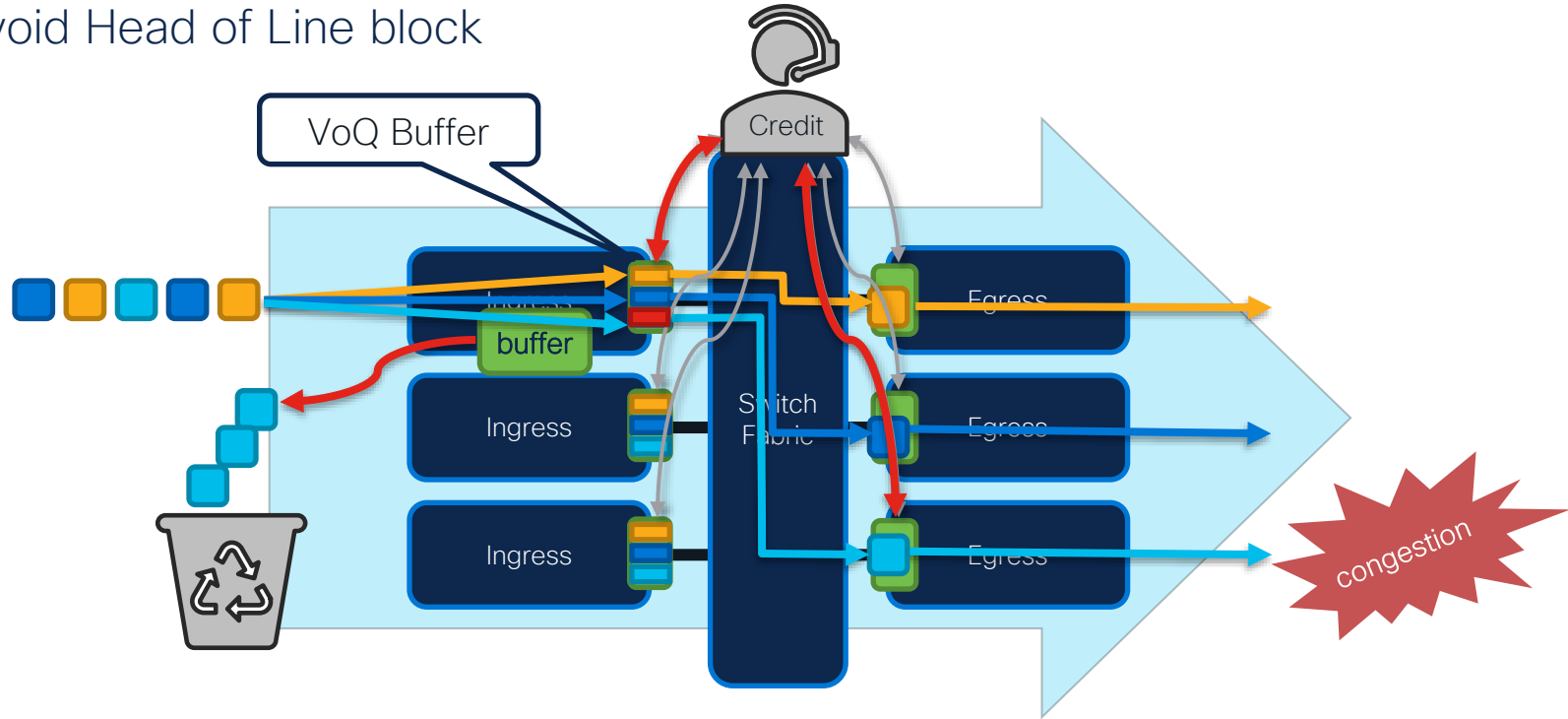
Output Queuing - UADP
Avoid Head of Line Blocking
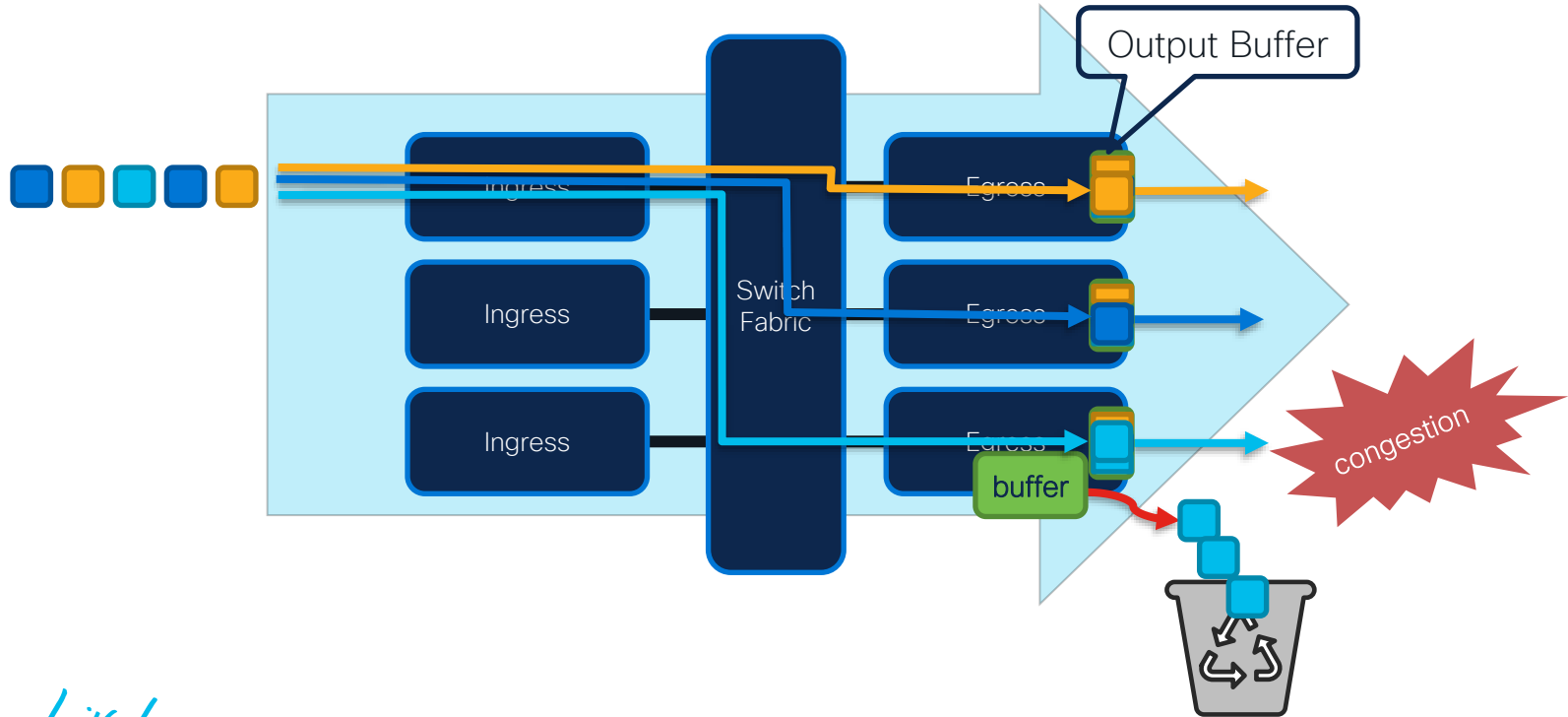
Silicon One QoS Overview

Catalyst 9000 Switches with Silicon One ASIC

C9600X-Sup-2

C9500X-28C8D
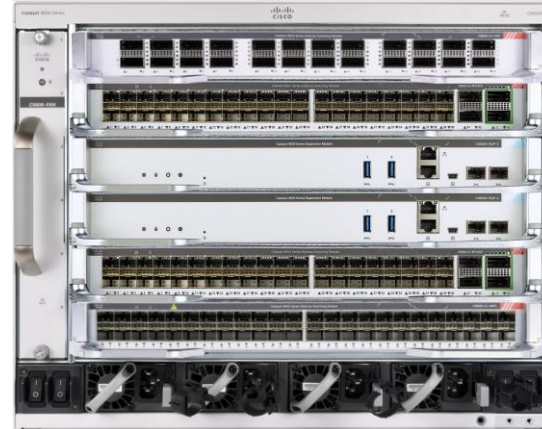
Silicon One

Features Mapping
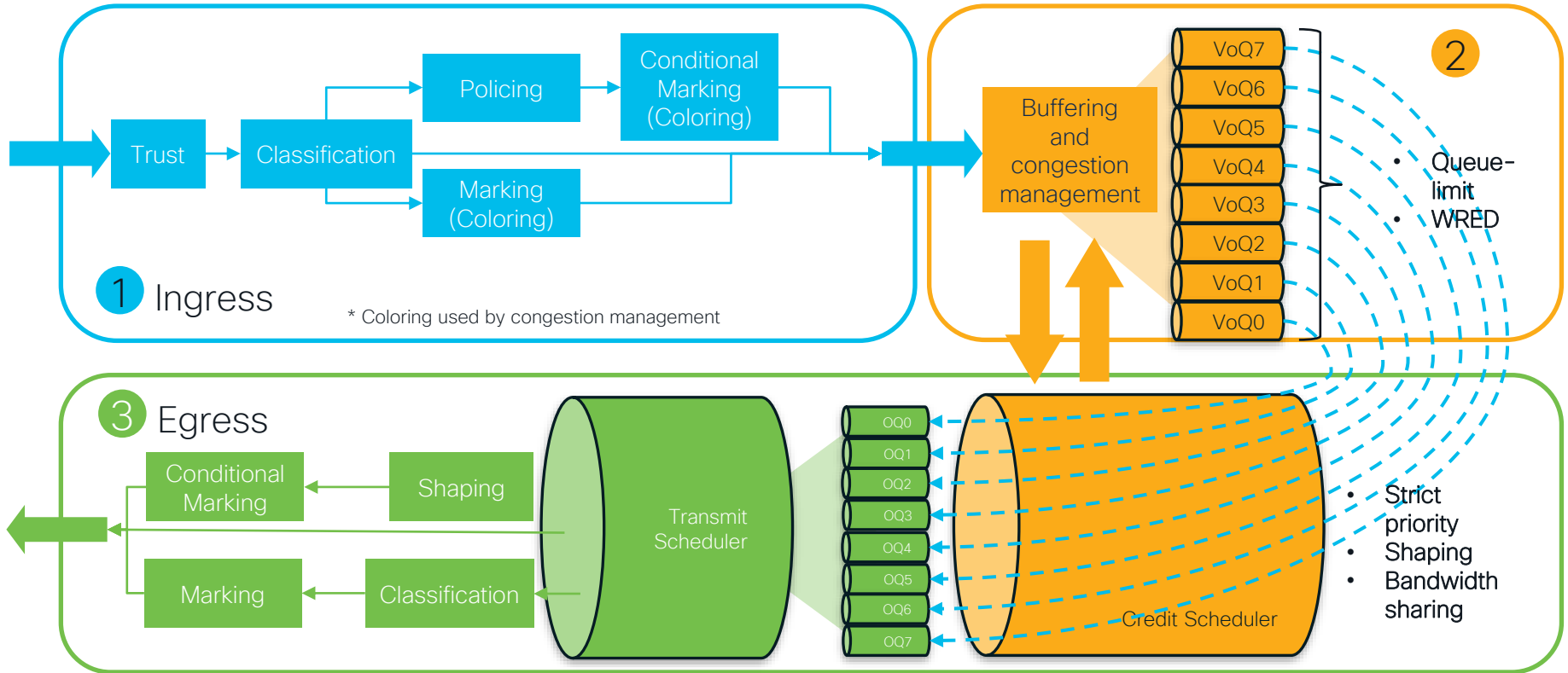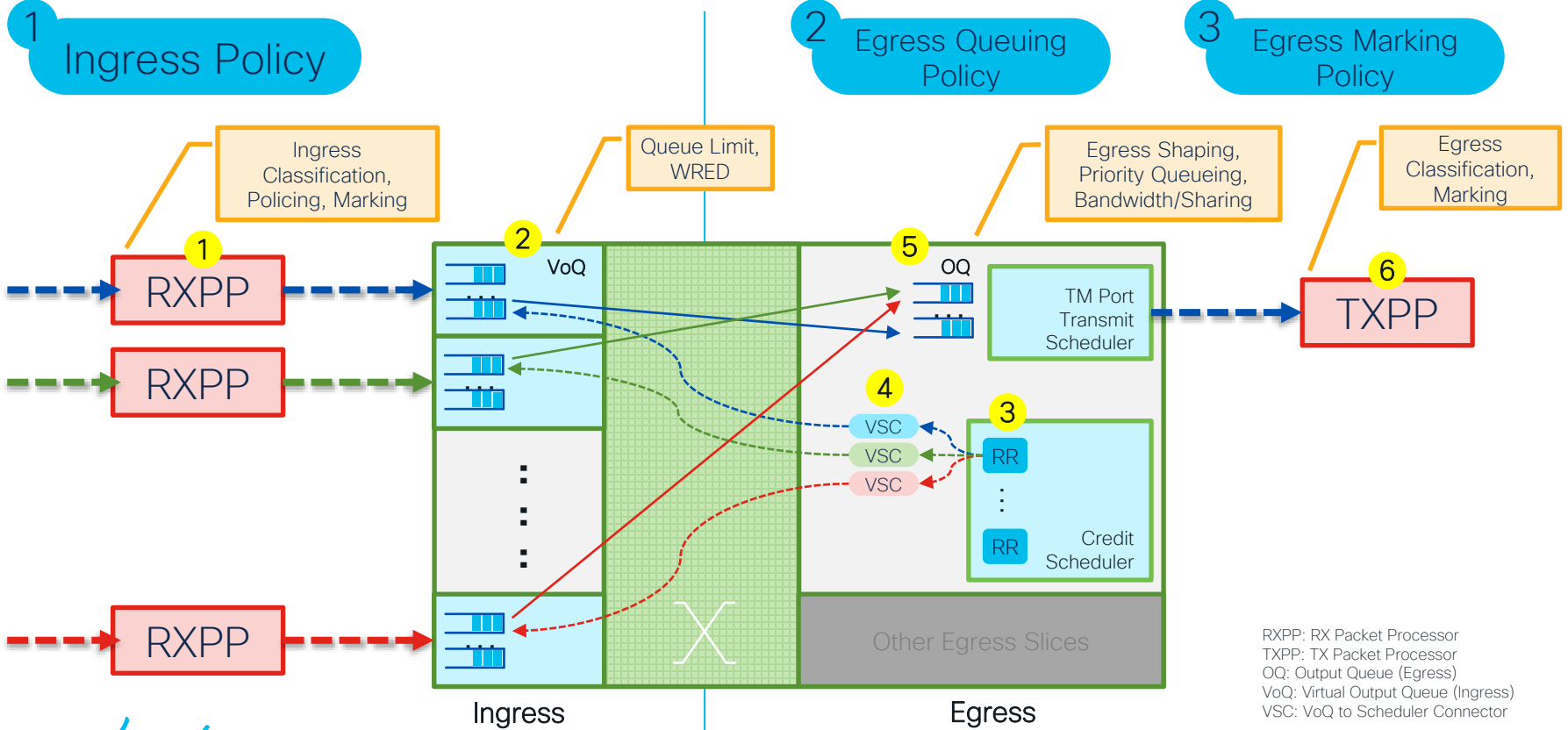
Traffic class

- S1 ASIC uses traffic classes to map traffic to different queues. **"traffic-class"** is local significant to the switch only

- 3-bit field => 8 values, traffic-class <0 - 7>

- Traffic-class 0 - lowest priority (maps to class-default); traffic-class 7 - highest priority (traffic-class 1 to 6 can be non-priority)

- **Ingress policies** classify packets to specific traffic classes

- Class-maps in **egress queuing policy** can only match traffic-class

Priority Level	Traffic class	
1 (statically)	7	Highest priority
2 (optional)	6	
3 (optional)	5	
4 (optional)	4	
5 (optional)	3	
6 (optional)	2	
7 (optional)	1	
Class default	0	Least priority
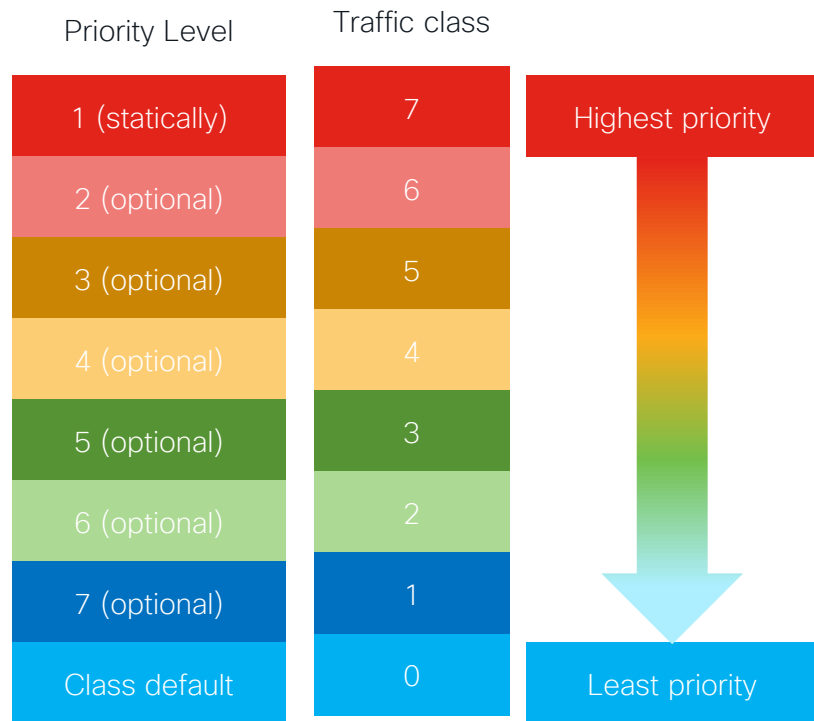
Traffic class vs QoS-group

	traffic-class	QoS-Group
=	Label for incoming packets in classification	
	Local signification (switch)	
	Egress class-map make use of these labels	
≠	Can be associated with **priority** in the egress	**Simple** label for use in the egress
	Associated with VoQ. (Multiple TCs can make to a same VoQ)	No priority or queue reference
	Default **mapping** (DSCP/COS to traffic-class) if not defined by ingress policy	Options for the egress

Traffic color – discard-class

- S1 ASIC uses traffic color to assign priority for packets within a traffic-class. "**discard-class**" is local significant to the switch only

- 1-bit field => 2 values.

- discard-class < 0– 1> (0 – green, 1 – yellow)

- **Ingress policies** can color the packet unconditionally or conditionally with a policer

- Default traffic color is 0 (green)

- Yellow (marked with 1) packet will be dropped first in event of congestion

discard-class

traffic-class

1

0
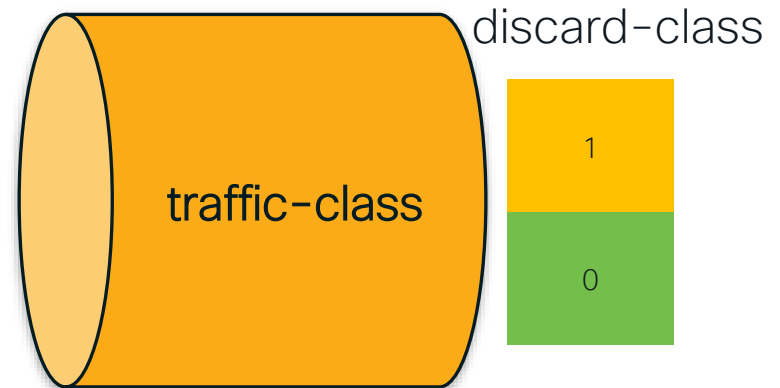
Silicon One Q200 QoS Default

- Catalyst 9000 Switches with Silicon One Q200 ASIC
  - QoS enabled
  - All ports trust at layer2 and layer3
  - Two queues (traffic-class 7 and traffic-class 0, traffic-class7 is priority level 1)

Traffic class

7	DSCP: 16, 24, 32, 46, 48, 56 COS: 4, 5
6	
5	
4	Not used
3	
2	
1	
0	DSCP: All other values; COS: All other values All EXP values
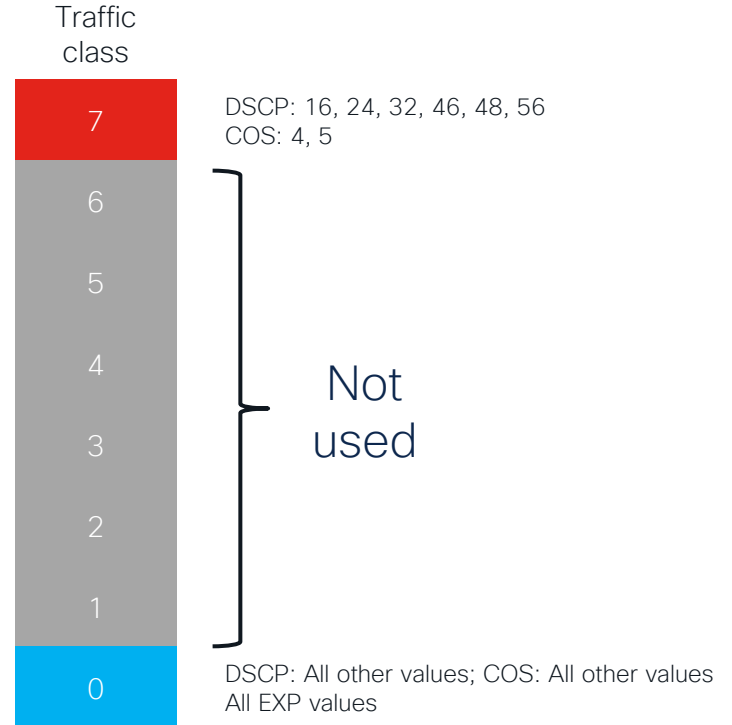
Classification, Marking and Policing

Classification and Marking

- Identify traffic
  - Access Control Lists (ACLs)
  - DSCP
  - IP precedence
  - CoS
  - QoS Group (local with the switch)
  - EXP (MPLS)
  - VLANs

- Marking (coloring)
  - Conditional or unconditional
  - Table map *
  - QoS group (local within switch)
  - Traffic-class (local within switch)
  - Traffic-color (local within switch)

* for policer markdown

Unclassified:
Uncontrolled Bandwidth

Webex
mgmt
HTTP
email
Sharepoint
Backup

Classified:
Controlled Bandwidth

VoIP/Webex
Email/HTTP
Sharepoint
Backup

Policing – Limit the traffic

1 rate 2 color

CIR

CBS

Packet of size B

B>Tc — No → Conform → Action

Yes ↓
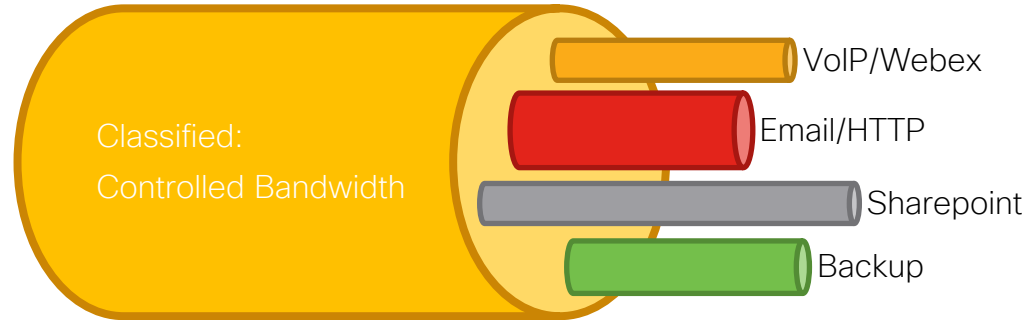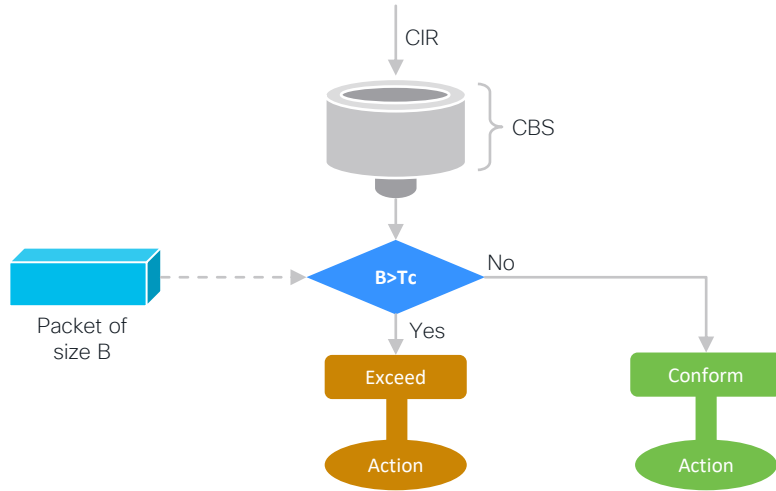
Exceed → Action

```
police cir 1g
   conform-action transmit
   exceed-action drop
```

2 rate 3 color

PIR   CIR

PBS   CBS

Packet of size B

B>Tp — No → B>Tc — No → Conform → Action

Yes ↓   Yes ↓

Violate   Exceed
↓   ↓
Action   Action
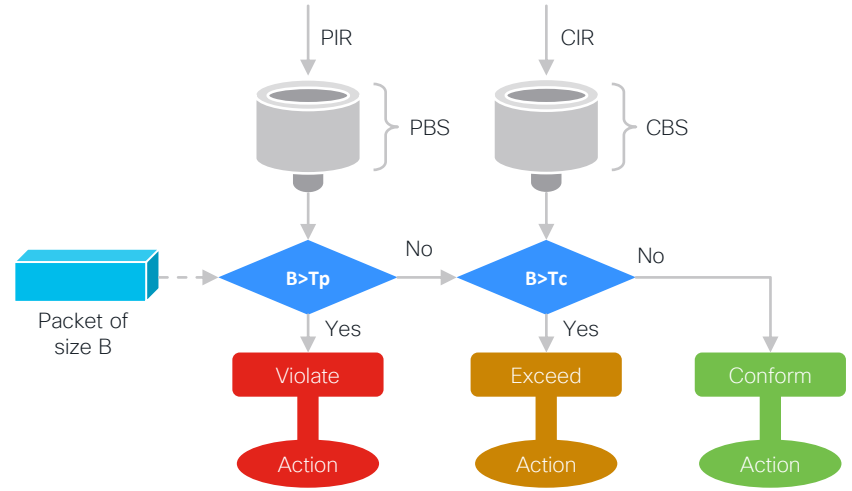
```
police cir percent 10 pir percent 50
   conform-action transmit
   exceed-action set-discard-class-transmit 1
   violate-action drop
```

Traffic color

CIR – Committed Information Rate   PBS– Peak Burst Size
PIR – Peak Information Rate   CBS – Committed Burst Size

Policing and marking/coloring example

Unconditional Traffic Marking/Coloring
```
policy-map ingress-policy
 class class-5-green
  set traffic-class 5
 class class-5-yellow
  set traffic-class 5
  set discard-class 1
```

> Different class-map
> Same traffic-class

1R2C Policing:
```
policy-map test-police-1R2C
 class dscp1
  set traffic-class 3
  police rate 10g bps
     conform-action transmit
     exceed-action drop
  !
```

Conditional Traffic Marking/Coloring
```
policy-map ingress-policy
 class class-5
  set traffic-class 5
  police rate 5g bps peak-rate 10g bps
   exceed-action set-discard-class-transmit 1
```

2R3C Policing:
```
policy-map test-police-2R3C
 class dscp1
  set traffic-class 3
  police rate 10g bps peak-rate 20g bps
   conform-action transmit
   exceed-action set-discard-class-transmit 1
   violate-action drop
```

Egress Toolset:

Queueing, Shaping and Scheduling

Queueing

Virtual output Queue (VoQ)
- 8 VoQ on each ingress slices for each interface
- Each traffic-class maps to a VoQ (multiple traffic-classes can map to same VoQ)

- VoQ maps to output Queue.

Output Queue
- 8 output queues (egress) for each interface
- Up to 7 strict priorities (level 1 – highest)
- Traffic-class 7 is always priority level 1, priority level is optional for other traffic-classes

Buffering and congestion management

VoQ7
VoQ6
VoQ5
VoQ4
VoQ3
VoQ2
VoQ1
VoQ0

2

- Queue-limit
- WRED

OQ0
OQ1
OQ2
OQ3
OQ4
OQ5
OQ6
OQ7

Credit Scheduler

- Strict priority
- Shaping
- Bandwidth sharing
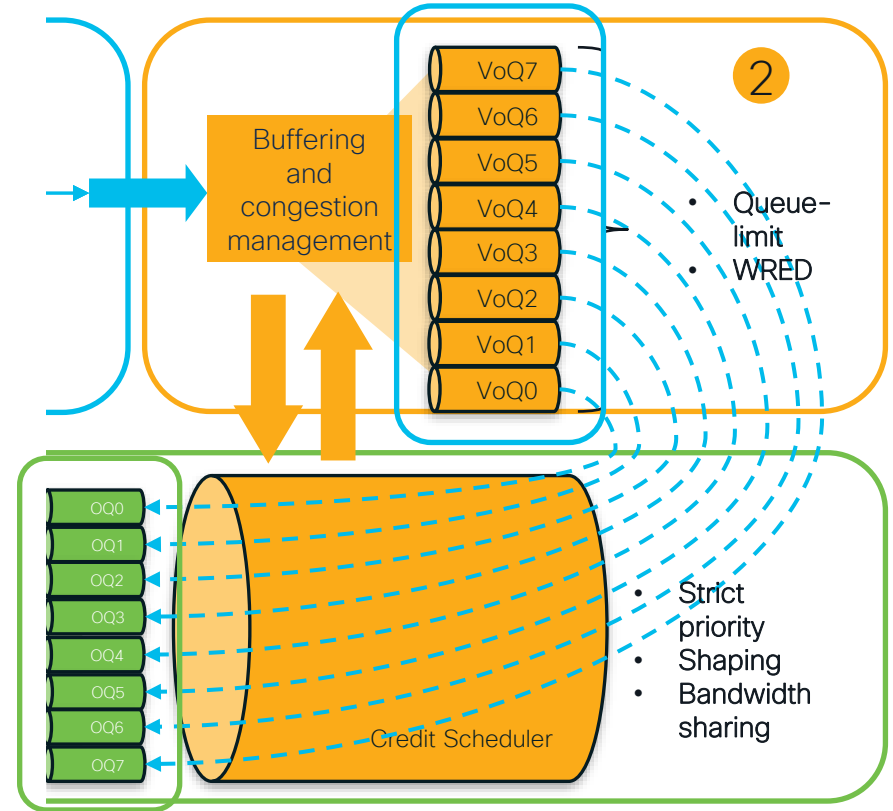
Scheduling

- Packet schedule from VoQ to OQ based on a credit scheduling system
- Packets are buffered at ingress (VoQ)
- Different type of queues are served differently
  - Strict priority queues
    - Always serviced first
    - Up to 7 PQs
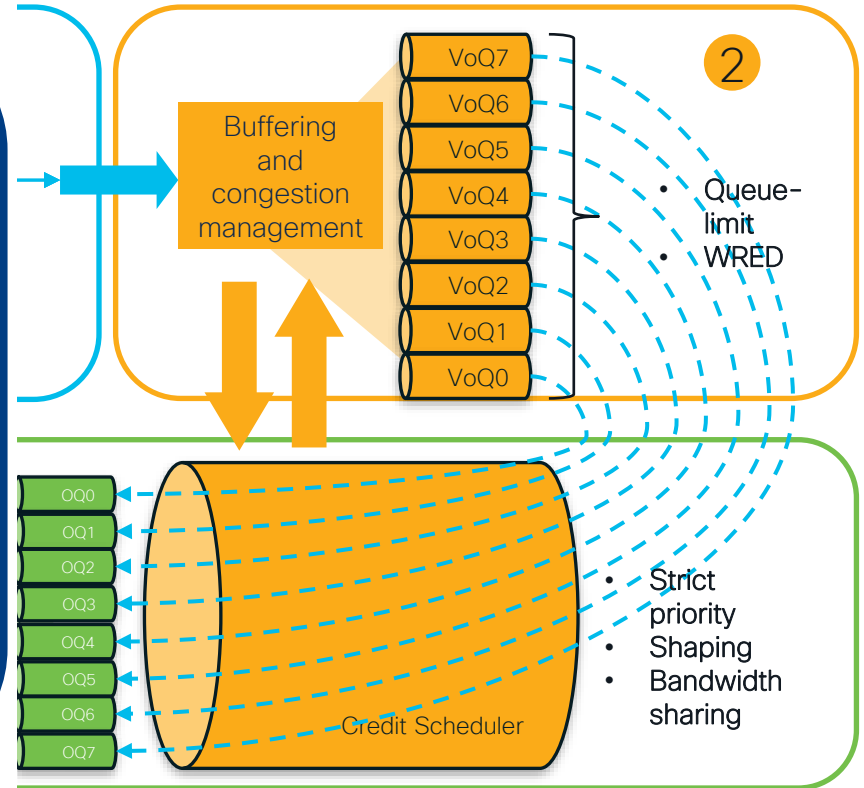 - Normal queues (without priority configured)
    - Served only after priority queues are empty
    - Use Weighted Round Robin (WRR) for scheduling

Buffering and congestion management

VoQ7
VoQ6
VoQ5
VoQ4
VoQ3
VoQ2
VoQ1
VoQ0

2

- Queue-limit
- WRED

OQ0
OQ1
OQ2
OQ3
OQ4
OQ5
OQ6
OQ7

Credit Scheduler

- Strict priority
- Shaping
- Bandwidth sharing

Scheduling - Example

```
class-map match-any tc-7
 match traffic-class 7
class-map match-any tc-6
 match traffic-class 6
…
class-map match-any tc-1
 match traffic-class 1
```

Map traffic to the queues

```
policy-map egress-policy
 class tc-7
  priority-level 1
 class tc-6
  Priority-level 2
 class tc-5
  bandwidth remaining ratio 1
 class t-4
  bandwidth remaining ratio 1
 class tc-3
  bandwidth remaining ratio 1
 class tc-2
  bandwidth remaining ratio 1
 class tc-1
  bandwidth remaining ratio 1
 class class-default
  bandwidth remaining ratio 1
```

- Two priority queues here
- Level 1 has the absolutely priority over level 2

- Use "bandwidth remaining ratio" to assign weight
- This example use the same weight for all the remaining 6 queues
- Served round robin around 6 queues as long as there isn't any traffic on the two PQs

Shaping

- Smooth out traffic peaks, microburst, with preserving traffic

- Control traffic rate to the desired value with buffering.

- Usually in the egress direction

- Can be applied on all classes, regardless of priority level.

Shaping Example:

```
policy-map type queueing egress-queueing
  class tc7
    priority level 1
    shape average 1g
  class tc6
    priority level 2
    shape average 5g
...

  class class-default
    shape average 5g
```

Original traffic

With shaping
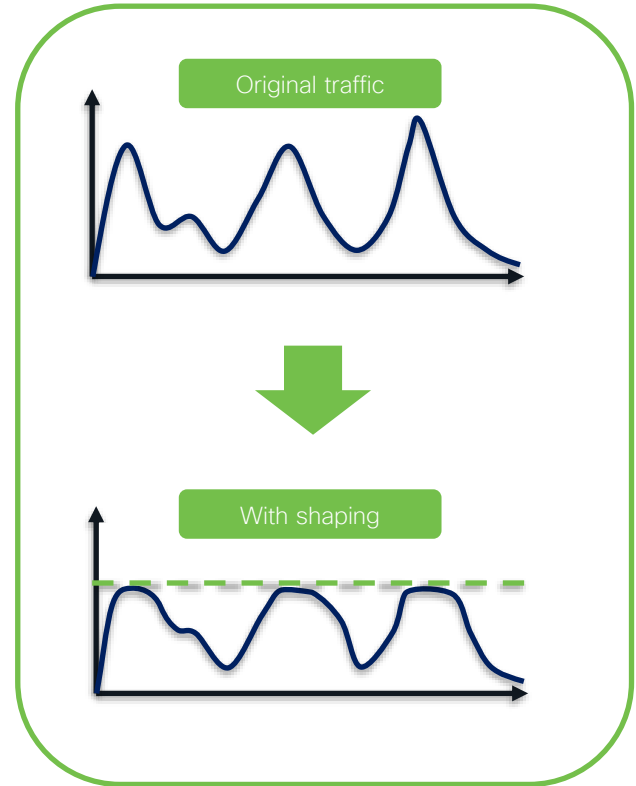
Egress Marking

Egress Marking

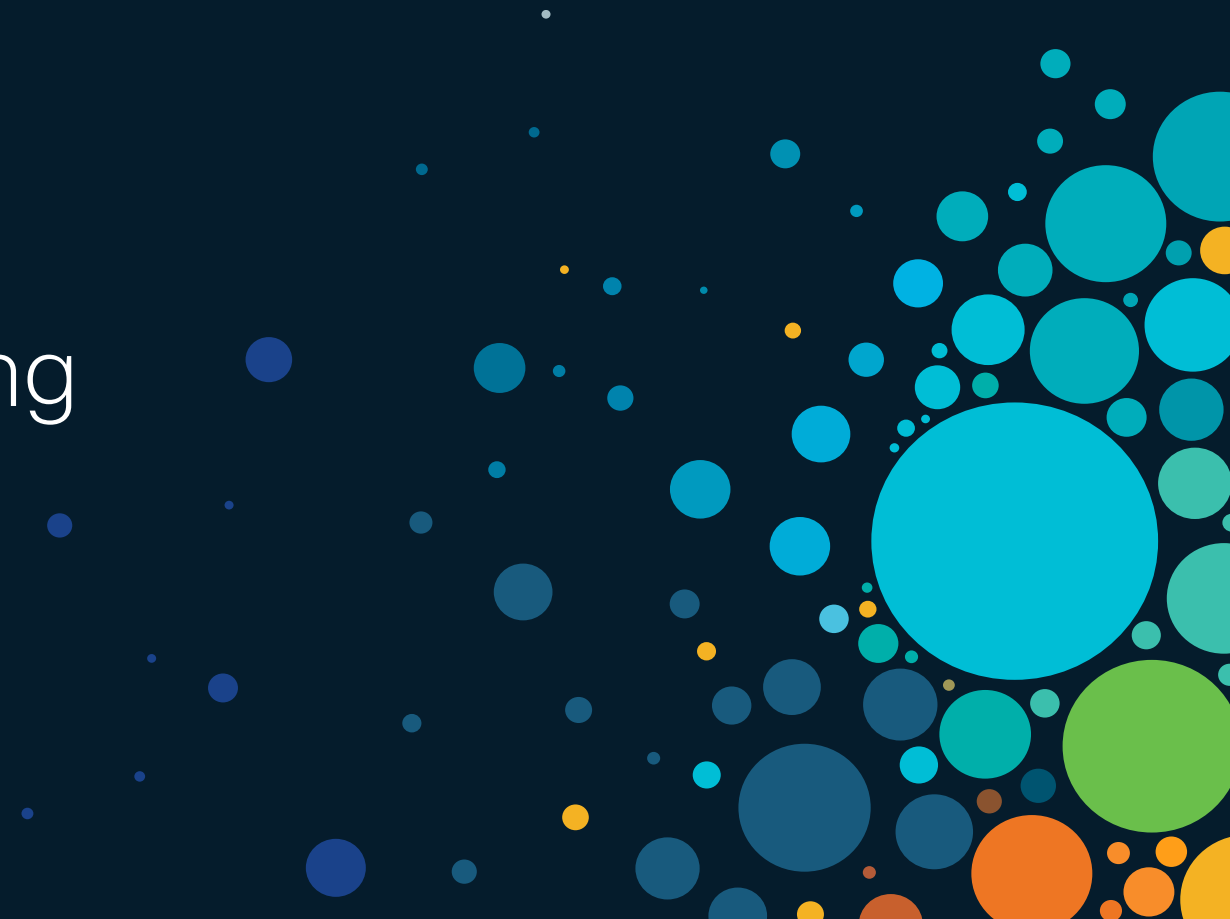- Used to change packet tags of packets egressing the switch.

- A separate policy-map apart from the queueing policy-map.

- If both queueing and marking egress policy-maps are applied, marking happens after queueing actions.

- ACL matching in egress is no supported.

```
class-map match-any dscp-af41
 match dscp af41
!

policy-map egress-map
 class dscp-af41
  set dscp af31
 !

interface interface <#>
 service-policy output egress-map
```

Congestion Management

Weighted Tail Drop (WTD)

Queue

Ingress Policy-map
```
policy-map ingress-policy
      class class-5-green
         set traffic-class 5
      class class-5-yellow
         set traffic-class 5
         set discard-class 1
```

```
…
class-map match-any traffic-class-5
 match traffic-class 5
…
```

Egress Policy-map
```
policy-map type queueing queue-policy
 ...
 class traffic-class-5
  queue-limit 100000000 bytes
  queue-limit discard-class 1 50000000
bytes
```

Green traffic will be dropped over this the threshold

Only traffic marked with green would be here
Yellow traffic would be dropped once it is over the yellow threshold

No drop for both Green and Yellow traffic here

Weighted Random Early Drop (WRED)

Queue

Drop probability 100%

WRED max

Drop probability between 0% to 100%

WRED min

No drop
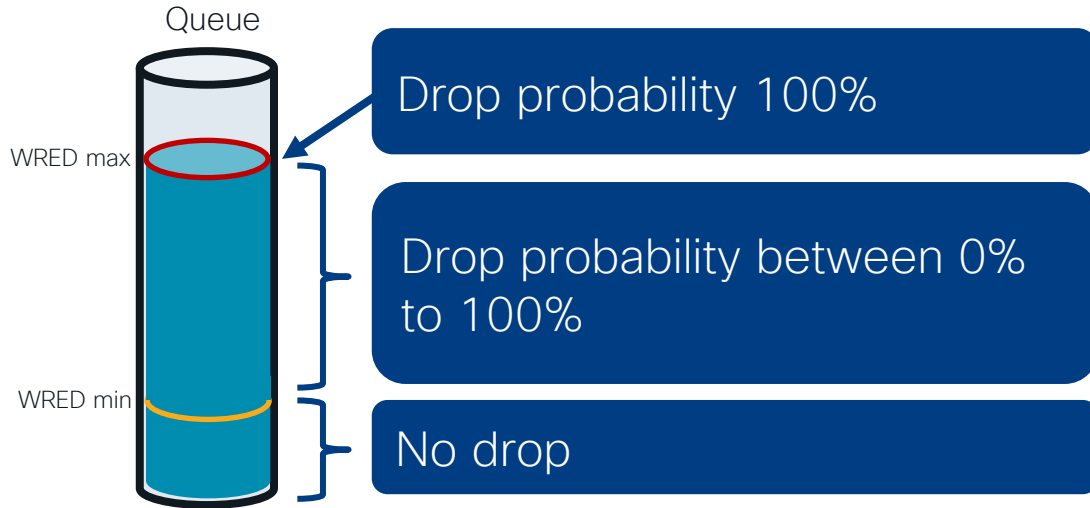
WRED – Drop probability

CLI:
`random-detect discard-class <0-1> percent <Min> <Max> <K>`

- Drop probability increases as the queue utilization increases

- Silicon One ASIC provides 16 regions (drop probabilities)

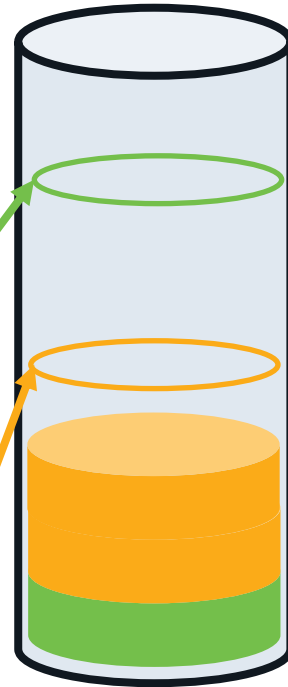- Silicon One ASIC provides a knob to influence the drop probability

WRED – Example

Ingress Policy-map
```
policy-map ingress-policy
…
 class class-5-green
  set traffic-class 5
 class class-5-yellow
  set traffic-class 5
  set discard-class 1
…
```
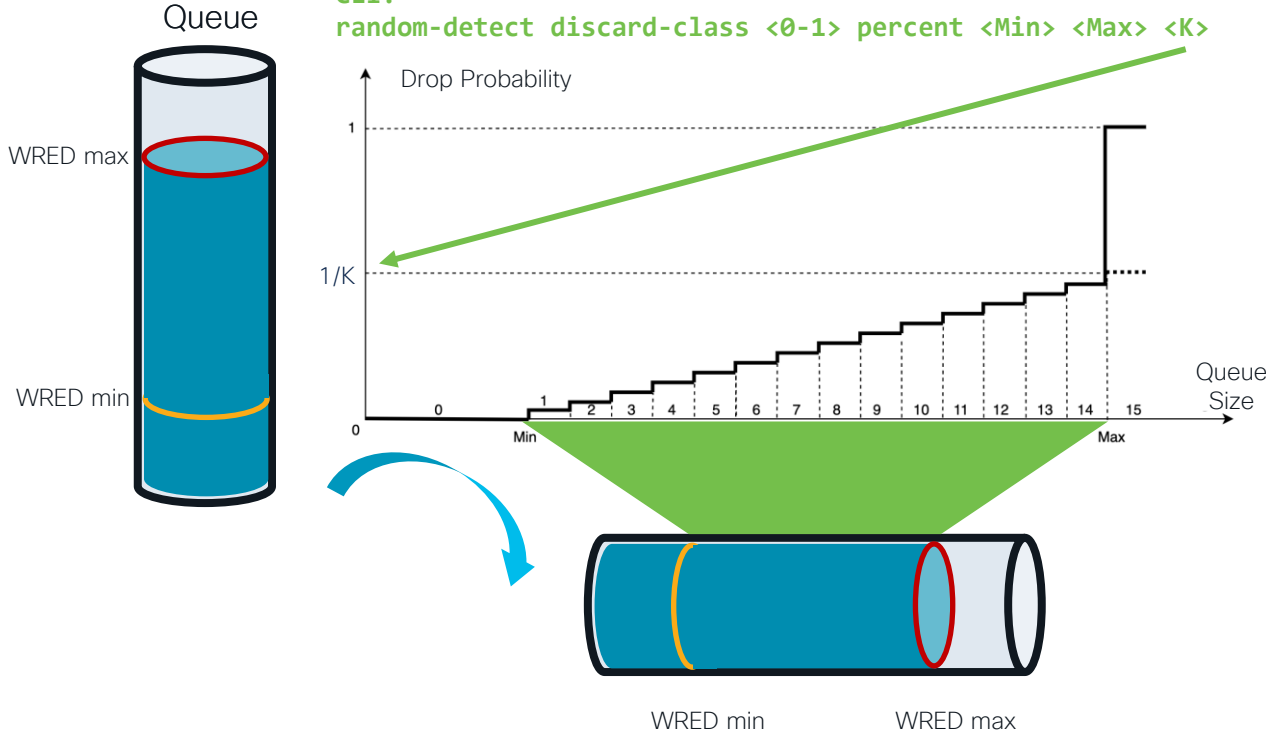
Ingress policy with marking/coloring of packets

class-map
```
class tc5
  match traffic-class 5
…
```

Map the ingress class to one of the traffic-class

Egress Policy-map
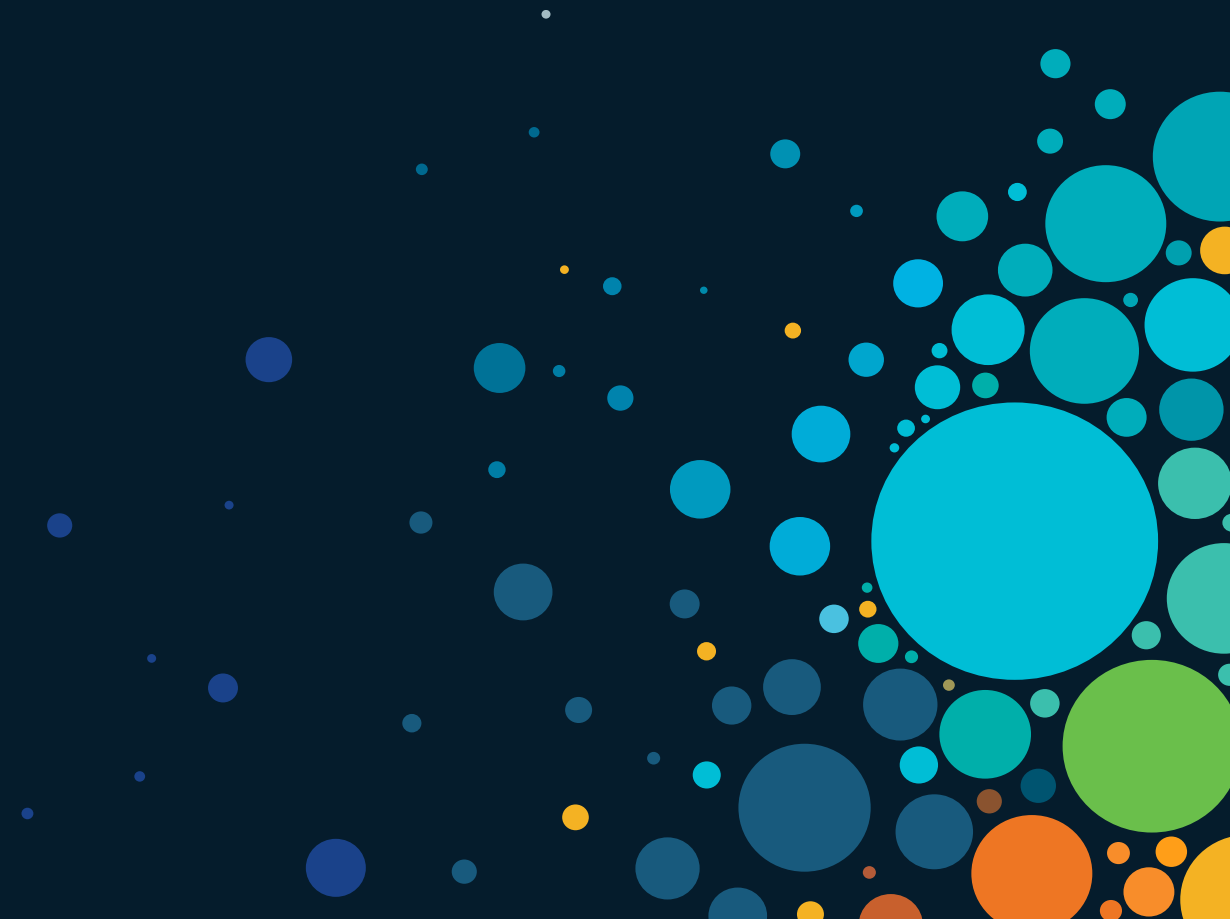```
policy-map type queueing queue-policy
...
 class tc5
  random-detect discard-class-based
  random-detect discard-class 0 percent 80 90 5
  random-detect discard-class 1 percent 40 70 2
...
```
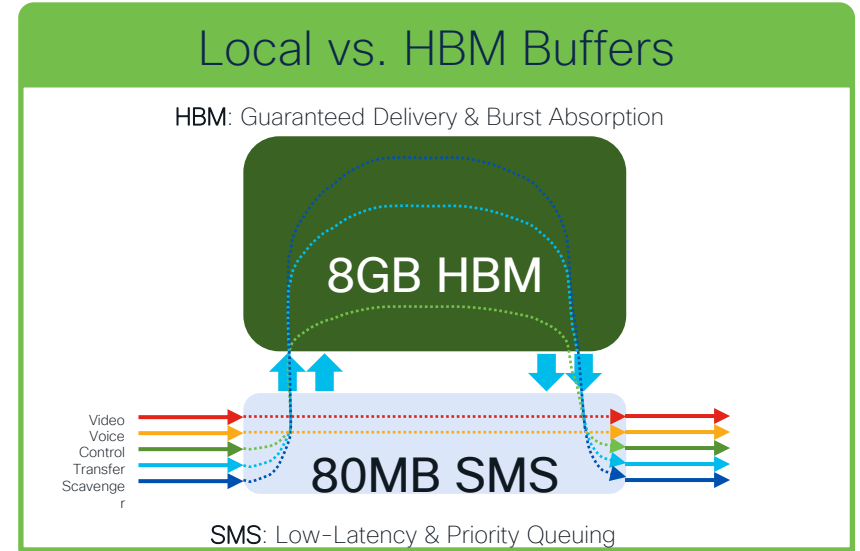
- Green traffic has higher Min and Max threshold comparing to yellow traffic
- Green traffic also has higher forwarding probability (lower drop probability) comparing to yellow traffic

# Buffers

# Silicon One Buffers

- Two different buffers to address two different requirements.

  - 80 MB of Shared Memory Sub-system (SMS) buffers:
    - Low latency packet queueing (video/voice packets)
    - Shallow specialized pool of buffers for quick queueing.

  - 8 GB of High Bandwidth Memory (HBM) buffers:
    - Deep pool of on-demand buffers for guaranteed delivery.
    - Reserve to absorb occasional bursts or address speed over-subscription between ingress and egress.



Local vs. HBM Buffers

HBM: Guaranteed Delivery & Burst Absorption

8GB HBM

Video
Voice
Control
Transfer
Scavenger

80MB SMS

SMS: Low-Latency & Priority Queuing

- Packet will always hit the SMS buffers first.
- SMS send the packet to HBM if additional buffers are needed.
- HBM **CANNOT** send the packet to the output queue, it has to be sent to the SMS again to be sent to the egress.

# HQoS

# Silicon One Hierarchical QoS (HQoS)

HQoS (two-level hierarchy) allows a parent and child policies on an interface for greater granularity. The Cisco Silicon One supports shaping as parent action.
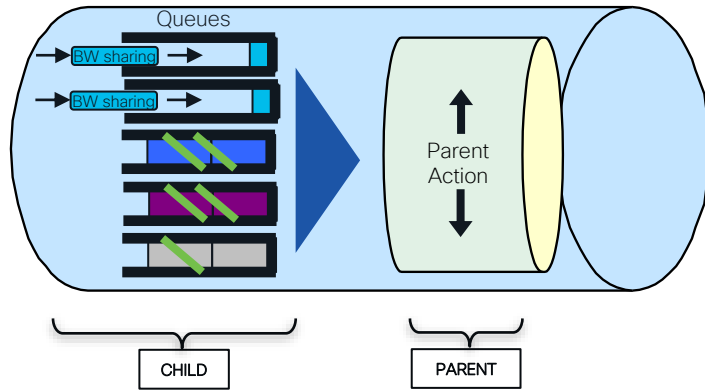


| Child Action | Parent Action |
|---|---|
| Bandwidth sharing + Priority | Shaping |
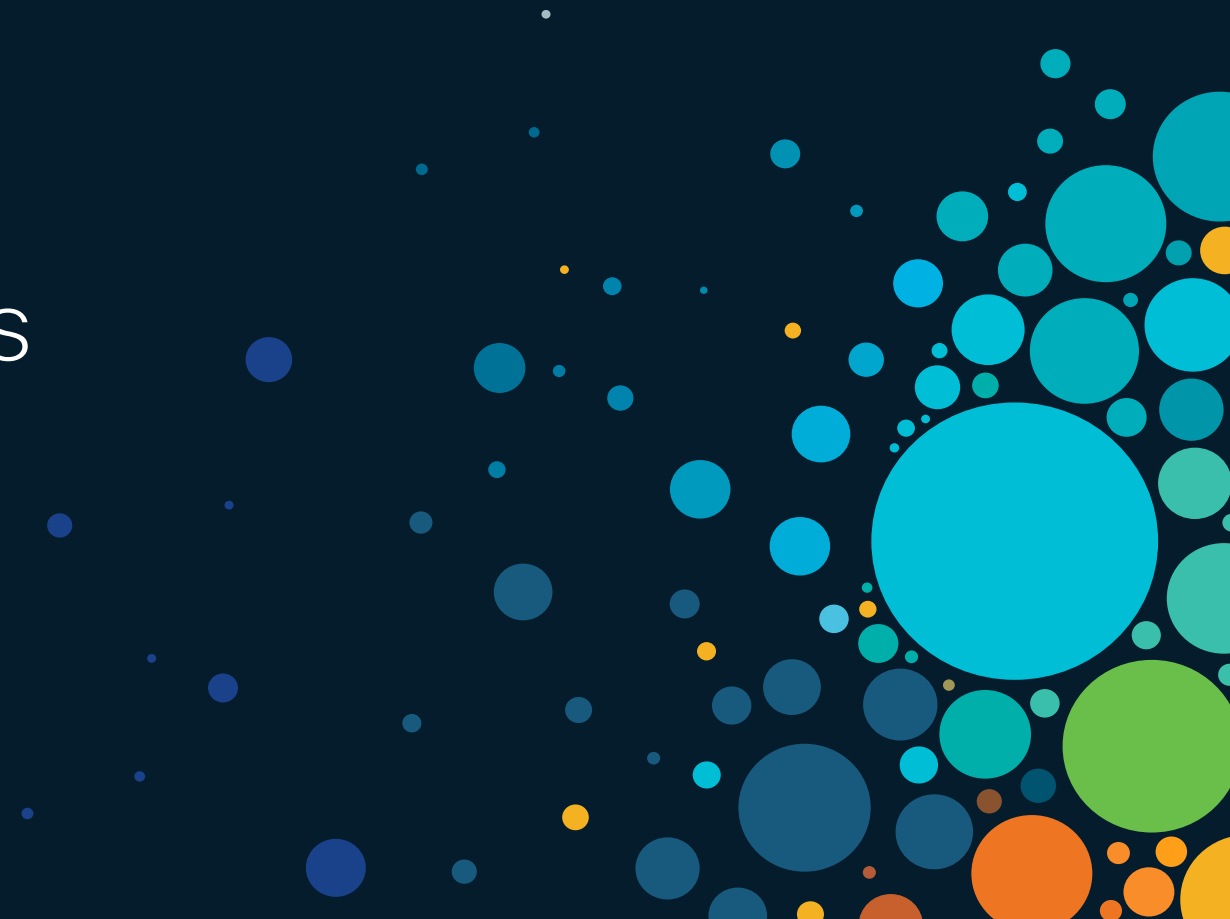
# QoS tools on UADP and Silicon One ASICs 1/2

| Features | UADP ASIC | Silicon One ASIC (Q200) |
|---|---|---|
| Trust | Trust all ports by default | Trust all ports by default |
| | | |
| Classification | Based on Packet header and ACL for both ingress and egress | Based on packet header and ACL for ingress<br>**Based on packet header for egress** |
| | | |
| Marking | Header, Table-map, QoS-Group for ingress<br>Header and table-map for egress | Header, Table-map, QoS-group, **traffic-class, discard-class** for ingress<br>Header and table-map for egress |
| | | |
| Policing | Both ingress and egress | Ingress only |

# QoS tools on UADP and Silicon One ASICs 2/2

| Features | UADP ASIC | Silicon One ASIC (Q200) |
|---|---|---|
| Queueing | Based on header or QoS group<br>Bandwidth and Bandwidth remaining | Based on **traffic-class**<br>**Bandwidth remaining** |
| | | |
| Buffering | Dedicated and shared buffer with DTS | SMS: Low-latency & priority queueing<br>HBM: Guaranteed Delivery & Burst Absorption |
| | | |
| Shaping | Egress | Egress |
| | | |
| Congestion Management | WTD: three thresholds per class<br>WRED: three thresholds' pairs per class | WTD: **two** threshold per class<br>WRED: **two** thresholds' pairs per class |

# QoS Config Migration

# Config Migration Philosophy

**1**   Define the problem/behavior addressed with QoS.

Simply copy-pasting existing configs between platform families will always throw errors due to differences in syntax and supported actions between platforms.

**2**   Determine the number of queues you need. Reduce if existing config has more than eight.

Its often not as much as you think you need. Broad generalized splits often are more efficient than granular splits

**3**   How many classes do you want to have strict priority enabled? Up-to 2 (7 for Silicon One Q200) strict priority queues supported.

Know what strict means. All traffic coming into it will be serviced at the expense of other classes.

**4**   Define traffic shaping/policing or sharing between queues.

Police/shape priority queues. Use weights to control bandwidth sharing with remaining queues

**5**   Do you want to modify/change WRED parameters.

Advanced configuration options, not required for most use cases.

# Config Migration from 6k to UADP
## MLS configs

```
        Catalyst 6K MLS config

!
mls qos
!
interface TenGigabitEthernet2/14
 platform qos queue-mode mode-dscp
 wrr-queue bandwidth 20 1 14 10 15 2 3
 priority-queue queue-limit 20
 wrr-queue dscp-map 1 1 0 1 2 3 4 5 6 7
 wrr-queue dscp-map 2 1 8 14 32 35 36 37 38
 wrr-queue dscp-map 3 1 10 22 24 30 49 50 51 52
 wrr-queue dscp-map 4 1 16 18
 wrr-queue dscp-map 5 1 26
 wrr-queue dscp-map 6 1 48 56
 wrr-queue dscp-map 7 1 34
```

1 Enable QoS Globally

2 Use DSCP mapping to different classes/queues

3 1 priority queue

4 7 normal queues
WRR and the weights

Config Migration from 6k to UADP
MLS configs

Catalyst 6K MLS config

```
!
mls qos
!
interface TenGigabitEthernet2/14
 platform qos queue-mode mode-dscp
 wrr-queue bandwidth 20 1 14 10 15 2 3
 priority-queue queue-limit 20
 wrr-queue dscp-map 1 1 0 1 2 3 4 5 6 7
 wrr-queue dscp-map 2 1 8 14 32 35 36 37 38
 wrr-queue dscp-map 3 1 10 22 24 30 49 50 51
52
 wrr-queue dscp-map 4 1 16 18
 wrr-queue dscp-map 5 1 26
 wrr-queue dscp-map 6 1 48 56
 wrr-queue dscp-map 7 1 34
```

1. Enable QoS Globally

2. Use DSCP mapping to different classes/queues

3. 1 priority queue

4. 7 normal queues WRR and the weights

default

Catalyst 9K(UADP) Config

```
class-map match-any queue1
 match dscp 0 1 2 3 4 5 6 7
class-map match-any queue2
 match dscp 8 14 32 35 36 37 38
class-map match-any queue3
 match dscp 10 22 24 30 49 50 51 52
class-map match-any queue4
 match dscp 16 18
class-map match-any queue5
 match dscp 26
class-map match-any queue6
 match dscp 48 56
class-map match-any queue7
 match dscp 34
class-map match-any priority
 match dscp ef
policy-map egress-queue
 class priority
  priority level 1 percent 20
 class queue1
  bandwidth remaining percent 20
 class queue2
  bandwidth remaining percent 1
 class queue3
  bandwidth remaining percent 14
 class queue4
  bandwidth remaining percent 10
 class queue5
  bandwidth remaining percent 15
 class queue6
  bandwidth remaining percent 2
 class queue7
  bandwidth remaining percent 3
```

* Consider weight as interface speed can be much higher now

Config Migration from 6k to UADP
MQC Configs

Catalyst 6K Configuration

```
class-map type lan-queuing match-all REALTIME
 match dscp ef
class-map type lan-queuing match-all NETWORK_CONTROL
 match dscp cs6  cs7
class-map type lan-queuing match-all VIDEO
 match dscp cs3  af31  af32  af33

policy-map type lan-queuing CAMPUS_EGRESS_6800_POLICY
 class type lan-queuing REALTIME
    priority level 1
 class type lan-queuing NETWORK_CONTROL
    bandwidth remaining percent 10
 class type lan-queuing VIDEO
    bandwidth remaining percent 20
 class class-default
    random-detect dscp-based
    random-detect dscp af11 percent 80 100

Interface gig1/0/1
 service-policy type lan-queueing output
CAMPUS_EGRESS_6800_POLICY
```

1 Use DSCP mapping to different classes/queues

2 1 priority queue

3 3 normal queues
WRR on non-default queue
WRED for class-deault

Config Migration from 6k to UADP
MQC Configs

Catalyst 6K Configuration

```
class-map type lan-queuing match-all REALTIME
 match dscp ef
class-map type lan-queuing match-all NETWORK_CONTROL
 match dscp cs6  cs7
class-map type lan-queuing match-all VIDEO
 match dscp cs3  af31  af32  af33

policy-map type lan-queuing CAMPUS_EGRESS_6800_POLICY
 class type lan-queuing REALTIME
   priority level 1
 class type lan-queuing NETWORK_CONTROL
   bandwidth remaining percent 10
 class type lan-queuing VIDEO
   bandwidth remaining percent 20
 class class-default
   random-detect dscp-based
   random-detect dscp af11 percent 80 100

Interface gig1/0/1
 service-policy type lan-queueing output
CAMPUS_EGRESS_6800_POLICY
```

1 Use DSCP mapping to different classes/queues

2 1 priority queue

3 3 normal queues
WRR on non-default queue
WRED for class-deault

Catalyst 9K Configuration

```
class-map match-any REALTIME
 match dscp ef
class-map match-any NETWORK_CONTROL
 match dscp cs6  cs7
class-map match-any VIDEO
 match dscp cs3  af31  af32  af33

policy-map CAMPUS_EGRESS_POLICY
 class type REALTIME
   priority level 1
 class type NETWORK_CONTROL
   bandwidth remaining percent 10
 class type VIDEO
   bandwidth remaining percent 20
 class class-default
   random-detect dscp-based
   random-detect dscp af11 percent 80 100

Interface gig1/0/1
 service-policy output CAMPUS_EGRESS_POLICY
```

Migration from Catalyst 6K to Silicon One Q200

Catalyst 6K Configuration

```
class-map type lan-queuing match-all REALTIME
 match dscp ef
class-map type lan-queuing match-all NETWORK_CONTROL
 match dscp cs6  cs7
class-map type lan-queuing match-all VIDEO
 match dscp cs3  af31  af32  af33
…
policy-map type lan-queuing CAMPUS_EGRESS_6800_POLICY
 class type lan-queuing REALTIME
    priority level 1
 class type lan-queuing NETWORK_CONTROL
    bandwidth remaining percent 10
 class type lan-queuing VIDEO
    bandwidth remaining percent 20
 class class-default
    random-detect dscp-based
    random-detect dscp af11 percent 80 100
```

1. Classified Based on DSCP value
2. 4 classes (3 defined + default)

3. 4 queues
4. 1 priority queue
5. Scheduling is WRR with "bandwidth remaining"
6. Congestion management is WRED with the default class

Config Migration from Catalyst 6K to Silicon One Q200

Catalyst 6K Configuration

```
class-map type lan-queuing match-all REALTIME
 match dscp ef
class-map type lan-queuing match-all NETWORK_CONTROL
 match dscp cs6  cs7
class-map type lan-queuing match-all VIDEO
 match dscp cs3  af31  af32  af33
…
policy-map type lan-queuing CAMPUS_EGRESS_6800_POLICY
 class type lan-queuing REALTIME
    priority level 1
 class type lan-queuing NETWORK_CONTROL
    bandwidth remaining percent 10
 class type lan-queuing VIDEO
    bandwidth remaining percent 20
 class class-default
    random-detect dscp-based
    random-detect dscp af11 percent 80 100
```

1. Classified Based on DSCP value
2. 4 classes (3 defined + default)
3. 4 queues (traffic-class), traffic-7 is priority level 1
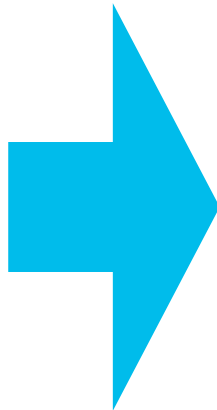
Apply policy on the ingress interface

Catalyst 9K(Q200) Configuration

```
class-map match-all REALTIME
 match dscp ef
class-map match-all NETWORK_CONTROL
 match dscp cs6  cs7
class-map match-all VIDEO
 match dscp cs3  af31  af32  af33
class-map match-all default-green
 match dscp af11


policy-map INGRESS
 class REALTIME
    set traffic-class 7
 class NETWORK_CONTROL
    set traffic-class 6
 class VIDEO
    set traffic-class 5
 class default-green
    set traffic-class 0
 class class-default
    set discard-class 1
```

Note: class-default is always assigned with traffic-class 0

Config Migration from Catalyst 6K to Silicon One Q200

Apply policy on the egress interface

Map the traffic-class marking defined on the ingress

Catalyst 6K Configuration

```
policy-map type lan-queuing CAMPUS_EGRESS_6800_POLICY
class type lan-queuing REALTIME
    priority level 1
class type lan-queuing NETWORK_CONTROL
    bandwidth remaining percent 10
class type lan-queuing VIDEO
    bandwidth remaining percent 20
class class-default
    random-detect dscp-based
    random-detect dscp af11 percent 80 100
```

3. 1 priority queue
4. Scheduling is WRR with "bandwidth remaining"
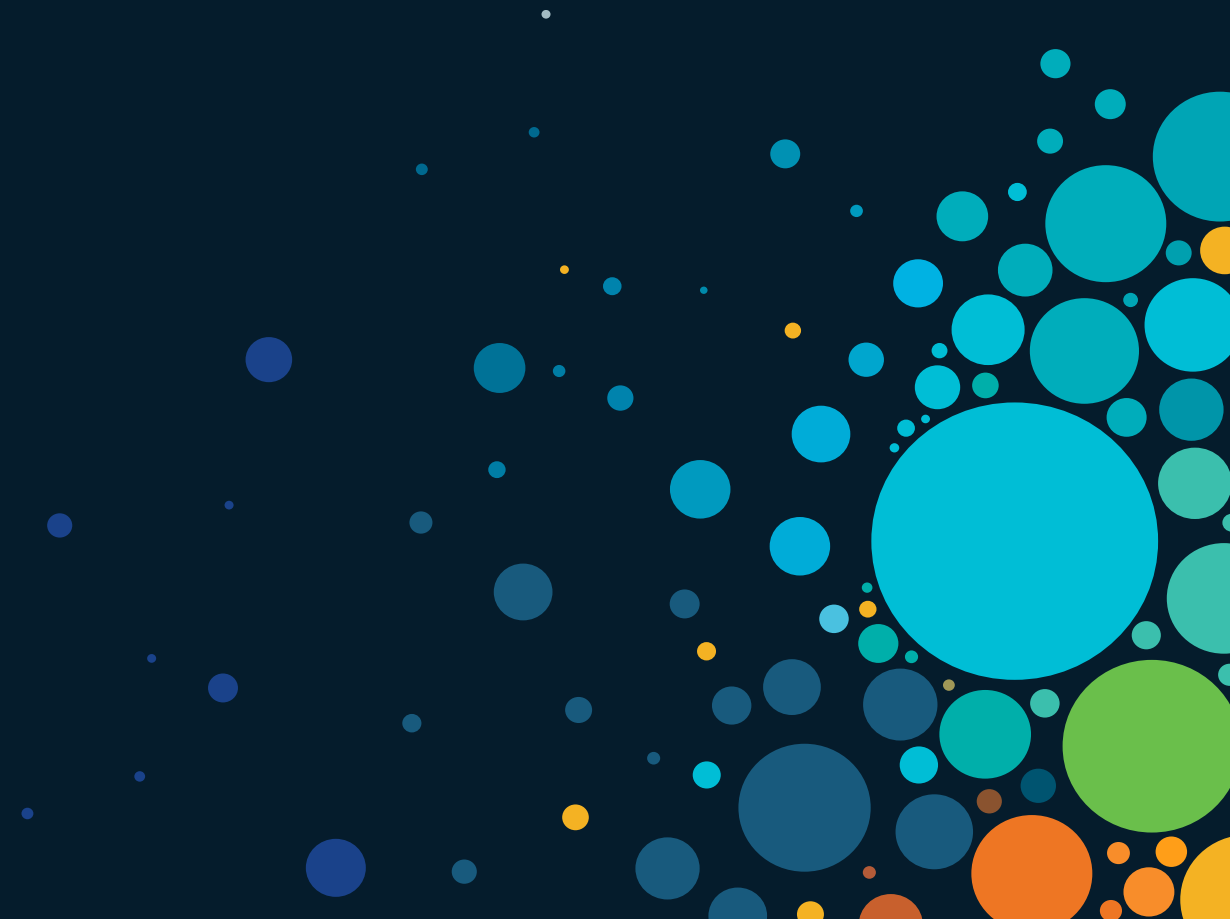5. Congestion management is WRED with the default class

Catalyst 9K(Q200) Configuration

```
class-map tc7
 match traffic-class 7
class-map tc6
 match traffic-class 6
class-map tc5
 match traffic-class 5

policy-map type queuing EGRESS
class tc7
    priority level 1
class tc6
    bandwidth remaining ratio 1
class tc5
    bandwidth remaining ratio 2
class class-default
    random-detect discard-class-based
    random-detect discard-class 0 percent 80 100
    random-detect discard-class 1 percent 40 100
```

Note: C6K WRED default min is 40, max is 100.

Summary

Why QoS in campus?

User Experience

| Guaranteeing voice quality | Bandwidth Savvy Business Applications | protect network infrastructure to deal with abnormal events |

| Video Quality | de-prioritizing non-business applications | protecting the control planes |

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