#CiscoLive

The bridge to possible

Catalyst 9000 Switching QoS Deep Dive

Part 1 – UADP ASIC

Kenny Lei – Technical Marketing Engineer

BRKENS-2096a

Content by Ninad Diwakar and Kenny Lei

cisco Live!

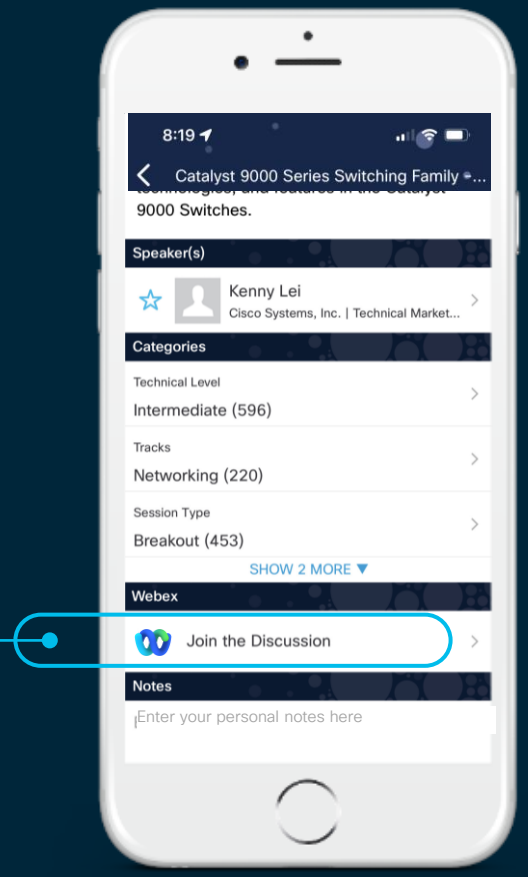
Cisco Webex App

Questions?

Use Cisco Webex App to chat
with the speaker after the session

How

1. Find this session in the Cisco Live Mobile App
2. Click “Join the Discussion”
3. Install the Webex App or go directly to the Webex space
4. Enter messages/questions in the Webex space



https://ciscolive.ciscoevents.com/ciscolivebot/#BRKENS-2096a

Webex spaces will be moderated by the speaker until June 17, 2022.

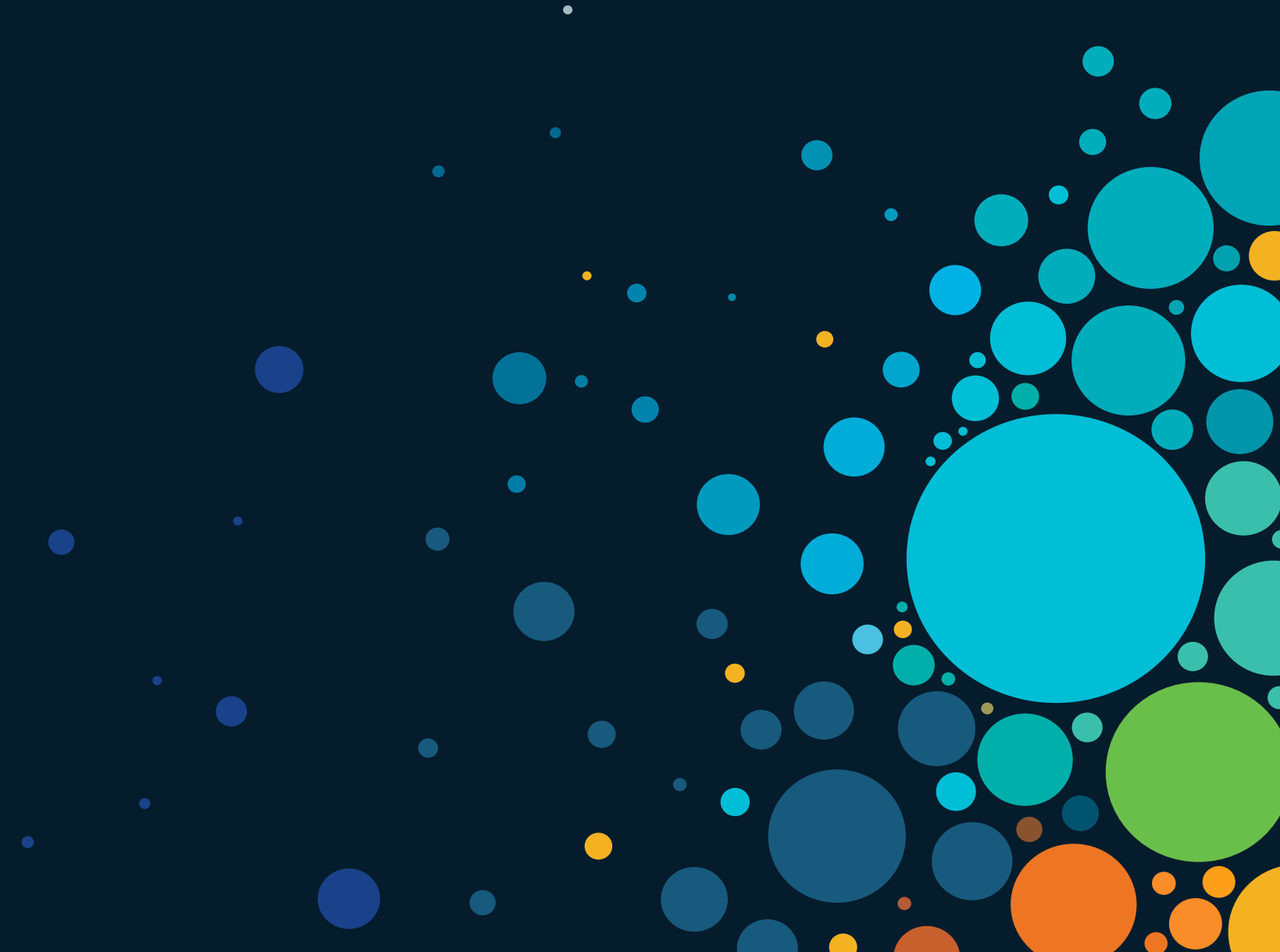
© 2022 Cisco and/or its affiliates. All rights reserved. Cisco Public

Agenda

- Overview
- UADP QoS Architecture
- Classification, Marking and Policing
- Queueing, Shaping and Scheduling
- Congestion Management and Buffers
- Migration to UADP
- Conclusion

© 2022 Cisco and/or its affiliates. All rights reserved. Cisco Public

Overview



Look familiar?

© 2022 Cisco and/or its affiliates. All rights reserved. Cisco Public

Why QoS in campus?

User Experience

Guaranteeing voice quality

Bandwidth Savvy Business Applications

protect network infrastructure to deal with abnormal events

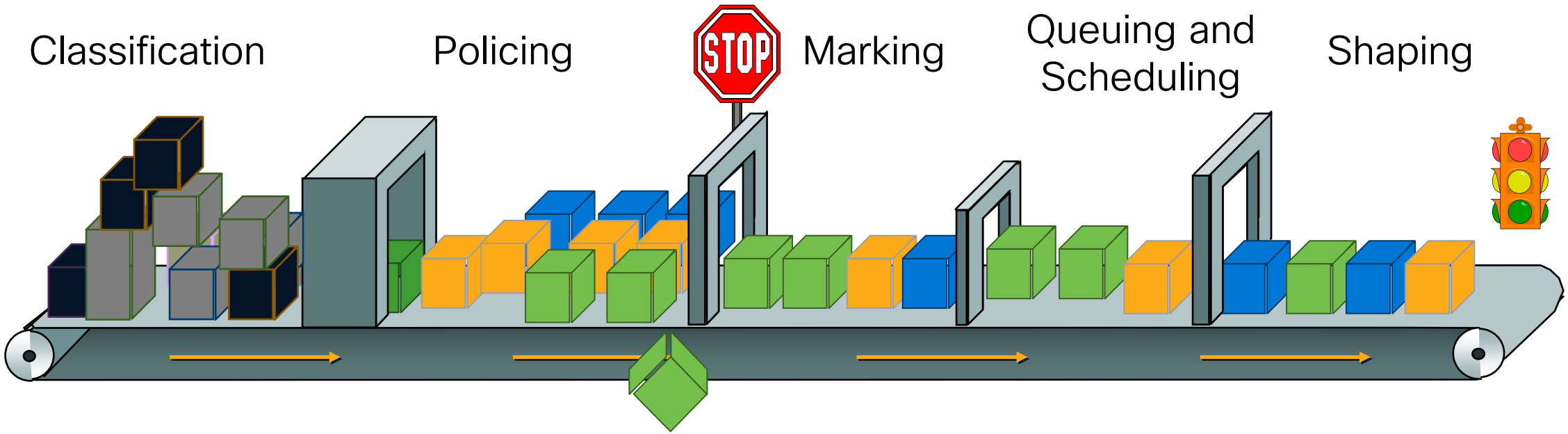
Video Quality

de-prioritizing non-business applications

protecting the control planes

© 2022 Cisco and/or its affiliates. All rights reserved. Cisco Public

The QoS Toolset



Identify and Split Traffic into Different Classes

Discard Misbehaving Traffic to Maintain Network Integrity

Mark Traffic According to Behavior and Business Policies

Prioritize, Protect and Isolate Traffic Based on Markings

Control Bursts and Conform Traffic

© 2022 Cisco and/or its affiliates. All rights reserved. Cisco Public

Hidden

QoS Terminology

Term	Explanation
Trust	Retain the packet markings as it is
Classification	Identify packet priority and place it into different classes
Marking	Change the tags (priority) on the packets
Policing	Limit the traffic to specified rate. Excess traffic can either be dropped or assigned lower priority
Shaping	Limit the traffic to specified rate. Excess traffic will be queued and buffered.
Queueing	Process the packet into separate queues
Buffering	Storage for packets to be queued

© 2022 Cisco and/or its affiliates. All rights reserved. Cisco Public

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
```


© 2022 Cisco and/or its affiliates. All rights reserved. Cisco Public

UADP QoS

Catalyst 9000 Switches with UADP ASICs

UADP 3.0x

Catalyst
9400X models

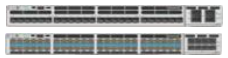
Catalyst
9500 High
performance
Series

Catalyst
9600 Series
with Sup-1

UADP 2.0x

Catalyst®
9200CX Series

Catalyst
9300X models



Catalyst
9200 Series

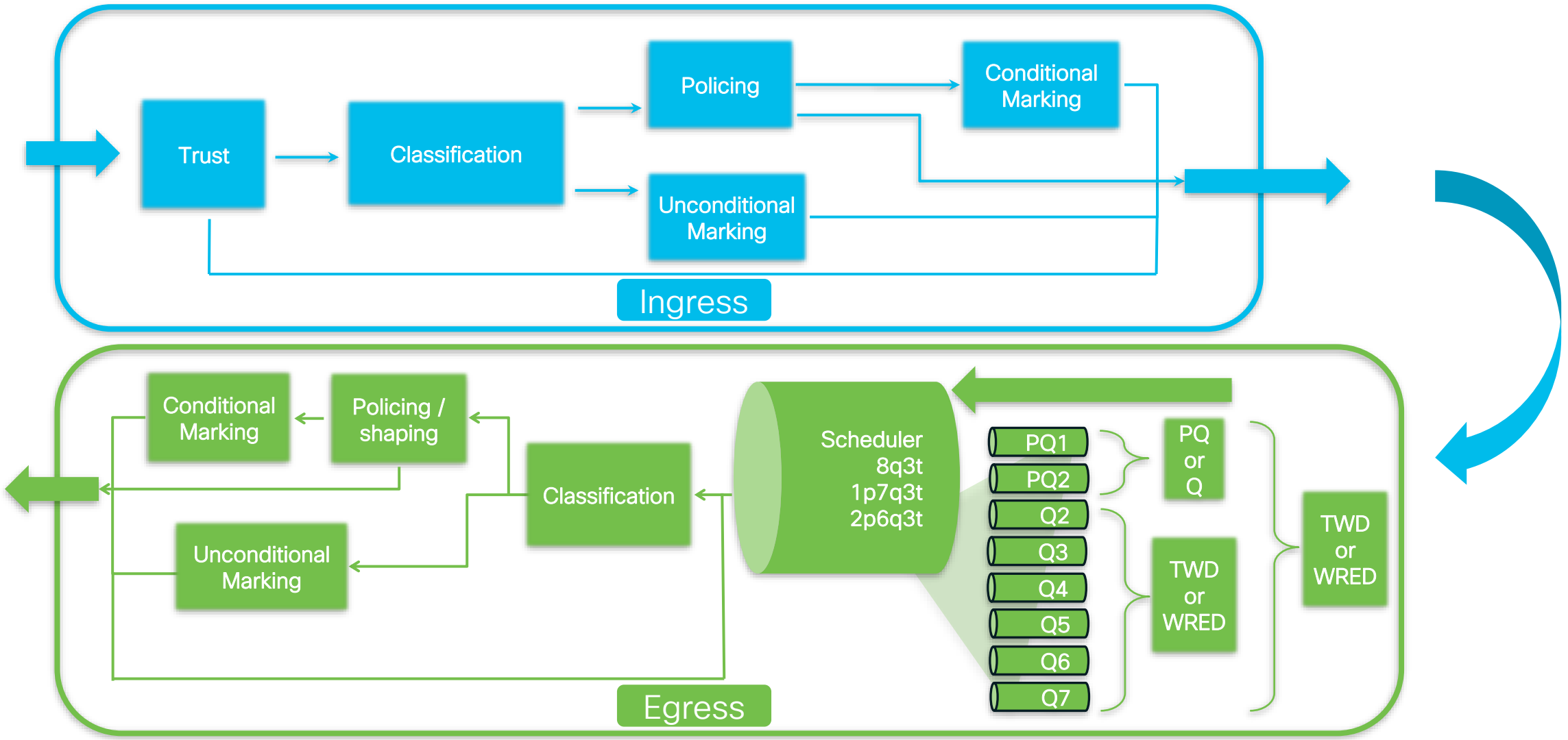
Catalyst
9300 Series

Catalyst
9400 Series

Catalyst
9500 Series

© 2022 Cisco and/or its affiliates. All rights reserved. Cisco Public

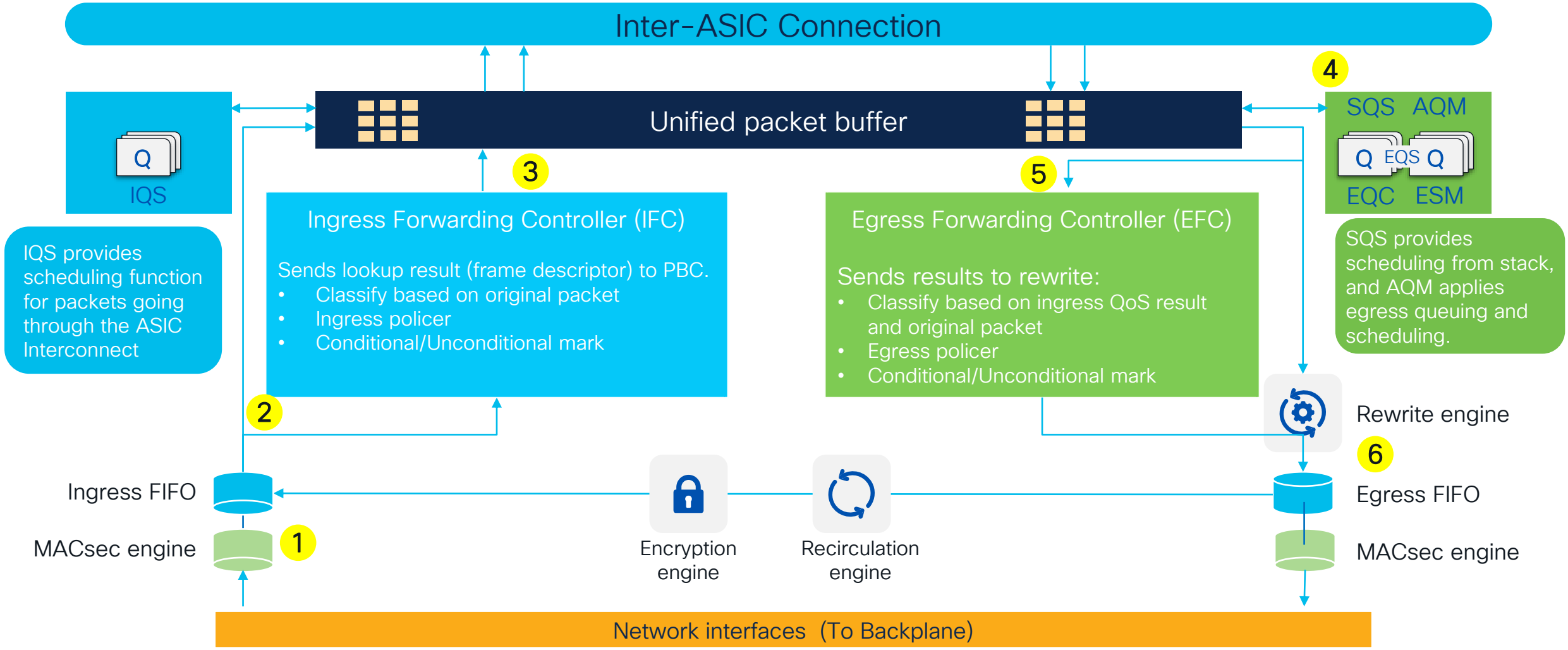
QoS Fundamental Actions in UADP



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

© 2022 Cisco and/or its affiliates. All rights reserved. Cisco Public

UADP QoS forwarding
ingress and egress



© 2022 Cisco and/or its affiliates. All rights reserved. Cisco Public

Hidden

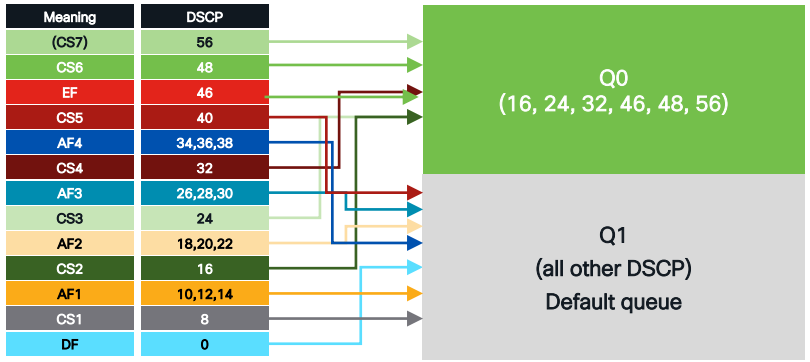
UADP forwarding

1. Packet arrives at ingress port, PHY converts the signal and serializes the bits, and then it sends to network interface ports. Network interface passes packet to ingress MACsec engine. MACsec engine decrypts the packet if needed and passes unencrypted packet to ingress FIFO.
2. IFC snoops the packet between FIFO and PBC. IFC returns lookup result (frame descriptor) to PBC.
3. PBC uses the frame descriptor to determine the egress port. Egress on same ASIC, so result to moved to EQS.
4. EQS schedule the packet for egress process. EQS – replication, scheduling, and queue management. PBC sends packet with new frame descriptor and enqueues the frame.
5. EFC snoops the packet between PBC and rewrite engine. EFC performs egress lookup functions to learn SRC MAC, egress SPAN, etc. and sends results to rewrite engine.
6. Rewrite engine rewrites packets and sends through the egress FIFO. MACsec engine encrypts packet prior to placing it on NIF.

© 2022 Cisco and/or its affiliates. All rights reserved. Cisco Public

UADP QoS Default

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



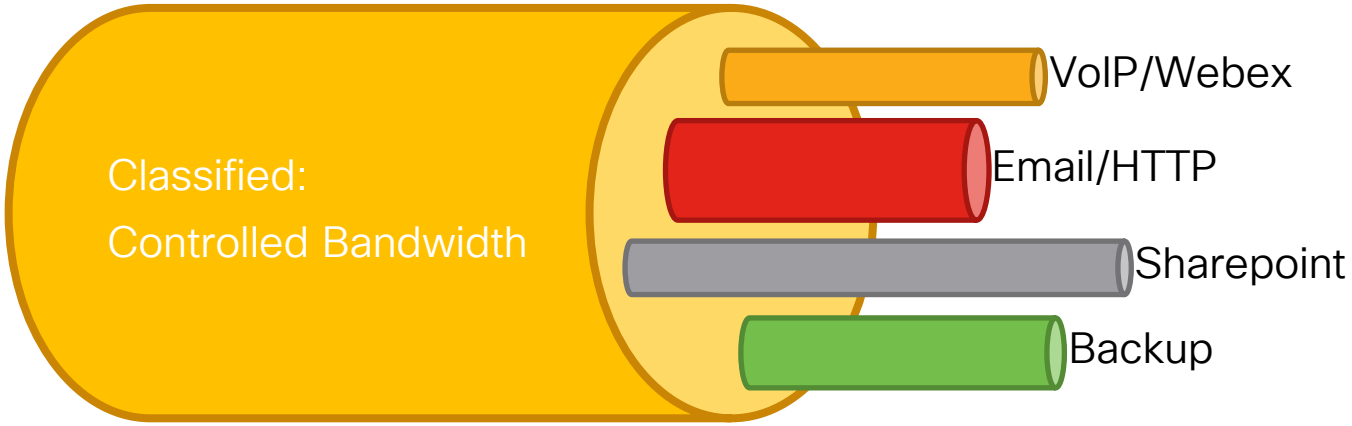
© 2022 Cisco and/or its affiliates. All rights reserved. Cisco Public

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)
  - Network-Based Application Recognition (NBAR) protocols *
  - VLANs
- Marking
  - Conditional or unconditional
  - Table map (default-class)
  - QoS group (local within switch)

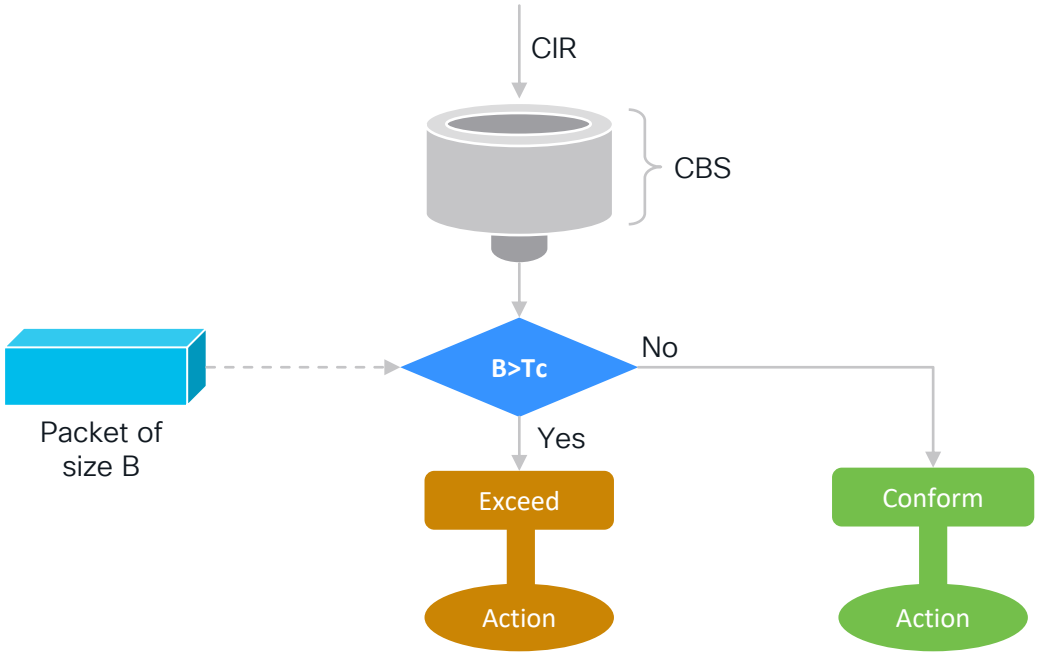
* Access platforms



© 2022 Cisco and/or its affiliates. All rights reserved. Cisco Public

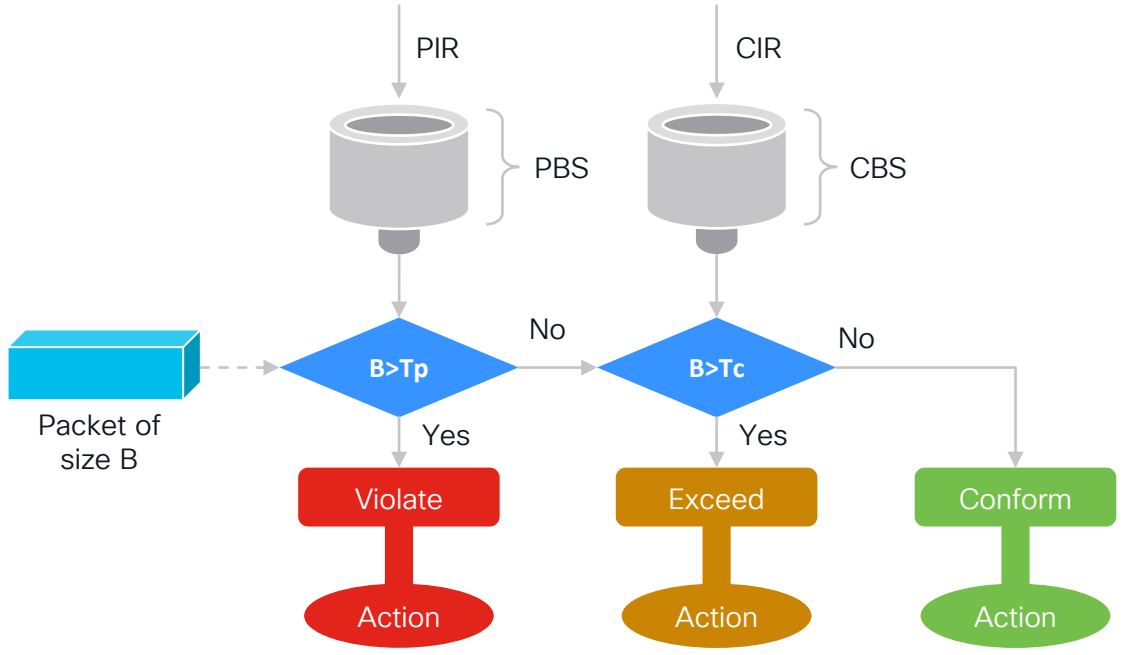
Policing – Limit the traffic

1 rate 2 color




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

2 rate 3 color




```
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

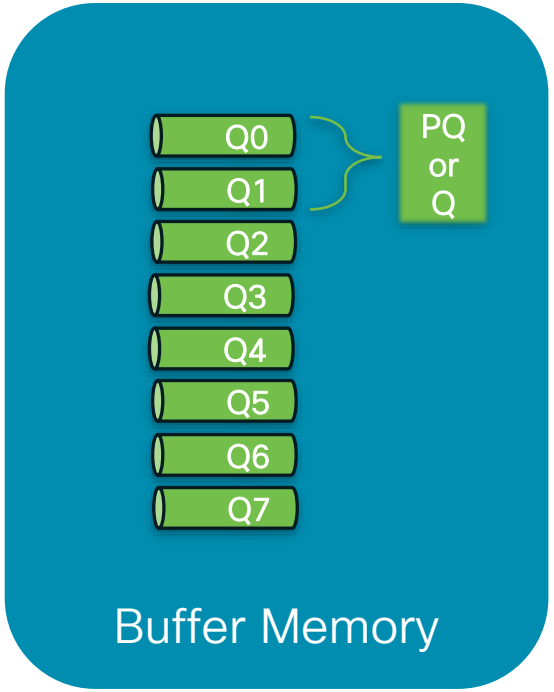
PBS- Peak Burst Size
CBS – Committed Burst Size

© 2022 Cisco and/or its affiliates. All rights reserved. Cisco Public

Queueing, Scheduling and Shaping

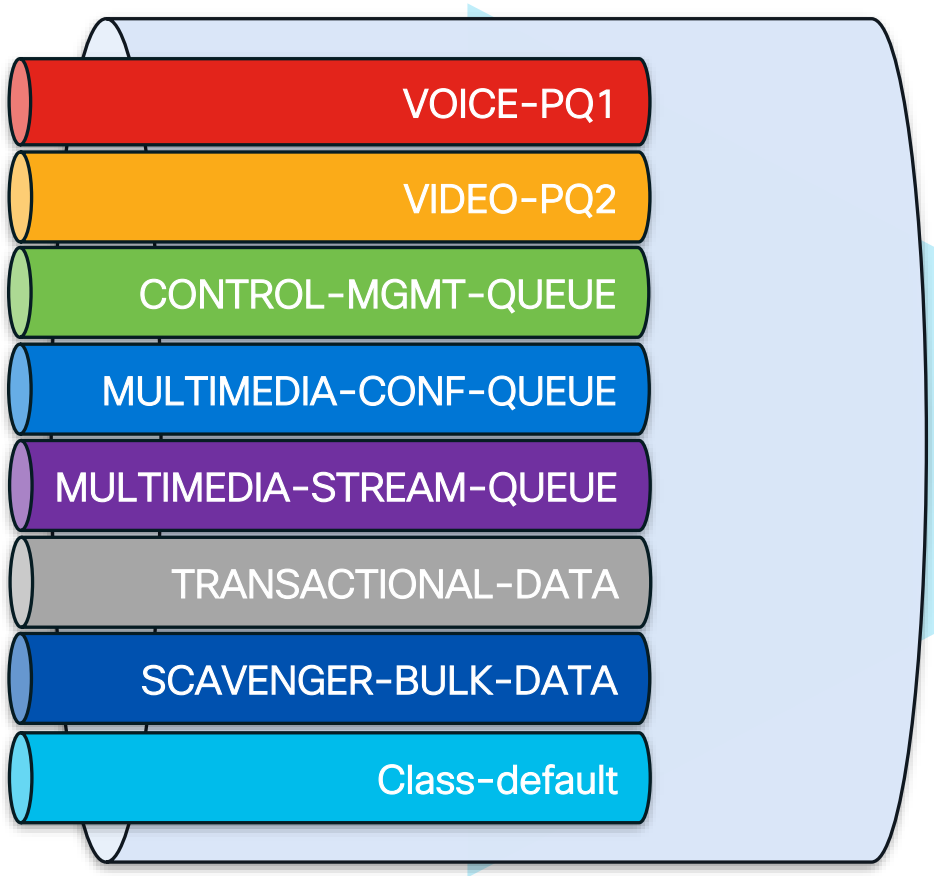
Queueing

- 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.



© 2022 Cisco and/or its affiliates. All rights reserved. Cisco Public

Queueing
2P6Q3T Example



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
```


© 2022 Cisco and/or its affiliates. All rights reserved. Cisco Public

Hidden

Queueing

Priority queue

```
policy-map 2P6Q3T
  class VOICE-PQ1
    priority level 1
```

- Priority queue.
- As long as there is traffic in priority queue all other queues will not be serviced.

```
policy-map 2P6Q3T
  class VOICE-PQ1
    priority level 1
      police rate percent 10
```

- Priority queue.
- **Limit (police)** traffic to 10 percent of link speed regardless the utilization of other queues

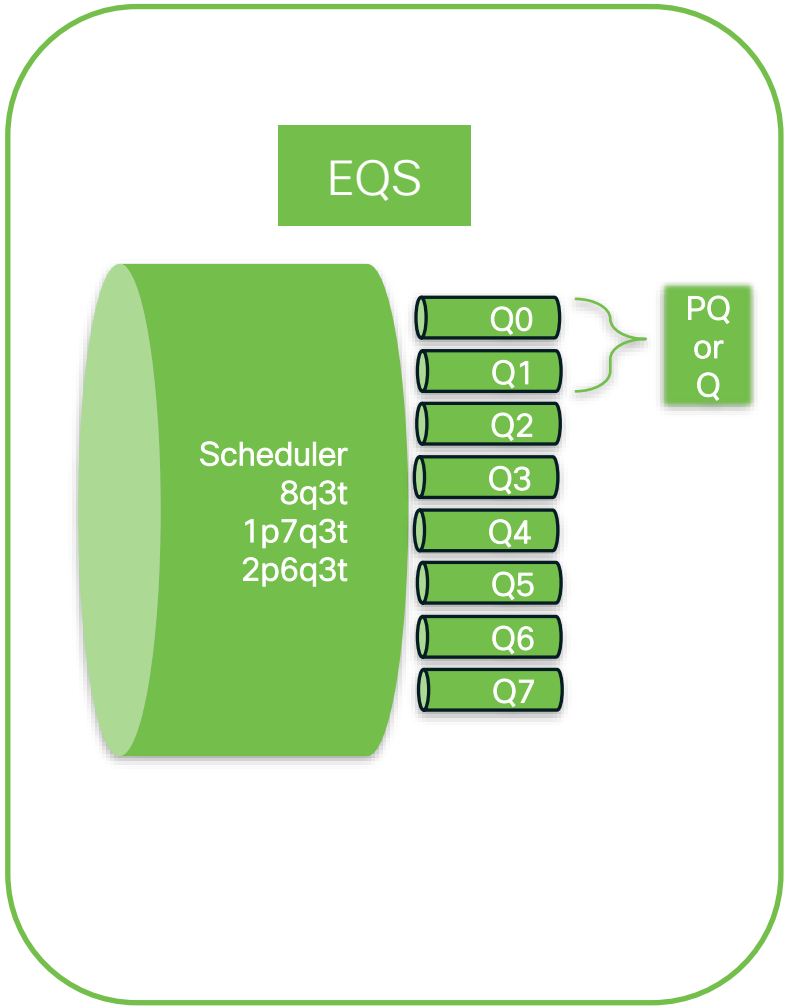
```
policy-map 2P6Q3T
   class VOICE-PQ1
     priority level 1 percent 10
```

- Enable strict priority queue.
- **Shape** traffic to 10 percent of link speed regardless the utilization of other queues

© 2022 Cisco and/or its affiliates. All rights reserved. Cisco Public

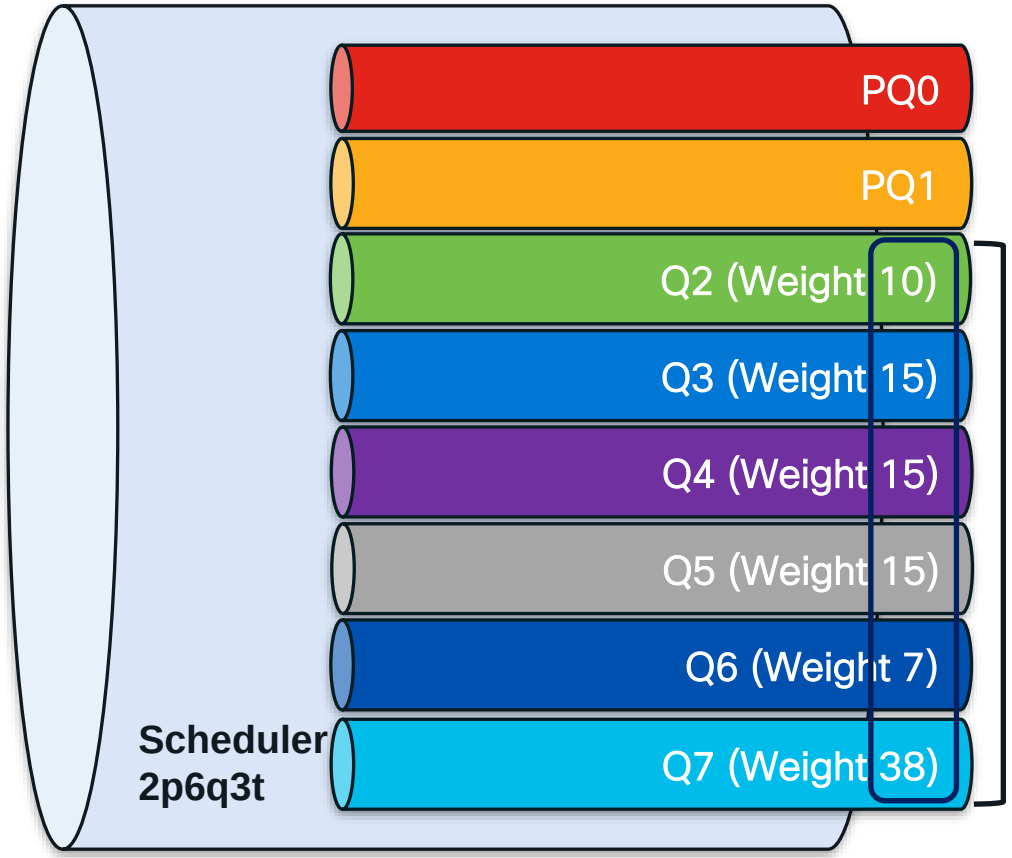
Scheduling – UADP

- 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



© 2022 Cisco and/or its affiliates. All rights reserved. Cisco Public

Scheduling – Example



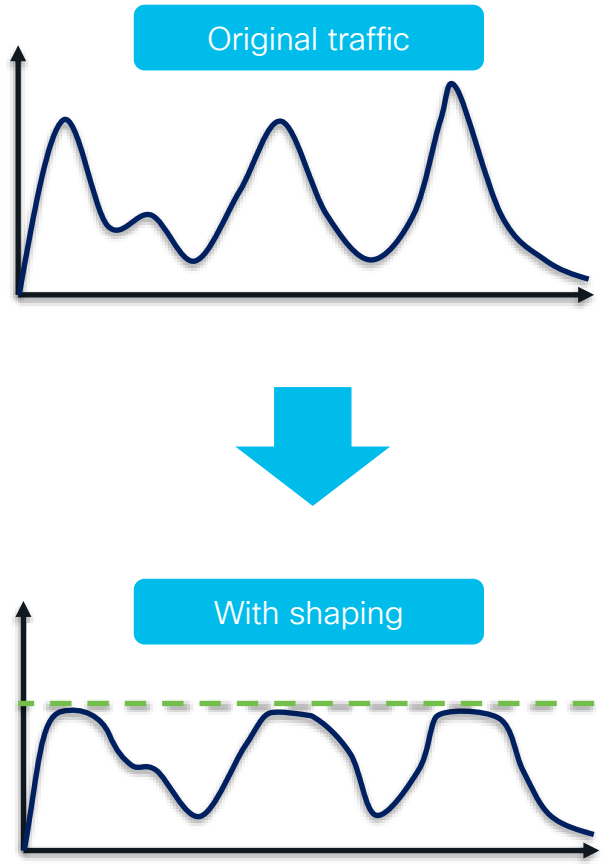
Policy Map Configuration

```
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
```


© 2022 Cisco and/or its affiliates. All rights reserved. Cisco Public

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
```

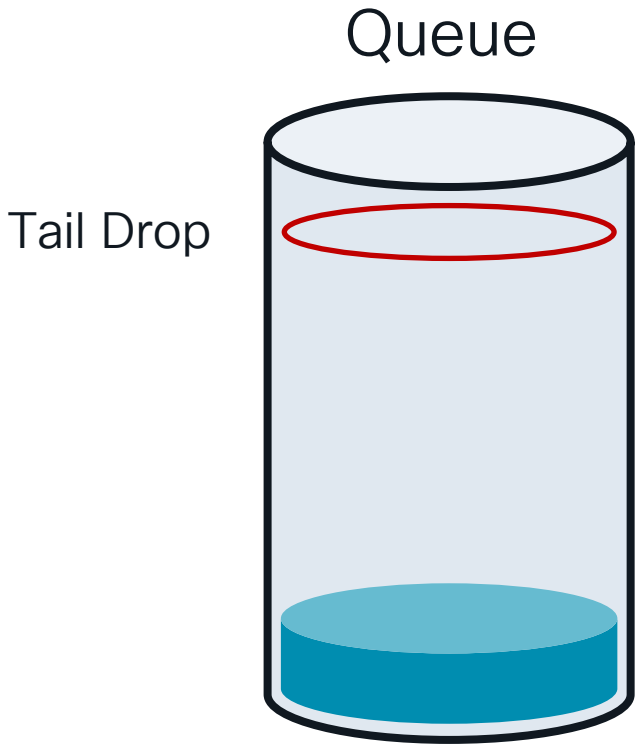

© 2022 Cisco and/or its affiliates. All rights reserved. Cisco Public

Congestion Management

cisco Live!

Congestion Management Tools

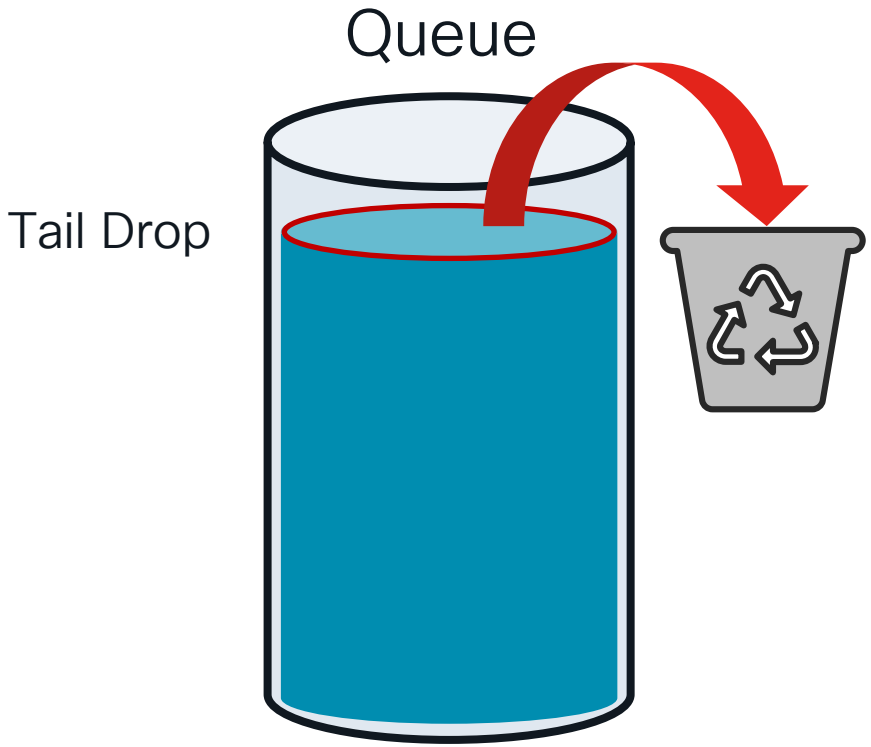
- Tail Drop (TD)
  - Drop packets at tail of the queue
  - Single threshold per queue



© 2022 Cisco and/or its affiliates. All rights reserved. Cisco Public

Congestion Management Tools

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

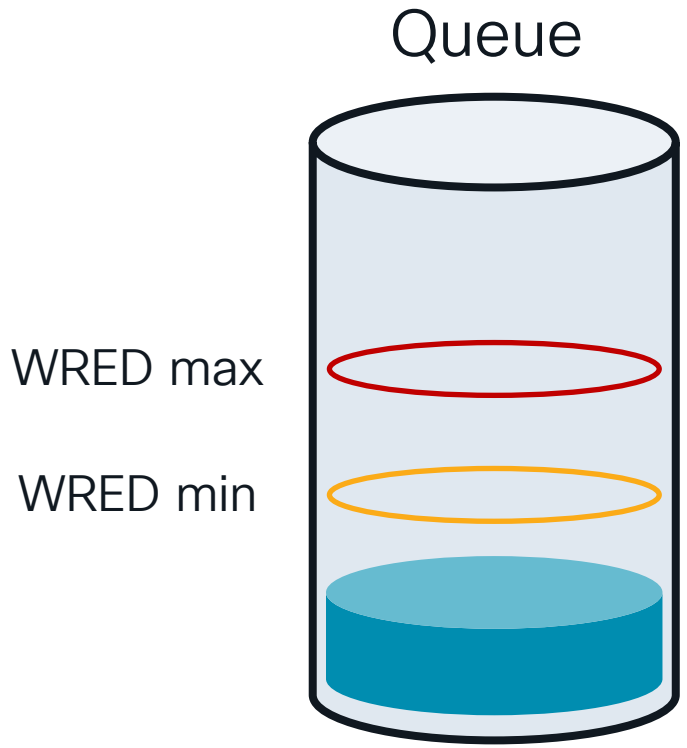


© 2022 Cisco and/or its affiliates. All rights reserved. Cisco Public

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

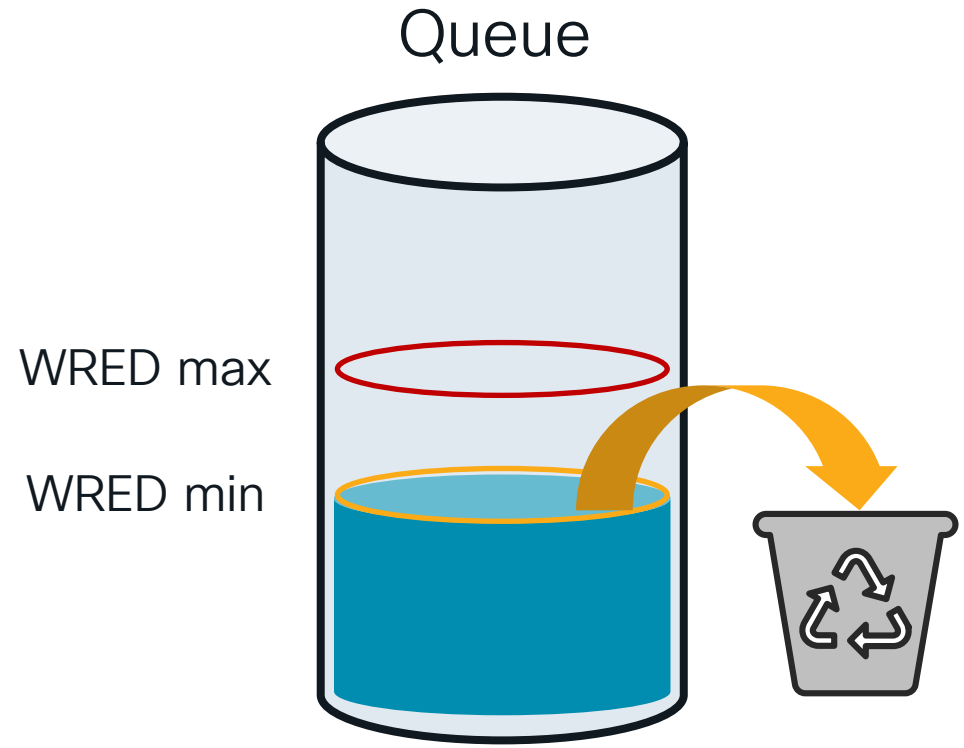


© 2022 Cisco and/or its affiliates. All rights reserved. Cisco Public

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

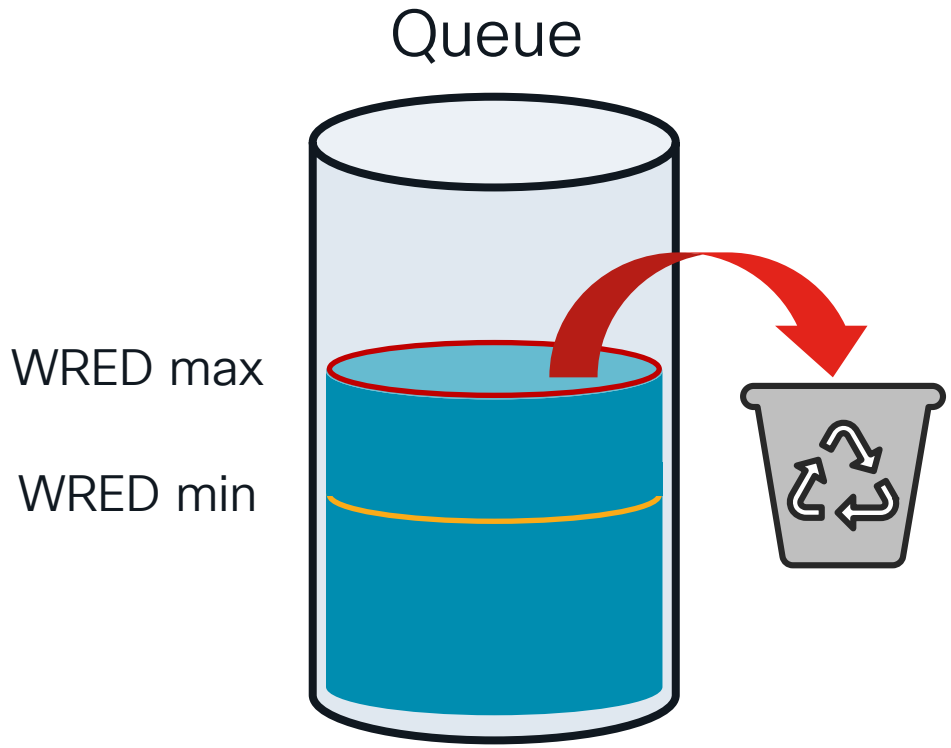


© 2022 Cisco and/or its affiliates. All rights reserved. Cisco Public

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



© 2022 Cisco and/or its affiliates. All rights reserved. Cisco Public

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

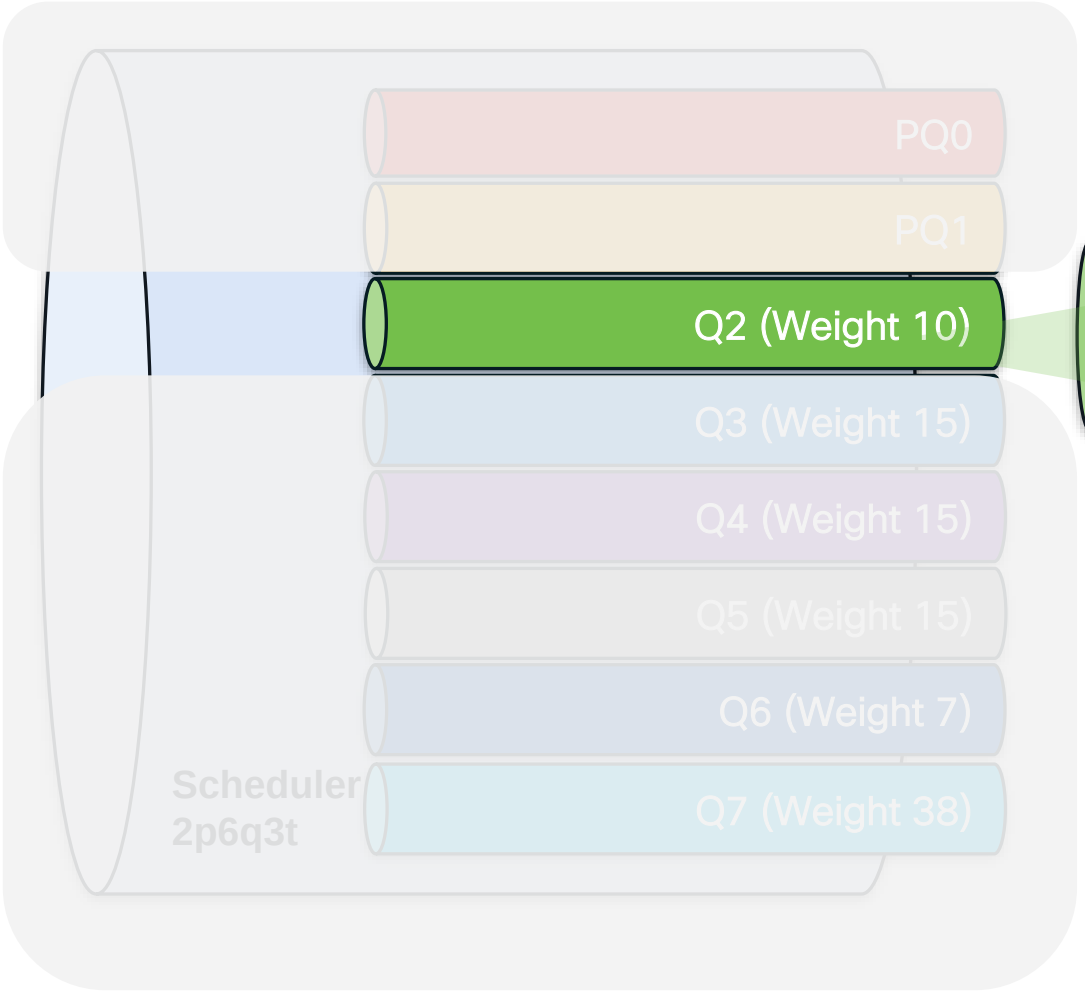
Weighted Random Early Detection (WRED)

- 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

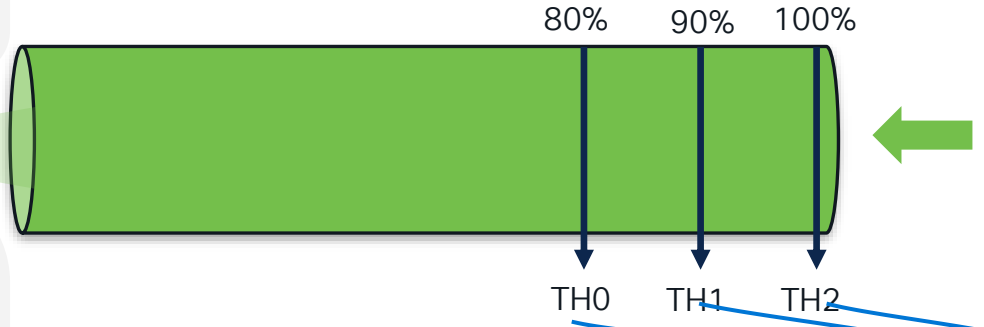
Weighted -> Multiple pair of thresholds

© 2022 Cisco and/or its affiliates. All rights reserved. Cisco Public

WTD – UADP Example



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



TH: threshold

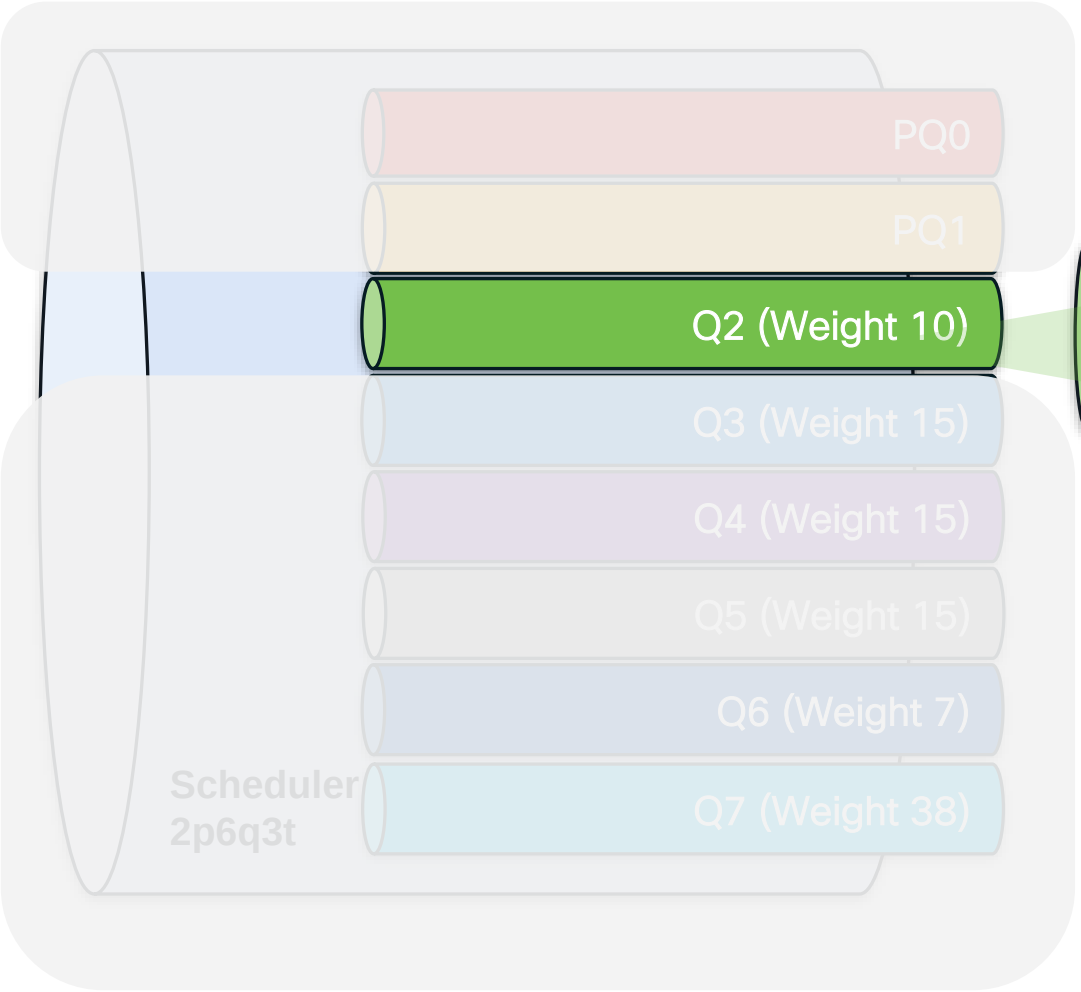
Policy Map Configuration

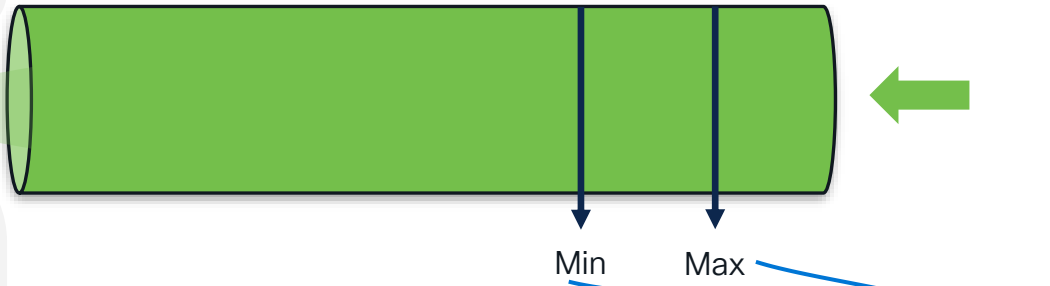
```
policy-map 2P6Q3T
 class DATA-QUEUE
  queue-limit dscp values af13 cs1 percent 80
  queue-limit dscp values af12 percent 90
  queue-limit dscp values af11 percent 100
```


© 2022 Cisco and/or its affiliates. All rights reserved. Cisco Public

WRED – UADP Example

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



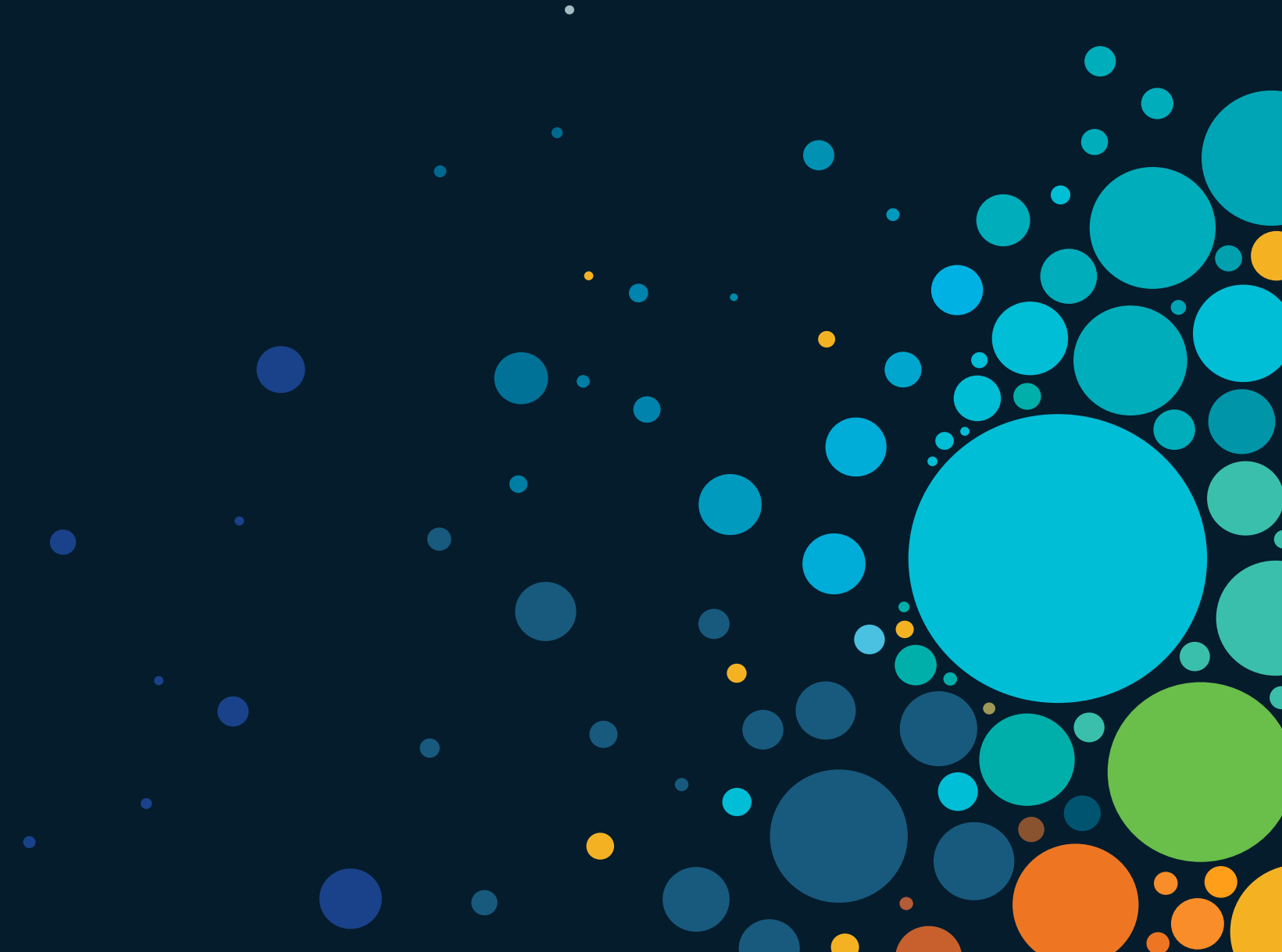


Policy Map Configuration

```
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
```

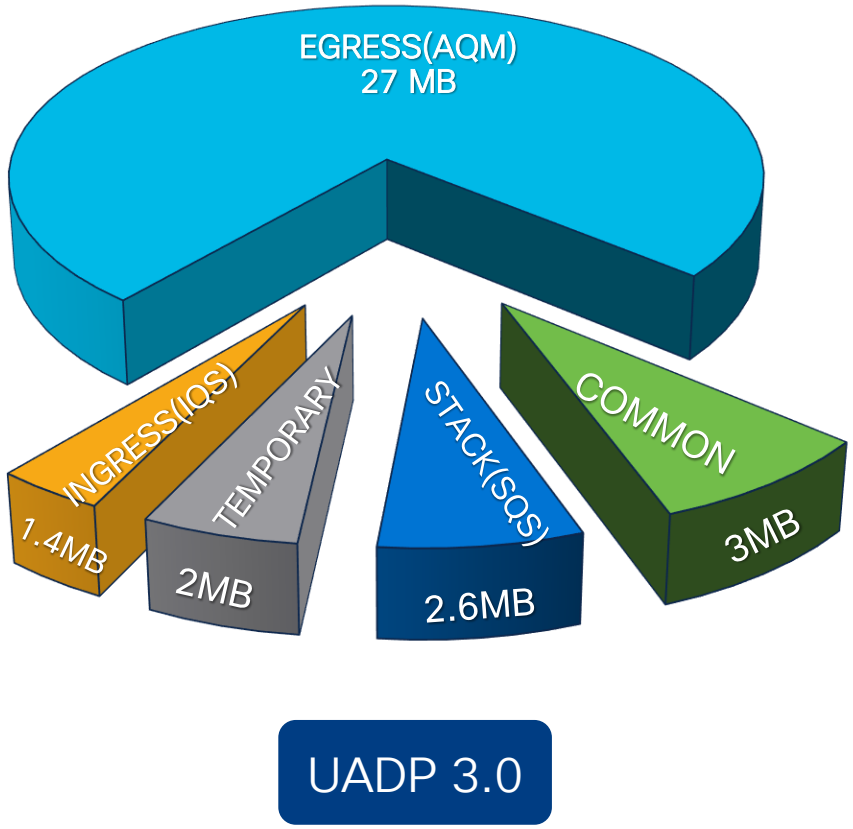

© 2022 Cisco and/or its affiliates. All rights reserved. Cisco Public

Buffers



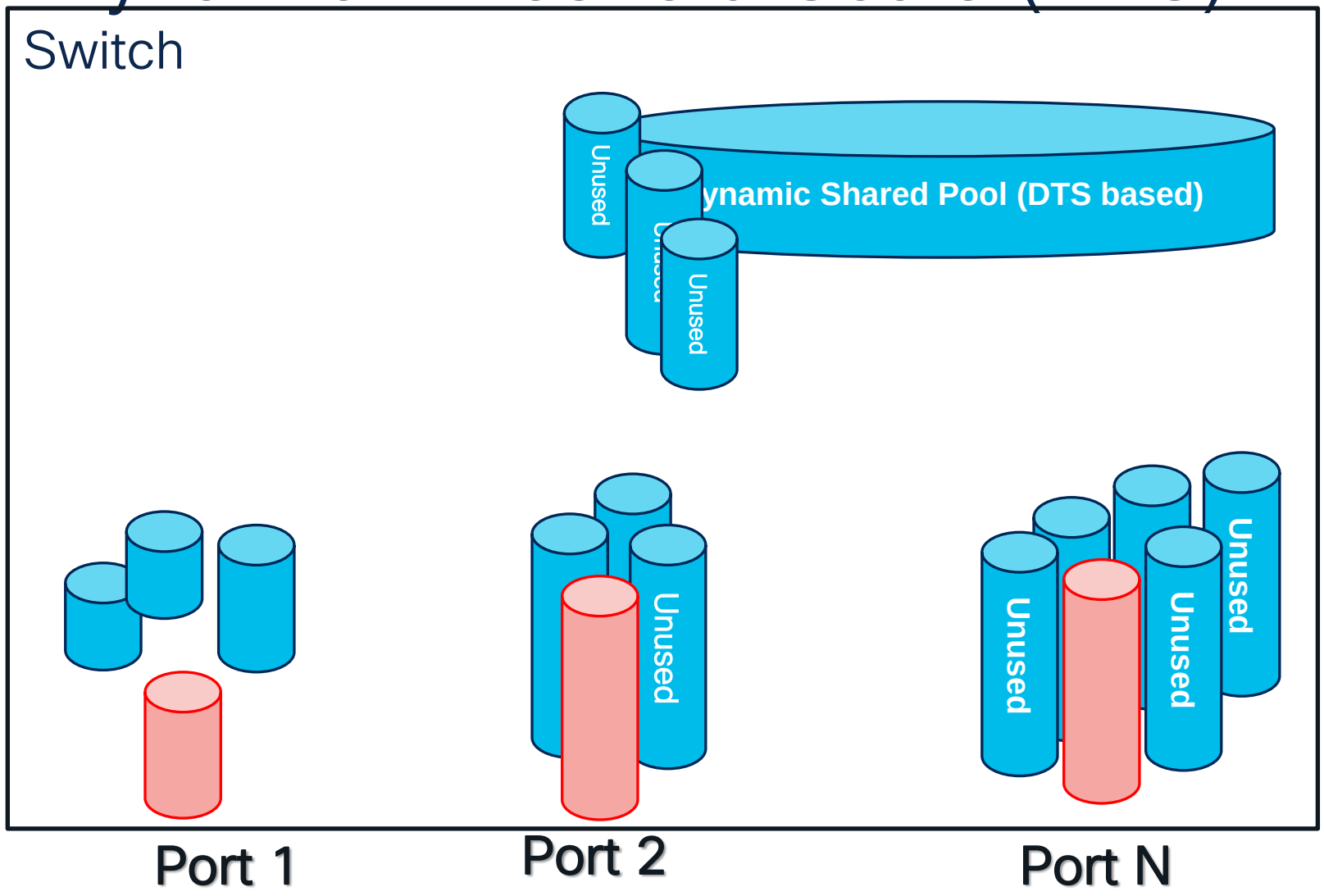
Buffers

- 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



© 2022 Cisco and/or its affiliates. All rights reserved. Cisco Public

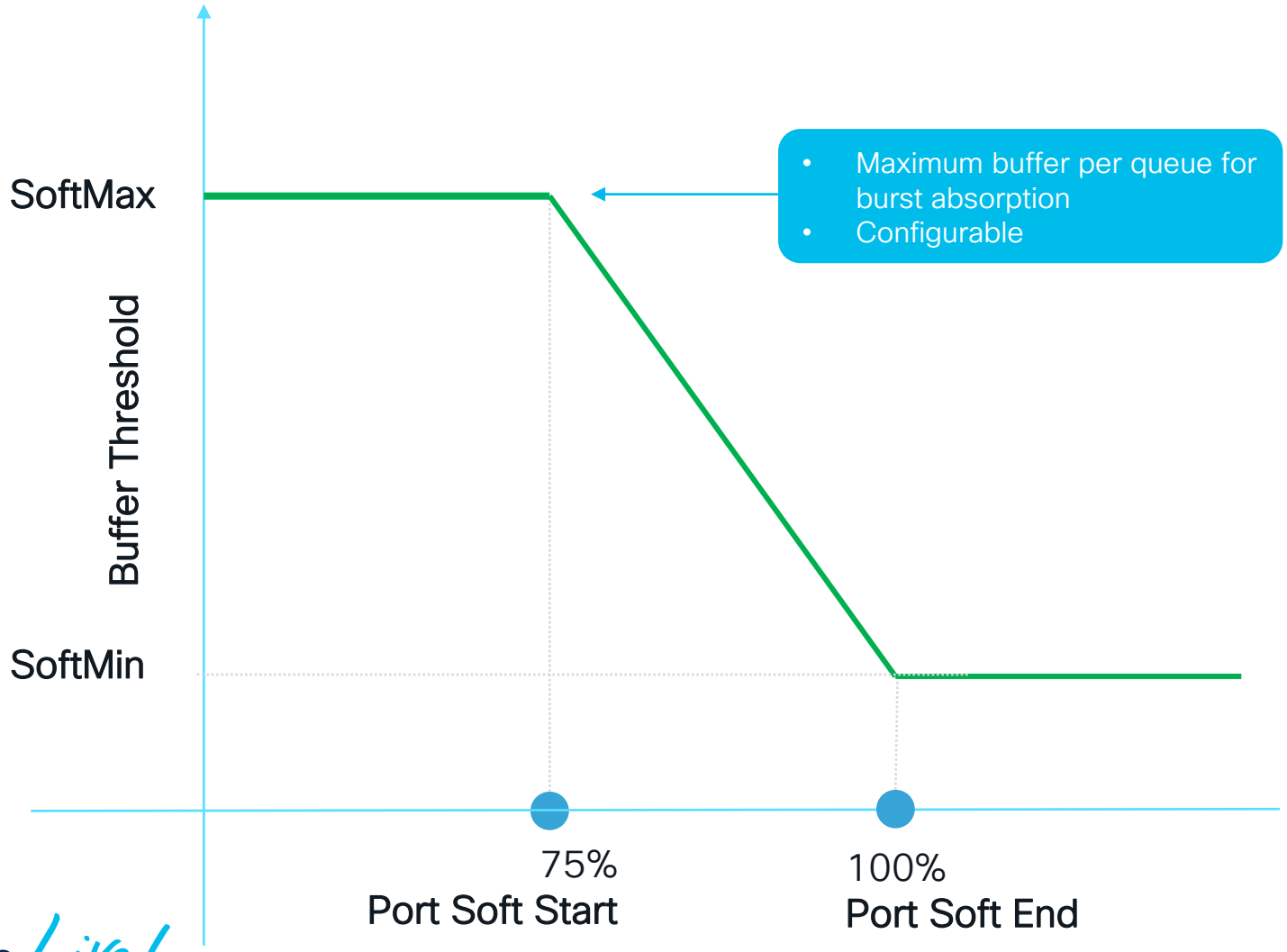
Dynamic Threshold Scale (DTS)



- 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

© 2022 Cisco and/or its affiliates. All rights reserved. Cisco Public

Dynamic Threshold Scale (DTS)
buffer allocation graph



- Maximum buffer per queue for burst absorption
- Configurable

- **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

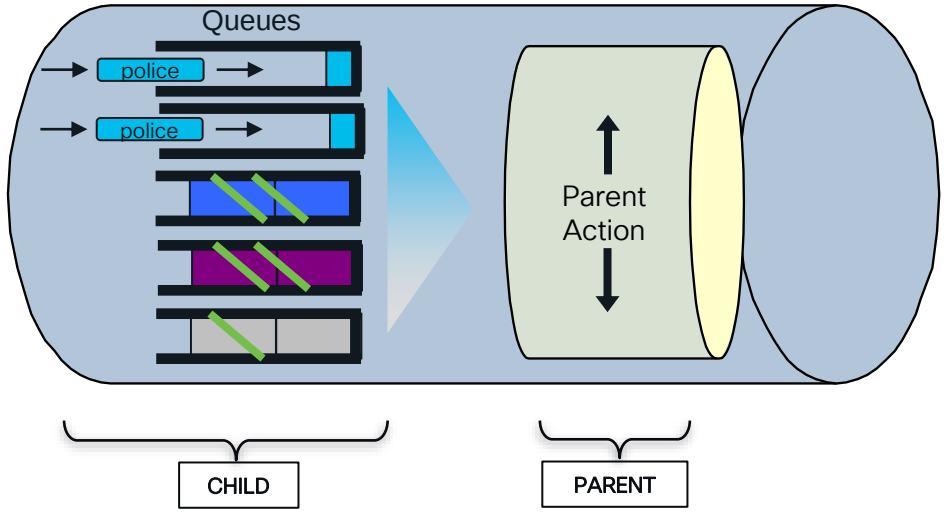
© 2022 Cisco and/or its affiliates. All rights reserved. Cisco Public

HQoS

UADP Hierarchical QoS (HQoS)

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

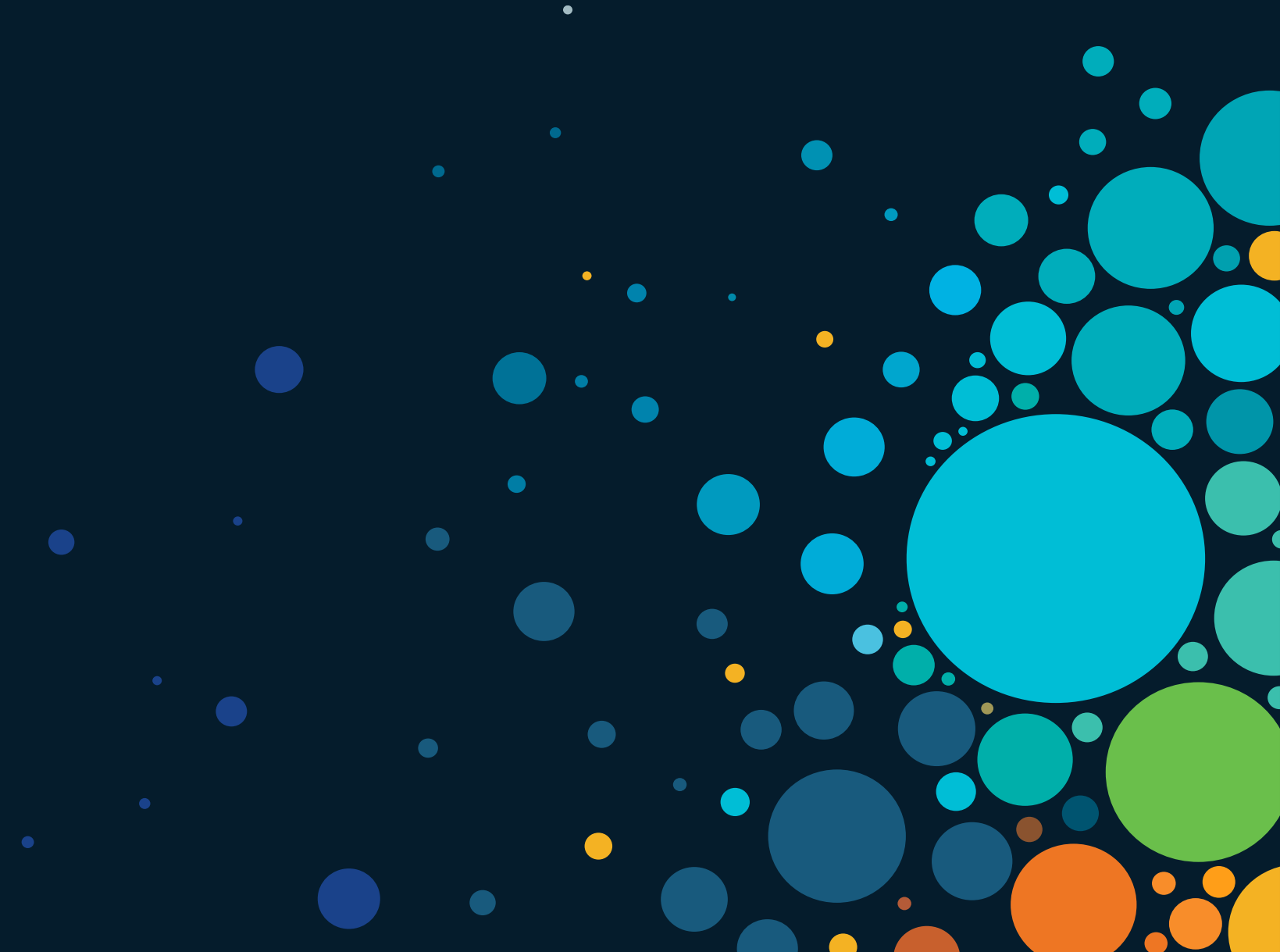
- Classification
- Policing
- Shaping



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

© 2022 Cisco and/or its affiliates. All rights reserved. Cisco Public

QoS Config Migration



cisco Live!

Config Migration Philosophy (UADP)

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 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.

© 2022 Cisco and/or its affiliates. All rights reserved. Cisco Public

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

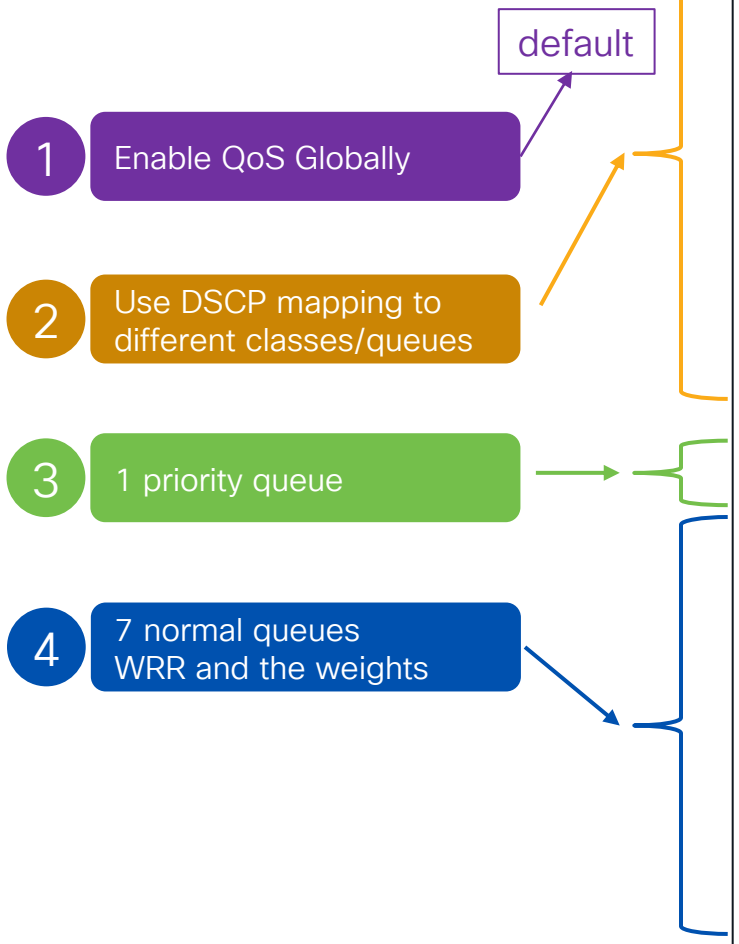
© 2022 Cisco and/or its affiliates. All rights reserved. Cisco Public

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
```



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

© 2022 Cisco and/or its affiliates. All rights reserved. Cisco Public

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

© 2022 Cisco and/or its affiliates. All rights reserved. Cisco Public

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

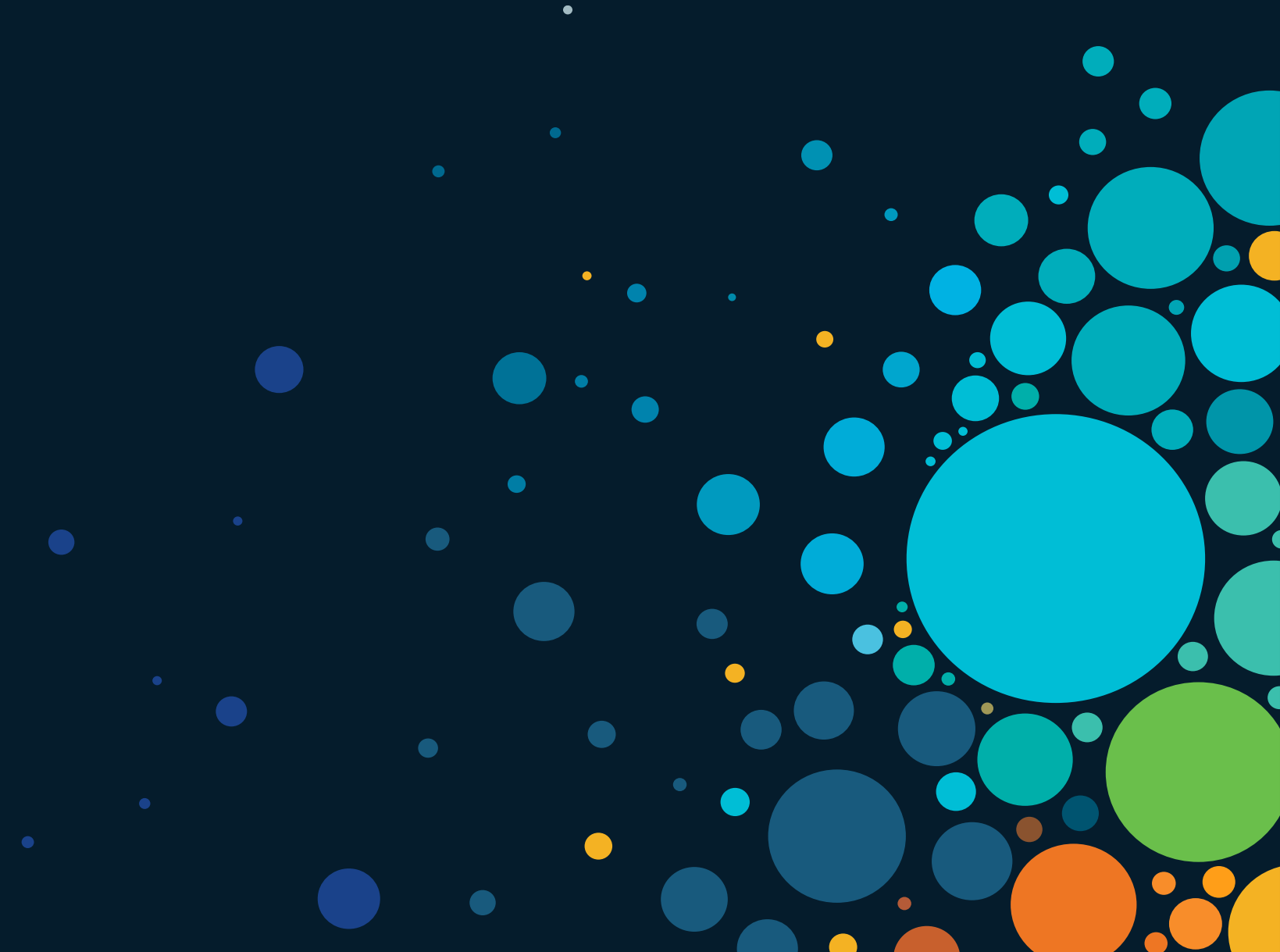
```
class-map match-any REALTIME
 match dscp ef
class-map match-any NETWORK_CONTROL
 match dscp cs6  cs7
class-map match-any VIDEO
 match dscp cs3  af31  af32  af33

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
```


© 2022 Cisco and/or its affiliates. All rights reserved. Cisco Public

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

© 2022 Cisco and/or its affiliates. All rights reserved. Cisco Public

Technical Session Surveys

- Attendees who fill out a minimum of four session surveys and the overall event survey will get Cisco Live branded socks!
- Attendees will also earn 100 points in the Cisco Live Game for every survey completed.
- These points help you get on the leaderboard and increase your chances of winning daily and grand prizes.

© 2022 Cisco and/or its affiliates. All rights reserved. Cisco Public

Cisco Learning and Certifications

From technology training and team development to Cisco certifications and learning plans, let us help you empower your business and career. www.cisco.com/go/certs

Pay for Learning with Cisco Learning Credits

(CLCs) are prepaid training vouchers redeemed directly with Cisco.

Learn

Cisco U.
IT learning hub that guides teams and learners toward their goals

Cisco Digital Learning
Subscription-based product, technology, and certification training

Cisco Modeling Labs
Network simulation platform for design, testing, and troubleshooting

Cisco Learning Network
Resource community portal for certifications and learning

Train

Cisco Training Bootcamps
Intensive team & individual automation and technology training programs

Cisco Learning Partner Program
Authorized training partners supporting Cisco technology and career certifications

Cisco Instructor-led and Virtual Instructor-led training
Accelerated curriculum of product, technology, and certification courses

Certify

Cisco Certifications and Specialist Certifications
Award-winning certification program empowers students and IT Professionals to advance their technical careers

Cisco Guided Study Groups
180-day certification prep program with learning and support

Cisco Continuing Education Program
Recertification training options for Cisco certified individuals

Here at the event? Visit us at **The Learning and Certifications lounge at the World of Solutions**

© 2022 Cisco and/or its affiliates. All rights reserved. Cisco Public

Continue your education

- Visit the Cisco Showcase for related demos
- Book your one-on-one Meet the Engineer meeting
- Attend the interactive education with DevNet, Capture the Flag, and Walk-in Labs
- Visit the On-Demand Library for more sessions at www.CiscoLive.com/on-demand

cisco Live!

© 2022 Cisco and/or its affiliates. All rights reserved. Cisco Public


cisco
The bridge to possible
Thank you
cisco Live!
#CiscoLive

#CiscoLive