The bridge to possible

End-to-End QoS Implementation and Operation with Nexus

Nemanja Kamenica, Technical Marketing Engineer

Session Objectives

- Provide a refresh of QoS Basics
- Understand QOS implementation on Nexus Operating System
- Provide a detailed understanding of QoS on Nexus Nexus 9000 Cloud Scale platforms
- Learn how to configure QOS on Nexus 9000 devices through real-world configuration examples

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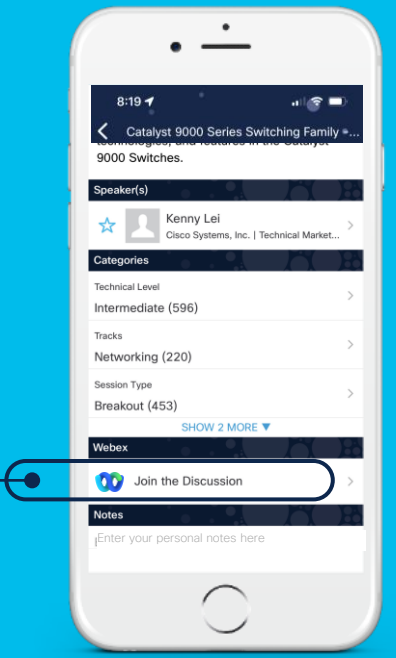


Session Non-Objectives

- Data Centre QoS Methodology
- Nexus hardware architecture deep-dive
- Application Centric Infrastructure (ACI) QOS

Agenda

- Introduction
- QoS Basics
- QoS Implementation on Nexus
- Nexus 9000 Cloud Scale QoS
- Real World Configuration Examples
- Conclusion

Congestion Happens Everyday!

Why QoS in the Data Centre?

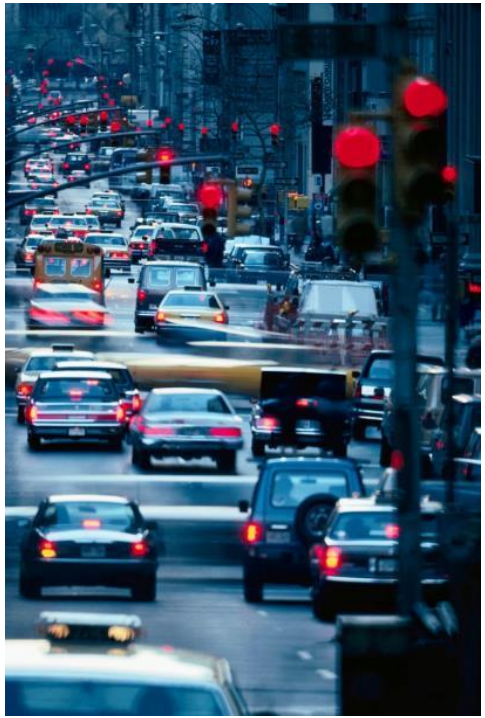
Assign Color to Traffic

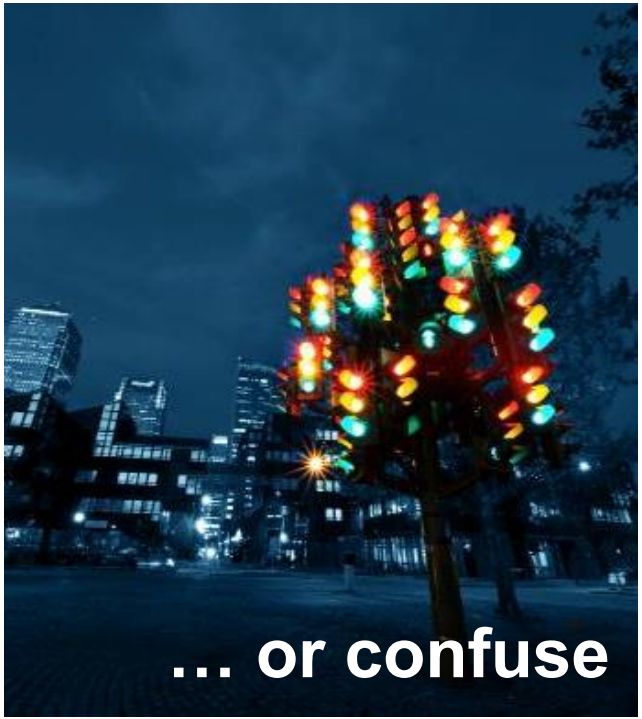
Manage Congestion

Maximize Throughput

Maximize Throughput and Manage Congestion!

Can Traffic Control help …





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- QoS Implementation on Nexus
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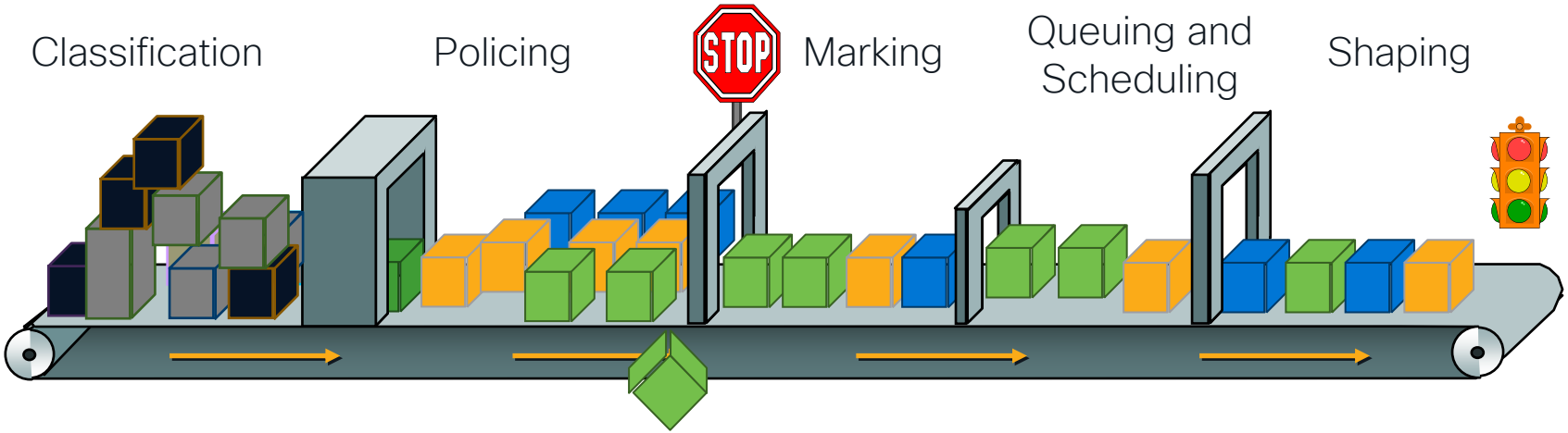
The QoS Toolset



Identify and Split Traffic into Different Classes

Discard Misbehaving Traffic to Maintain Network Integrity

Mark Traffic According to Behavior and Business Policies

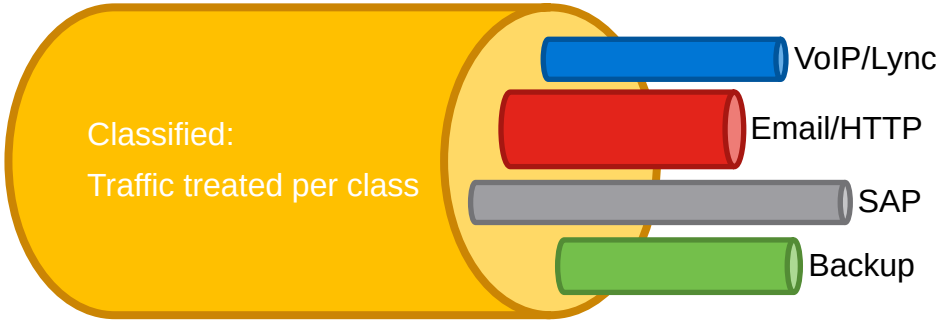
Prioritize, Protect and Isolate Traffic Based on Markings

Control Bursts and Conform Traffic

Classification and Marking

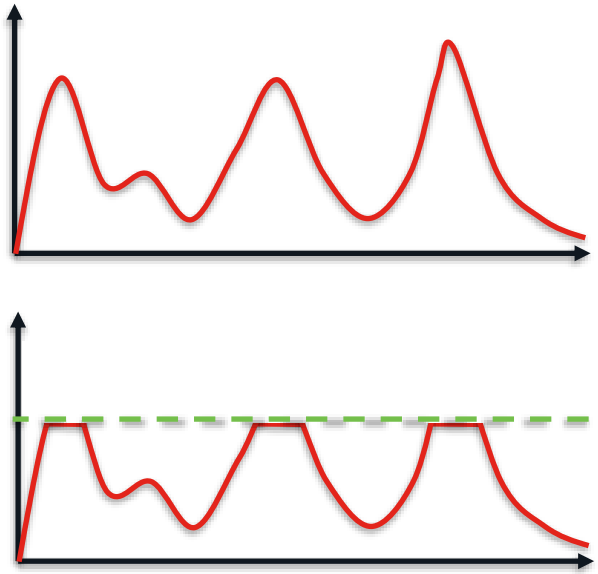
Two sides of a coin

- Classification – Identify and separate traffic in classes
- Identify traffic
  - ACLs
  - CoS
  - DSCP
  - IP PREC
- Marking – Mark traffic with QoS priority value
- Marking Traffic
  - With new priority value (i.e. CoS or DSCP)
  - Changing Like to Like (i.e. CoS to CoS)
  - Like to Unlike (i.e. DSCP to CoS)



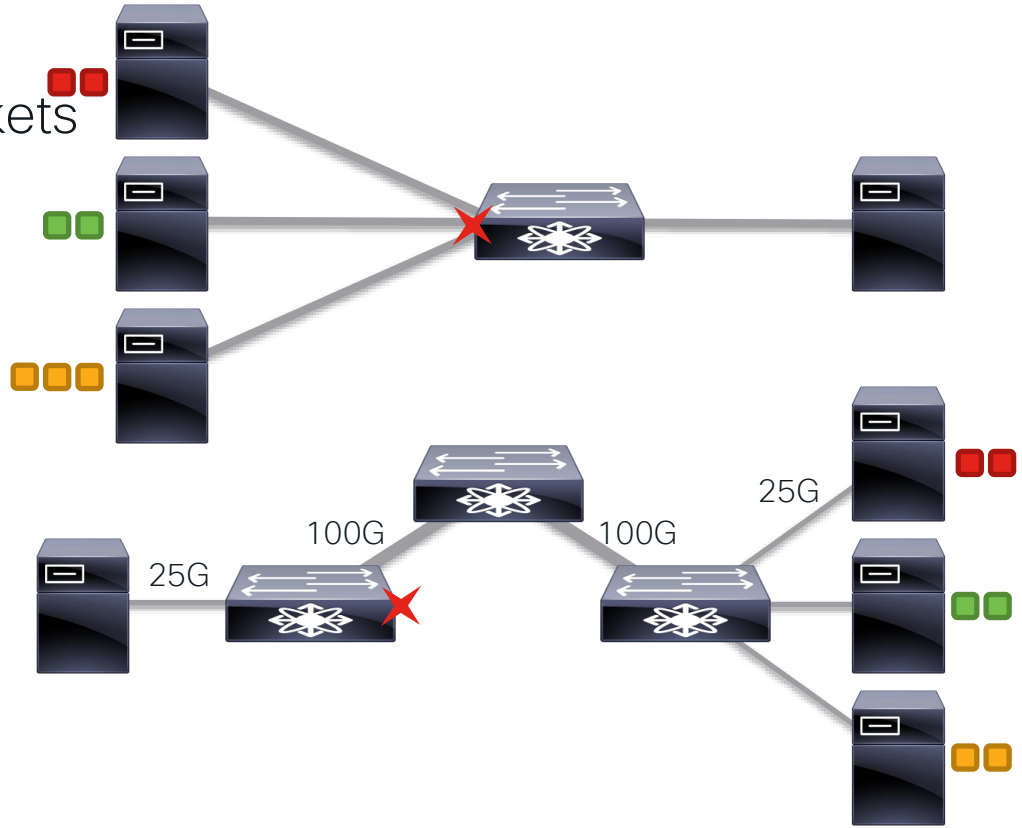
Policing – Limit Misbehaving Traffic

- Policing – Protecting other classes by dropping traffic in misbehaving class
- Single rate Two Color Policer
  - Conform Action (permit)
  - Exceed Action (drop)
- Two rate Three Color Policer
  - Conform Action (permit)
  - Exceed Action (markdown)
  - Violate Action (drop)



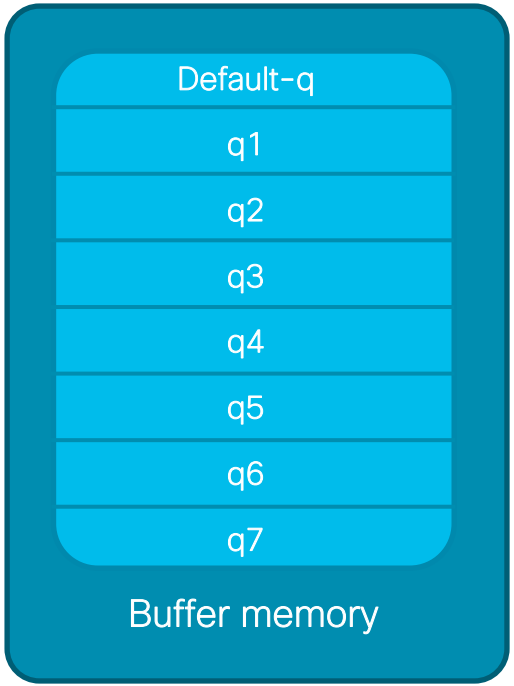
Buffering – Why do we need it?

- Buffering – Storing data packets in memory
- Many to One Conversations
  - Client to Server
  - Server to Storage
  - Aggregation Points
- Speed Mismatch
  - Client to WAN to Server



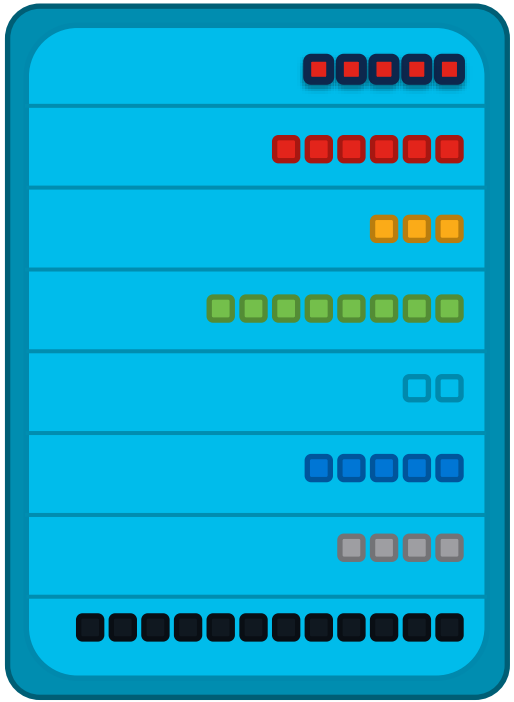
Queueing

- Traffic in buffer is divided logically in the queues
- Queueing provide dedicated buffer for packets of different priority
- Traffic separation allows multiple traffic classes to be mapped to same or different queue
- Traffic in a queue can be treated differently from other queues



Scheduling

- Scheduling – defines order of transmission of traffic out the queues
- Different types of queue are server differently
  - Strict Priority Queue – always serviced first
  - Normal Queues – served only after priority queue is empty
- Normal queues can have different algorithms

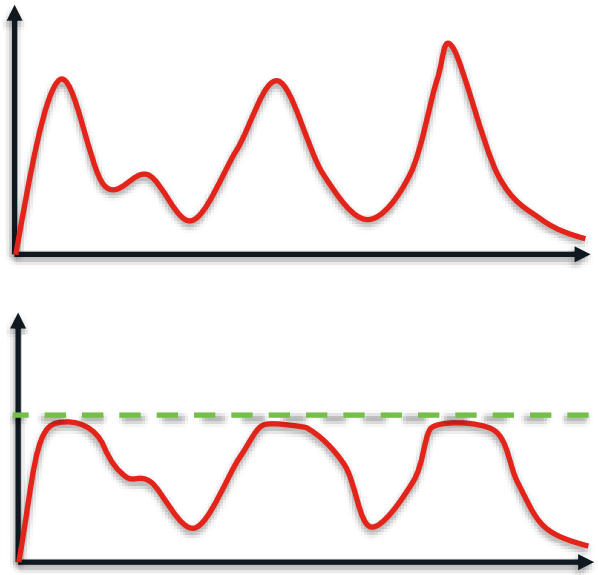


Common Scheduling Algorithms

- Round Robin (RR)
  - Simple and Easy to implement
  - Starvation-free
- Weighted Round Robin (WRR)
  - Serves n packets per non-empty queue
  - Assumes a mean packet size
- Deficit Weighted Round Robin
  - Variable sized packets
  - Uses a deficit counter
- Shaped Round Robin
  - More even distributed ordering
  - Weighted interleaving of flows

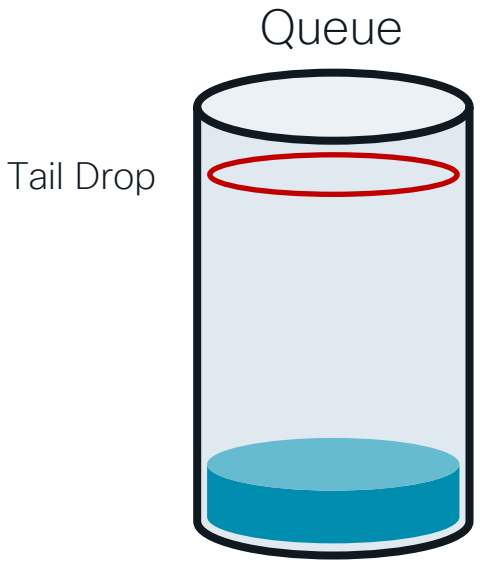
Shaping

- Shaping – Smooth out traffic peaks, microburst, with preserving all traffic
- Usually in egress direction to limit traffic toward ISP



Congestion Avoidance Tools

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



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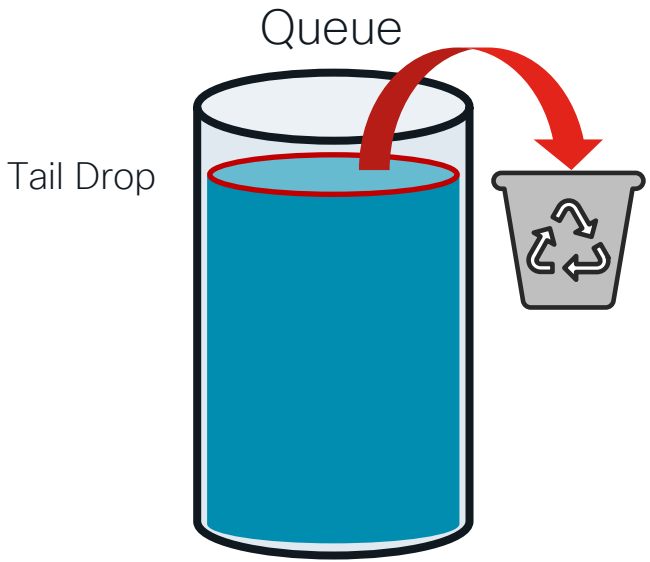

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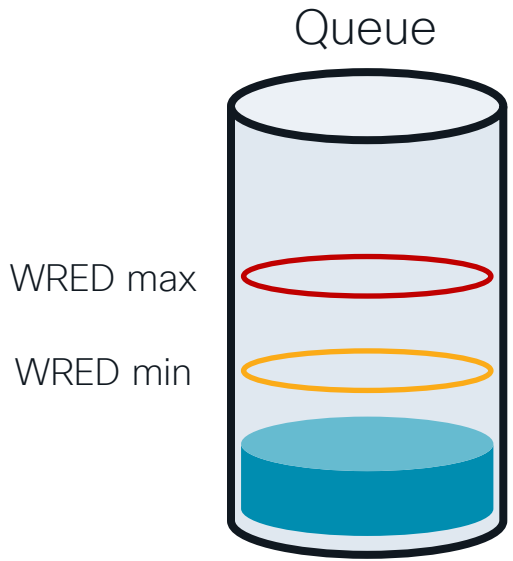
  - Threshold associated with priority
  - Buffer usage below threshold no affect



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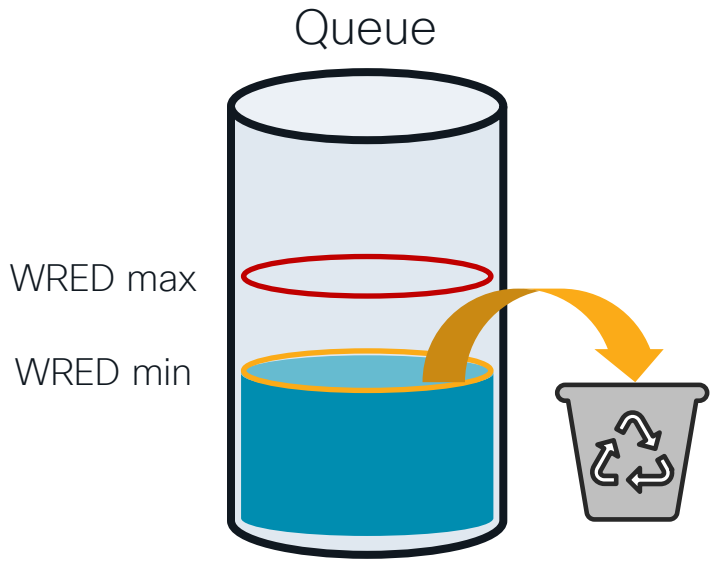

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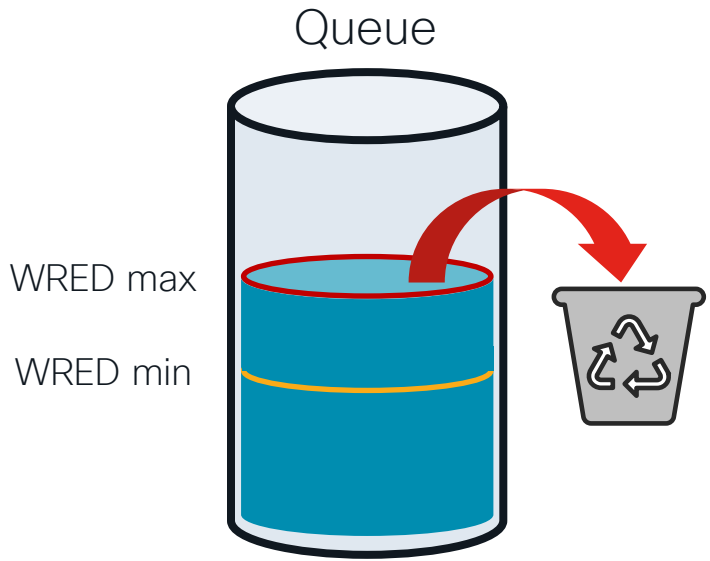
  - Buffer usage over max threshold = all traffic drop



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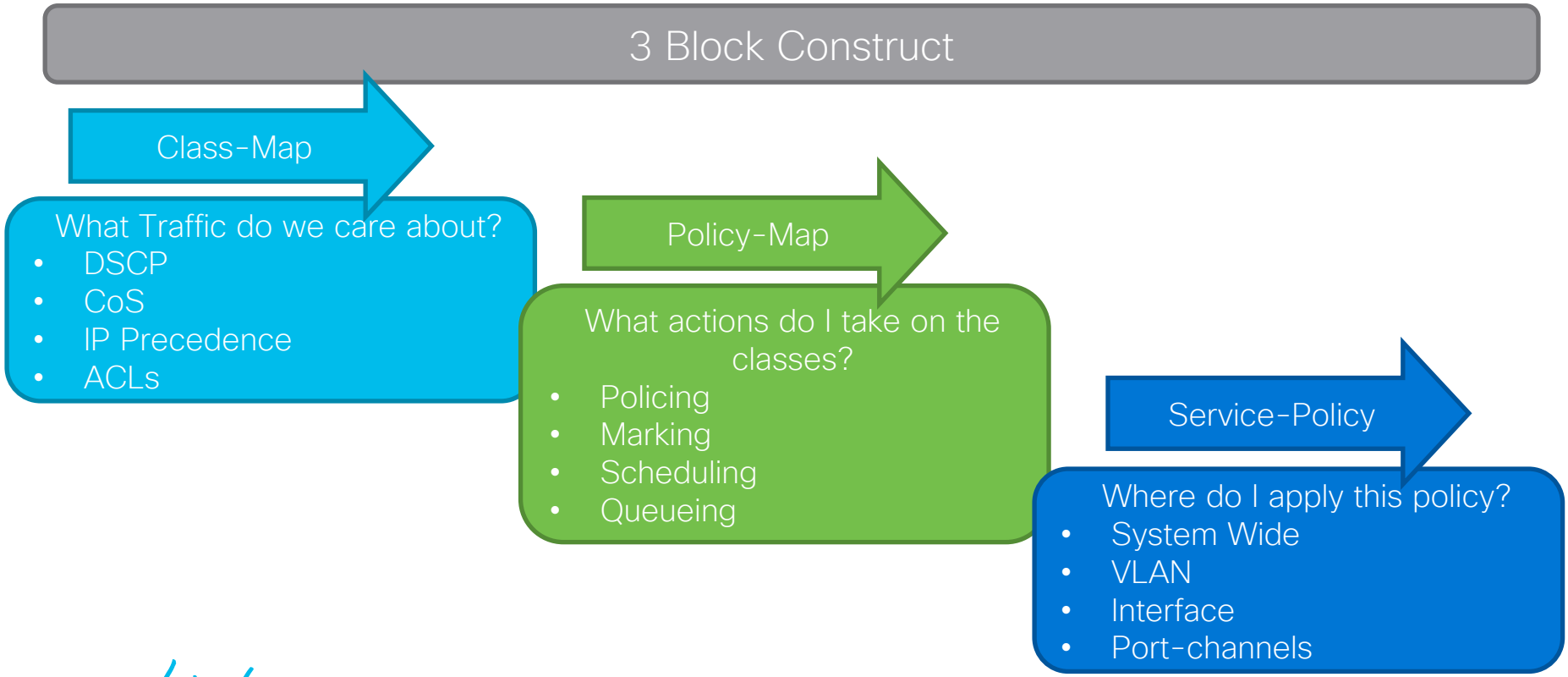
Nexus uses Modular QOS CLI (MQC)



Three Different Types

Class-map

Type QoS
- CoS
- DSCP
- PREC
- ACLs

Type Queuing
- qos-group

Type Network-QoS
- qos-group

Policy-map

Type QoS
- Classification
- Marking
- Policing

Type Queuing
- Queuing
- Scheduling
- Shaping

Type Network-QoS
- MTU
- Non-drop

Service-policy

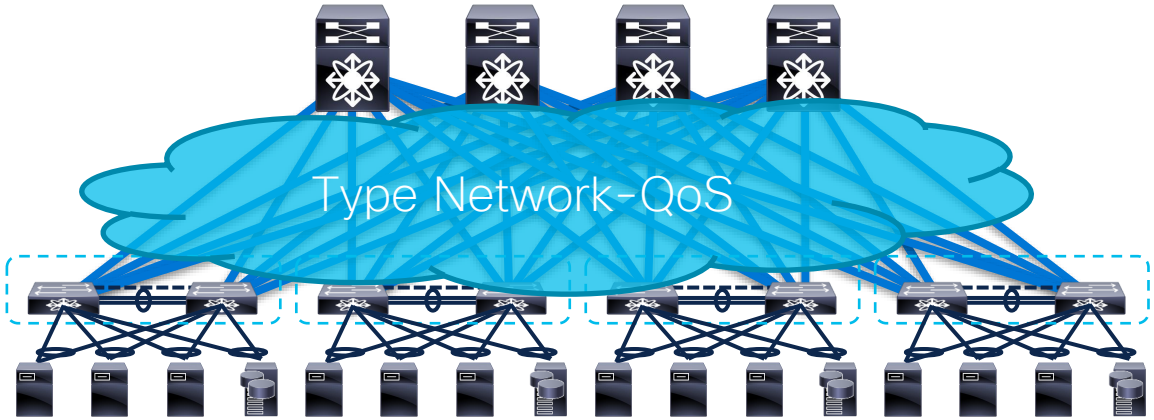
Type QoS
- Interface
- Port-channel
- VLAN

Type Queuing
- Interface
- System-qos

Type Network-QoS
- System-qos

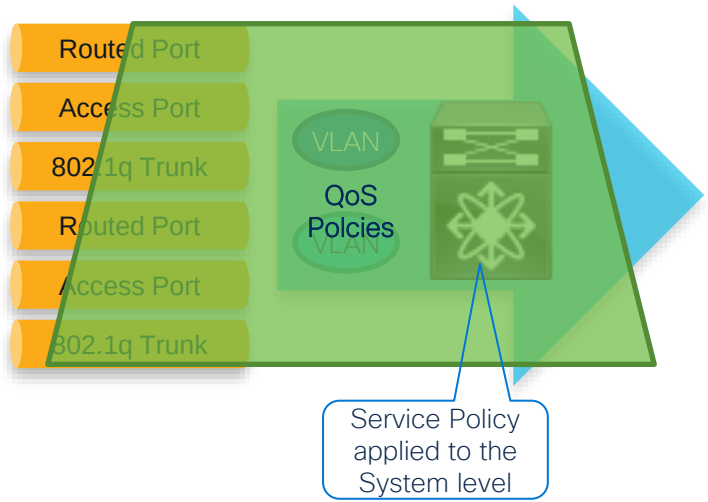
Type Network-QoS Policy

- Define global queuing and scheduling parameters for all interfaces in switch
  - Identify drop/no-drop classes, MTU and WRED/TD, etc.
- One Network-QoS policy per system, applies to all ports
- Assumption is Network-QoS policy defined/applied consistently network-wide



System Based Policy Attachment

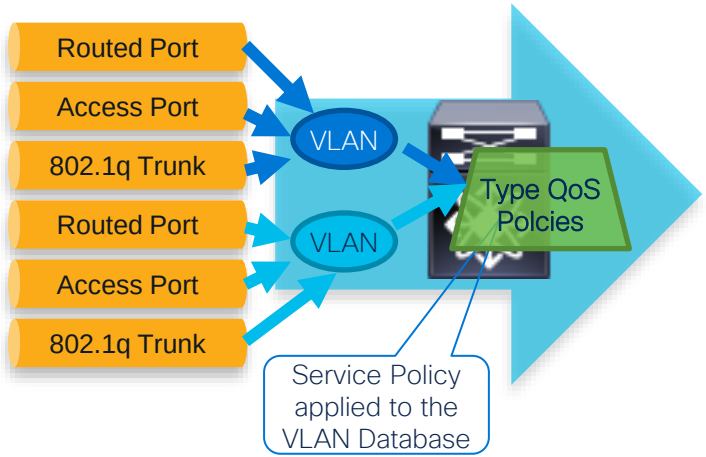
- System based QoS Policy gets globally applied to a system (to all interfaces)
- System based QoS Policy is configured in System QoS
- Type Queueing can be attached to the system level
- Type Network-QoS is mandatory to be attached to the system level




```
Nexus(config)# system qos
Nexus(config-sys-qos)# service-policy type network-qos myPolicy
```

VLAN Based QoS Policy Attachment

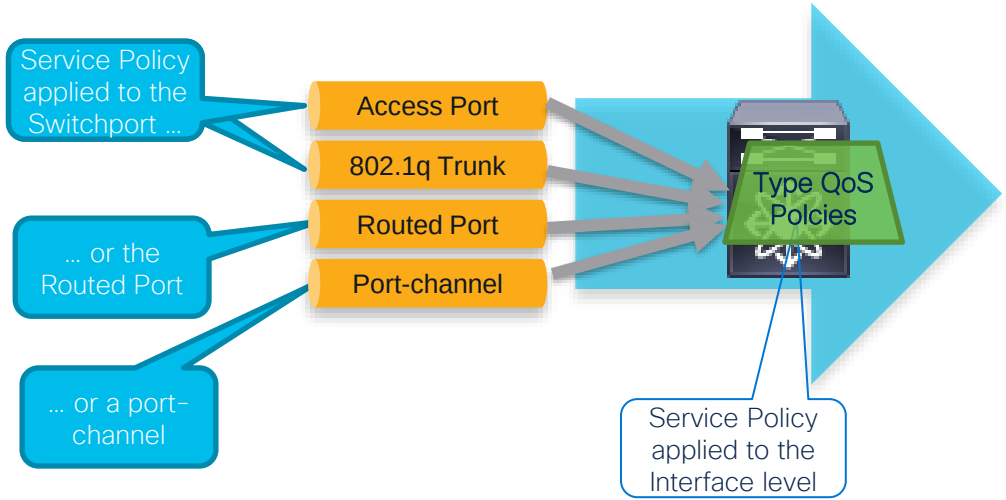
- VLAN based QoS Policy is configured in VLAN Database
- No SVI (aka L3 VLAN Interface) required




```
Nexus(config)# vlan configuration <vlan-id>
Nexus(config-vlan)# service-policy type qos input myPolicy
```

Interface based Type QOS Policy attachment

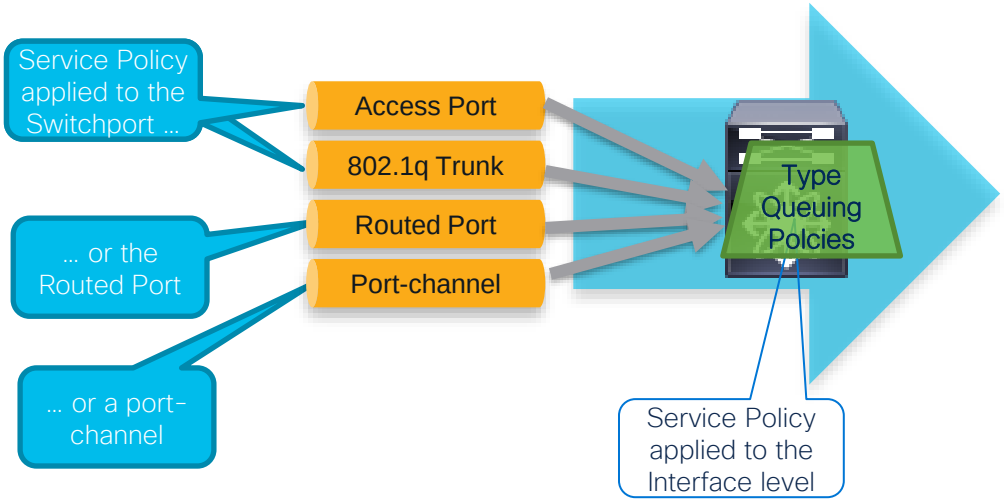
- Interface based type qos Policy takes precedence over VLAN
- Can also be attached to port-channel and applies to all member-ports




```
Nexus(config)# interface ethernet 1/1
Nexus(config-if)# service-policy type qos input myPolicy
```

Interface based Type Queuing Policy attachment

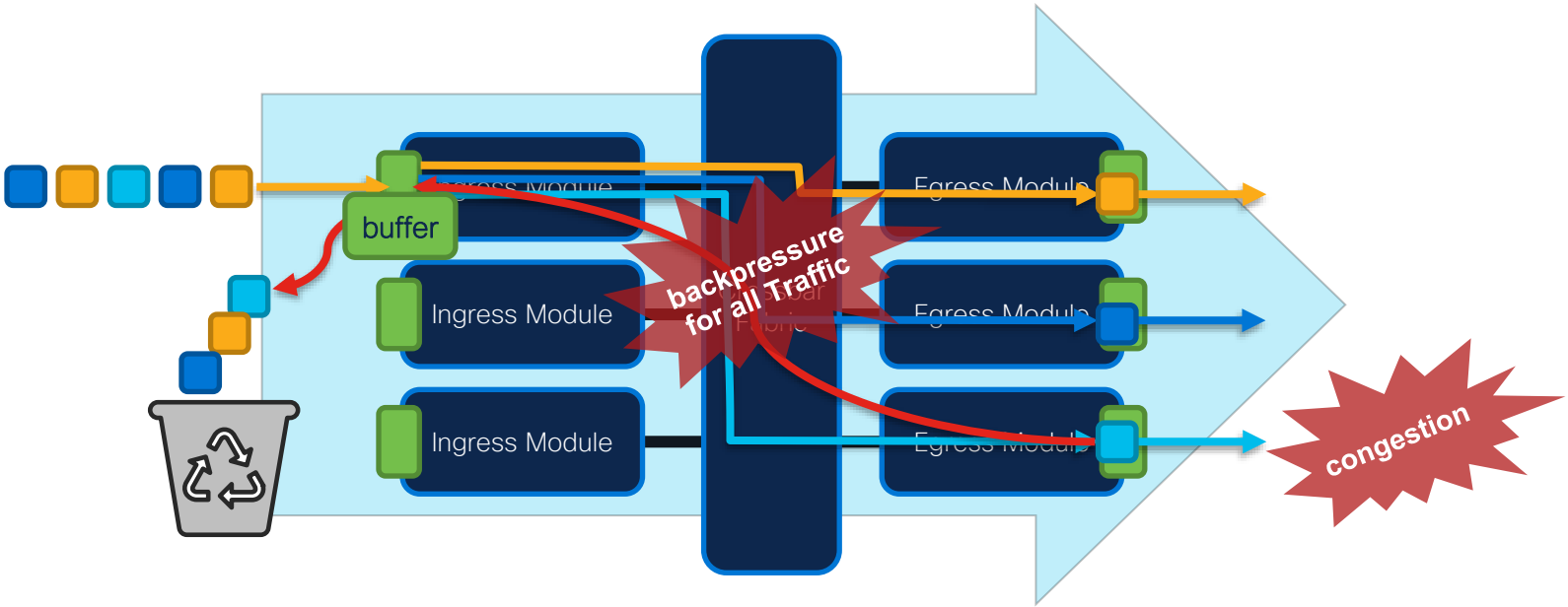
- Type Queuing has to be attached to a physical interface or system level
- Queuing Policy can be attached to port-channel and all member ports



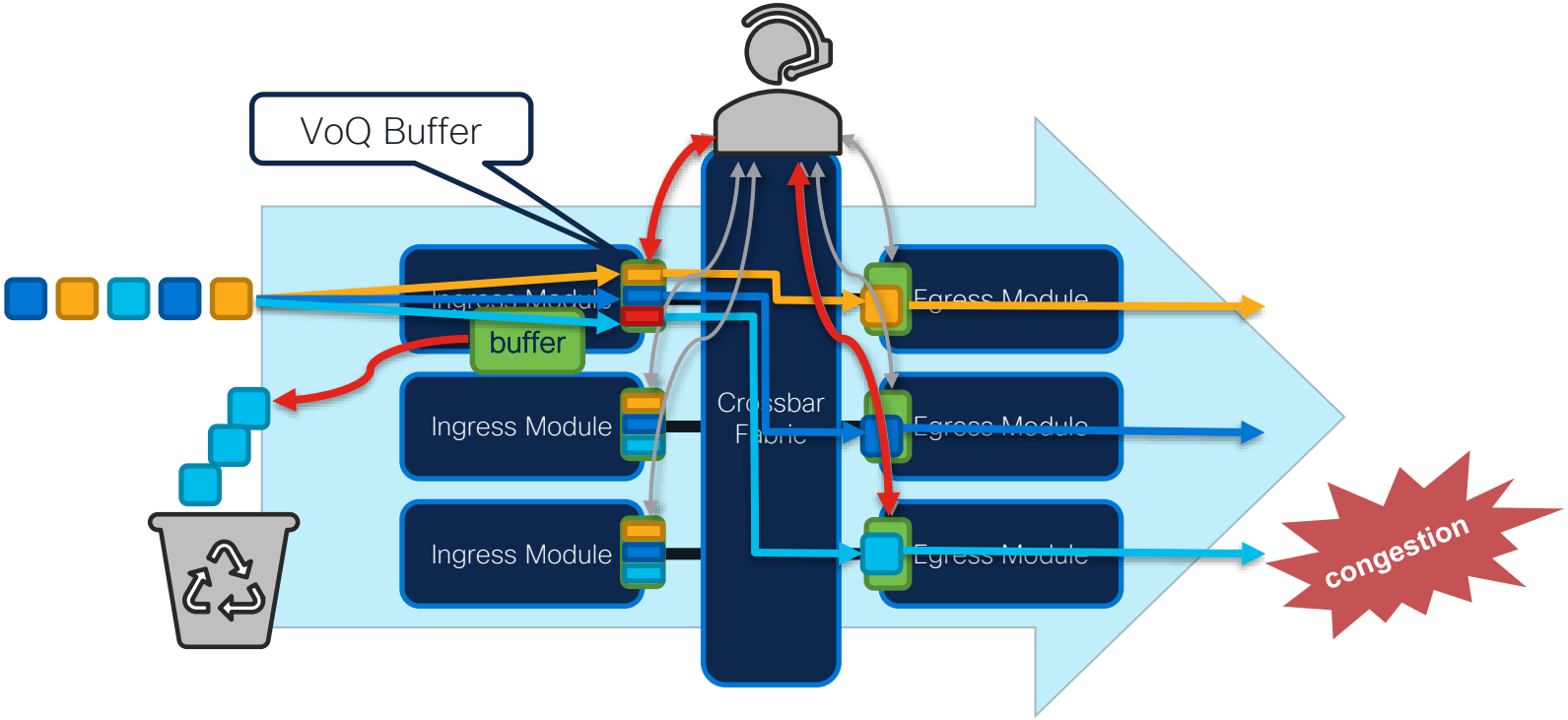

```
Nexus(config)# interface ethernet 1/1
Nexus(config-if)# service-policy type queueing output myPolicy
```

Buffer types – Head of Line Blocking

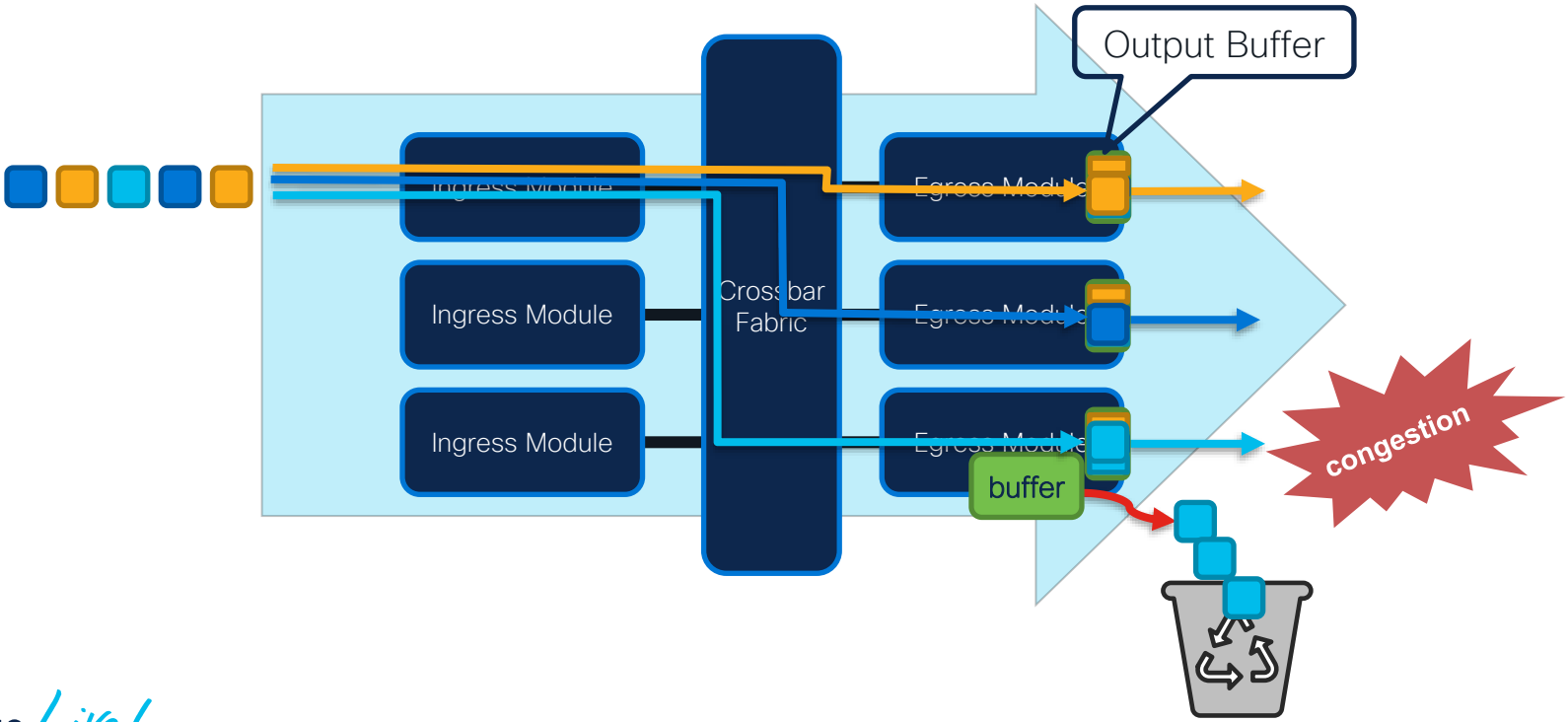
What is the Problem?



Virtual Output Queuing

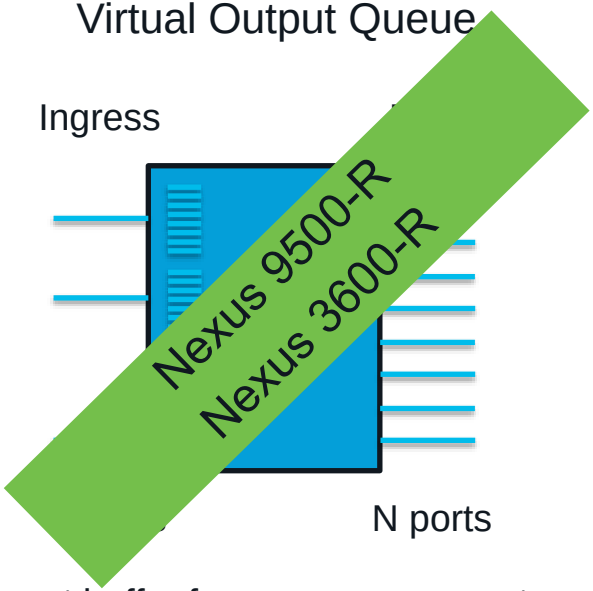


Output Queuing



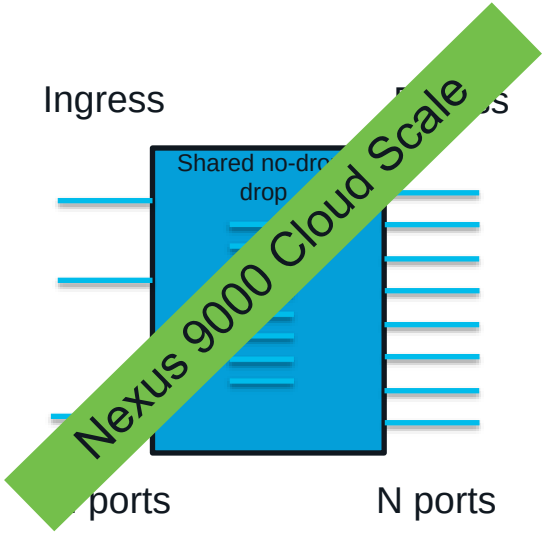
Buffering on Nexus Models

VOQ
Virtual Output Queue



Input buffer for every egress port
NxN buffer size

Output Queue Buffer



Shared buffer for N egress ports
N buffer size

4 Class Queuing Model

- Matches most Service-Provider offerings
- Ready for No-Drop traffic like FCoE
- One Class left to place traffic above or below Best-Effort traffic priority
  - Special Application which is drop sensitive (above Best-Effort - Critical)
  - Non-Critical Bandwidth intensive application (below Best-Effort - Scavenger)

Class	CoS	Queues
Priority	5-7	PQ
No-Drop	3	Q2
Better or Worse than Best-Effort	1,2,4	Q1
Best-Effort	0	Default-Q

8 Class Queuing Model

- Matches often a Campus QoS concept
- DSCP to CoS derivation does NOT apply anymore
  - (Topmost 3-Bit mapping from DSCP to CoS)
- No-Drop still with CoS3
- DSCP 24-30 are usable for IP storage traffic (RoCEv2)

Class	DSCP	Queues
Priority	CS6 (CS7)	PQ
Platinum	EF	
Gold	AF41	Q7
Silver	CS4	Q6
No-Drop	CoS3	Q5
Bronze	AF21	Q4
Management	CS2	Q3
Scavenger	AF11	Q2
Bulk Data	CS1	Q1
Best-Effort	0	Default-Q

To Trust or Not To Trust?

- Data Centre architecture provides a new set of trust boundaries
- Virtual Switch extends the trust boundary into the Hypervisor
- Nexus Switches always trust CoS and DSCP

Data Center QoS Capabilities

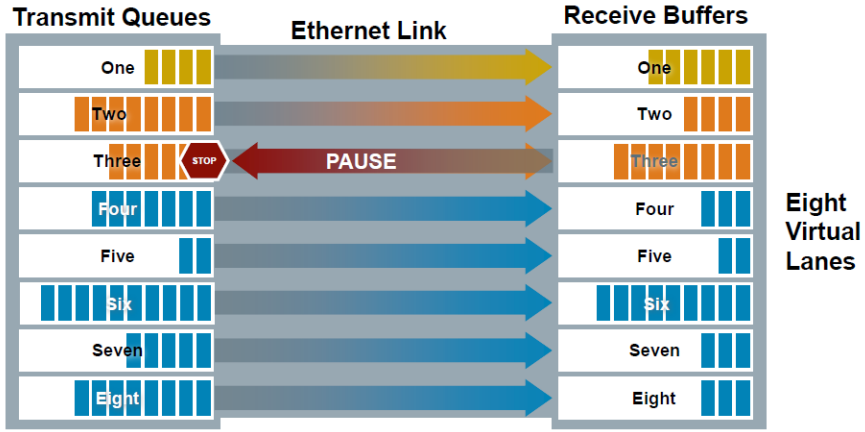
Data Centre Converged Infrastructure

- Enable, sensitive to drop, storage traffic to use Ethernet
- Simplification of the infrastructure by using Ethernet for data and storage traffic
- Data Center QoS capabilities, enabling new transport:
  - PFC – Priority Flow Control
  - ETS – Enhanced Transmission Selection
  - DCBX – Data Center Bridging Exchange
  - ECN – Explicit Congestion Notification

Priority Flow Control

Flow Control Mechanism – 802.1Qbb

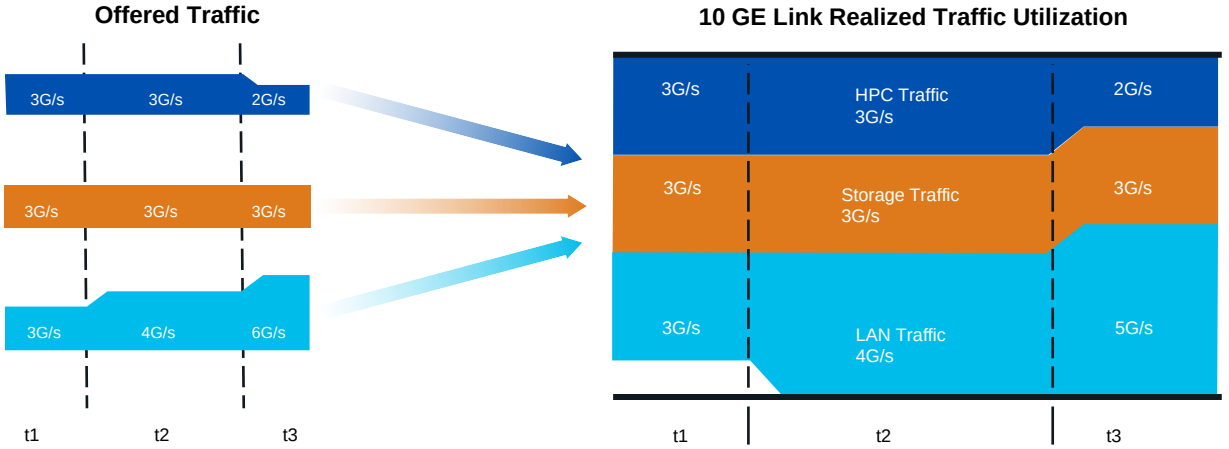
- A.k.a "Lossless Ethernet"
- PFC enables Flow Control on a Per-Priority basis
- Therefore, we have the ability to have lossless and lossy priorities at the same time on the same wire
- Allows traffic to operate over a lossless priority independent of other priorities
- Other traffic assigned to other priority will continue to transmit and rely on upper layer protocols for retransmission



Enhanced Transmission Selection

(ETS) Bandwidth Management – 802.1Qaz

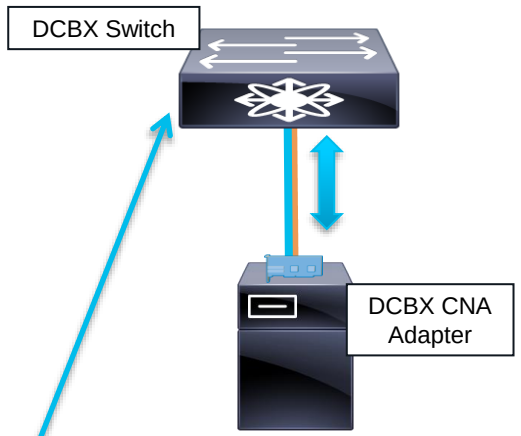
- Prevents a single traffic class of “hogging” all the bandwidth and starving other classes
- When a given load doesn’t fully utilize its allocated bandwidth, it is available to other classes
- Helps accommodate for classes of a “bursty” nature



Data Center Bridging Exchange Protocol

DCBX Overview – 802.1Qaz

- Negotiates Ethernet capability's PFC, ETS, CoS values between DCB capable peer devices
- Simplifies Management allows for configuration and distribution of parameters from one node to another
- DCBX is LLDP with new TLV fields



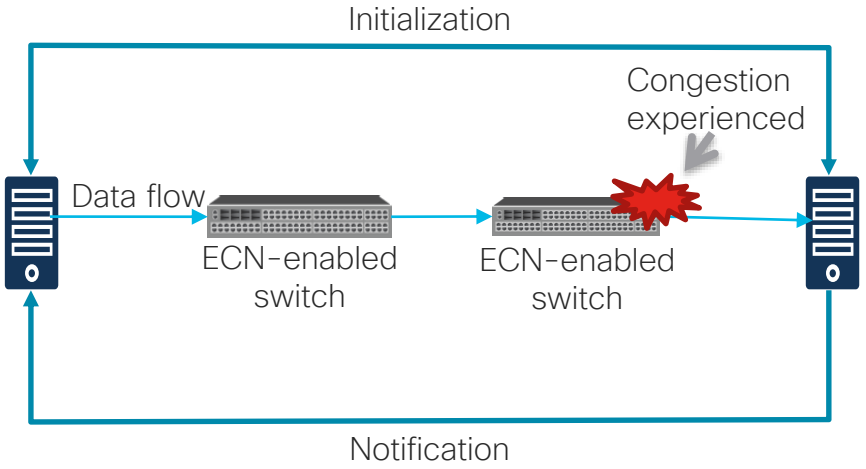

```
dc11-5020-3# sh lldp dcbx interface eth 1/40

Local DCBXP Control information:
Operation version: 00  Max version: 00  Seq no: 7  Ack no: 0
Type/
Subtype    Version    En/Will/Adv Config
006/000     000        Y/N/Y      00
<snip>
```

https://www.cisco.com/en/US/netsol/ns783/index.html

Explicit Congestion Notification (ECN)

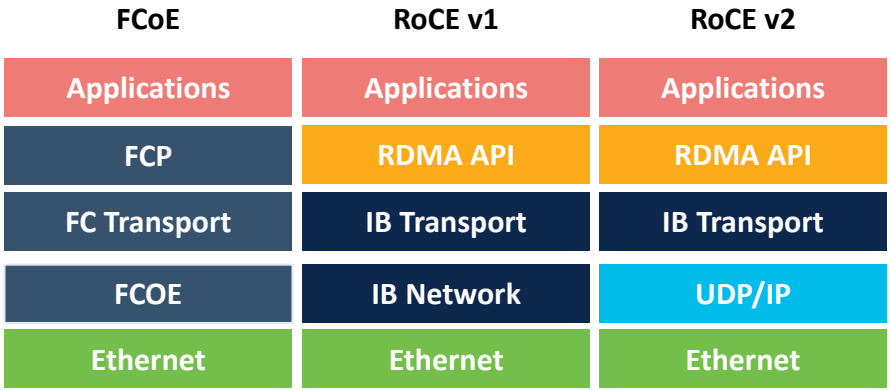
- IP Explicit Congestion Notification (ECN) is used for congestion notification.
- ECN enables end-to-end congestion notification between two endpoints on a IP network
- In case of congestion, ECN gets transmitting device to reduce transmission rate until congestion clears, without pausing traffic.
- ECN uses 2 LSB of Type of Service field in IP header



ECN	ECN Behavior
0x00	Non ECN Capable
0x10	ECN Capable Transport (0)
0x01	ECN Capable Transport (1)
0x11	Congestion Encountered

IP Storage Transports in Data Center

- Converged storage Protocols:
- Requirement for FCoE and RoCEv1:
  - PFC
  - ETS
- Requirement for RoCEv2
  - PFC
  - ETS
  - ECN

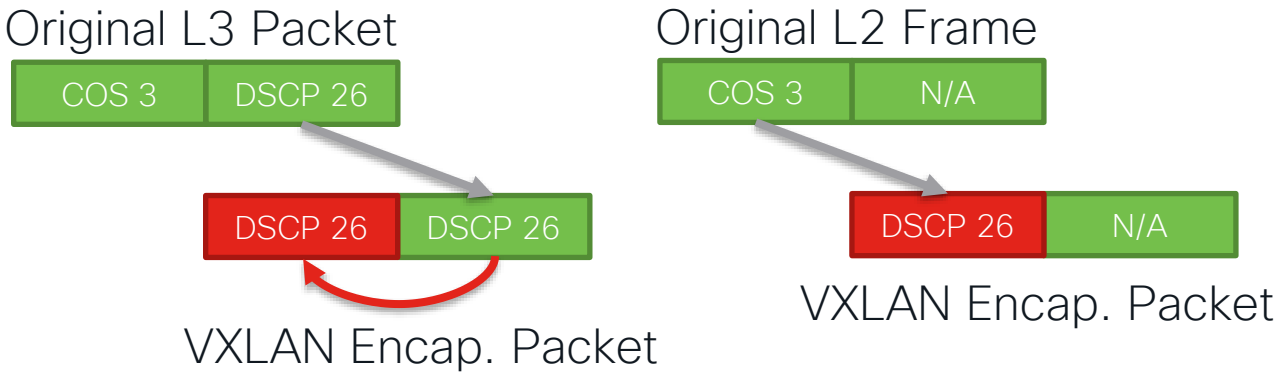


Overlay QOS

Overlay QoS

VXLAN EVPN – VXLAN Encapsulation

- Ingress L3 packet, original priority is mapped to outer header priority
- Ingress L2 frame, COS value will be mapped to outer priority
- VLAN header is not preserved in VXLAN tunnel

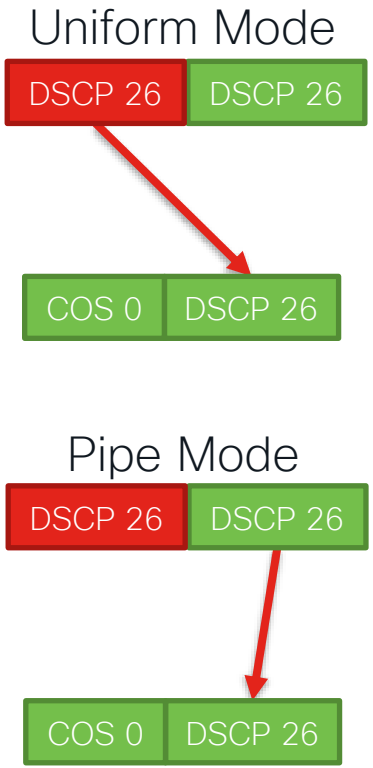


COS	DSCP
0	0
1	8
2	16
3	26
4	32
5	46
6	48
7	56

Overlay QoS

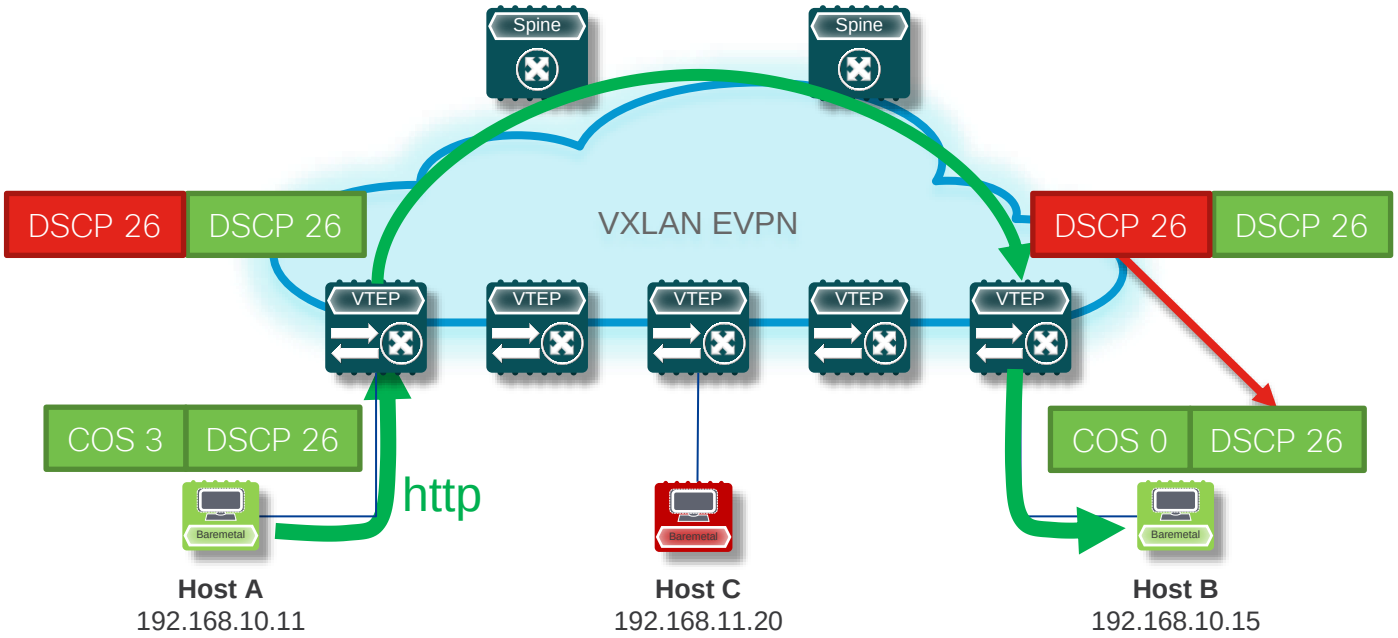
VXLAN EVPN – VXLAN Decapsulation

- DSCP value is derived based on a priority mode for L3 traffic:
  - Uniform mode: delivers overlay priority copying outer header to decapsulated frame
  - Pipe mode: extends original priority copying inner header to decapsulated frame
- Marking can be configure on the egress VTEP mark decapsulated traffic with priority (COS, DSCP)



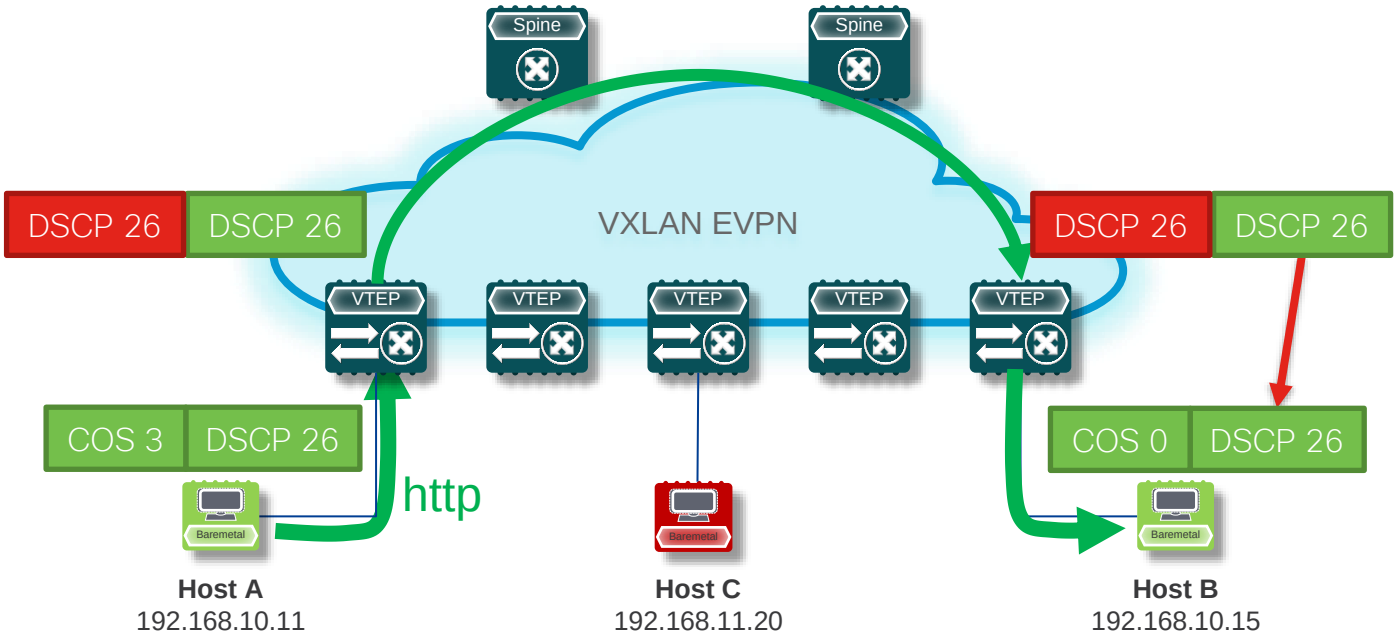
Overlay QoS

VXLAN – Uniform Mode



Overlay QoS

VXLAN – Pipe Mode



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- **QoS Implementation on Nexus**
- Nexus 9000 Cloud Scale QoS
- Real World Configuration Examples
- Conclusion

Nexus 9000 Overview

- Modular and Fixed chassis
- Optimized for high density 10G/25G/40G/50G/100G/ 200G/400G
- Standalone and ACI Mode
- Cisco Silicon – Cloud Scale
  - Advanced QoS capabilities

Nexus 9000 – Cloud Scale

LS25600GX2A

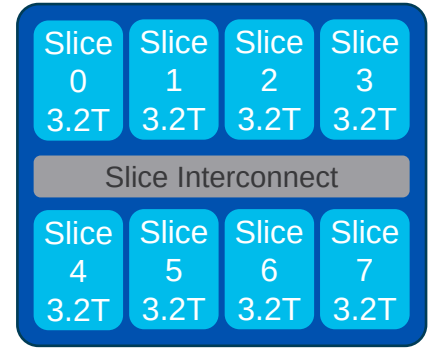
- 25.6T chip – 8 slices of 8 x 400G each
- 9300-GX2A, 9408 TORs

LS12800GX2B

- 12.8T chip – 4 slices of 8 x 400G each
- 9300-GX2B TORs

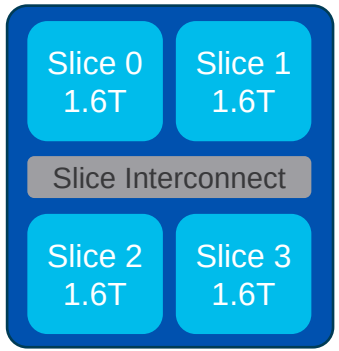
LS6400GX

- 6.4T chip – 4 slices of 4 x 400G each
- 9300-GX TORs



LS25600GX2A – 64 x 400G

LS12800GX2A – 32 x 400G



LS6400GX – 16 x 400G

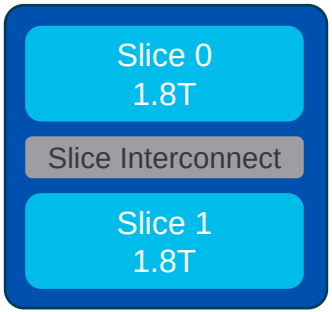
Nexus 9000 – Cloud Scale

LS3600FX2

- 3.6T chip – 2 slices of 18 x 100G with MACSEC
- 9300-FX2 TORs

LS1800FX/FX3

- 1.8T chip – 1 slice of 18 x 100G with MACSEC
- X9700-FX modular line cards; 9300-FX/FX3 TORs



LS3600FX2 – 36 x 100G

LS1800FX/FX3

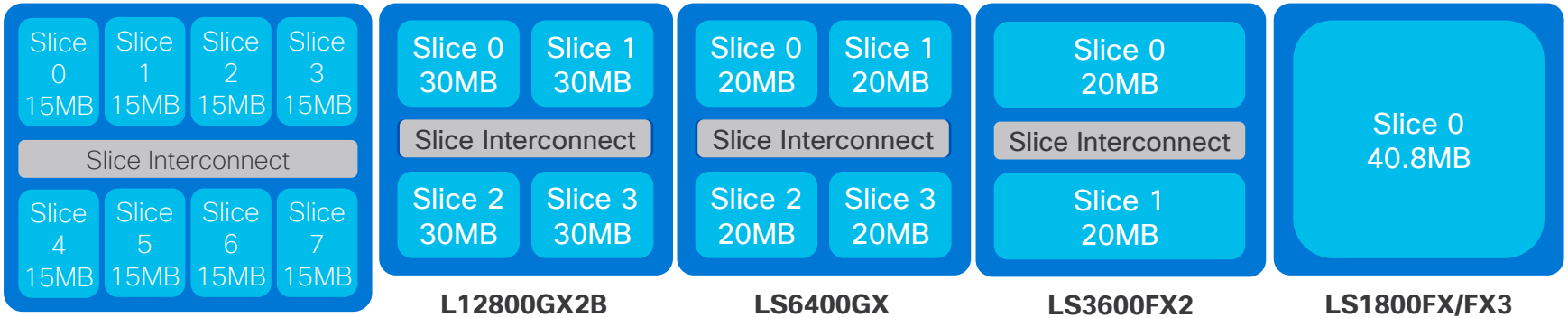
18 x 100G

Cisco Nexus 9000 – Cloud Scale QoS Features

- Classification based on:
  - ACL
  - DSCP, CoS, and IP Precedence
- Marking traffic with:
  - DSCP
  - CoS
  - IP Precedence
- Policing:
  - 1R2C and 2R3C
  - Ingress and Egress
- Buffering/Queueing:
  - Shared egress buffer; 8 Egress Queues
- Scheduling:
  - Strict Priority Queuing and DWRR
- Shaping:
  - Egress per queue shaper
- Congestion Avoidance:
  - Tail Drop
  - WRED with ECN

Buffering

- Cloud Scale platforms implement shared-memory egress buffered architecture
- Each ASIC slice has dedicated buffer – only ports on that slice can use that buffer
- Dynamic Buffer Protection adjusts max thresholds based on class and buffer occupancy
- Intelligent buffer options maximize buffer efficiency



LS25600GX2A
15MB/slice
(120MB total)

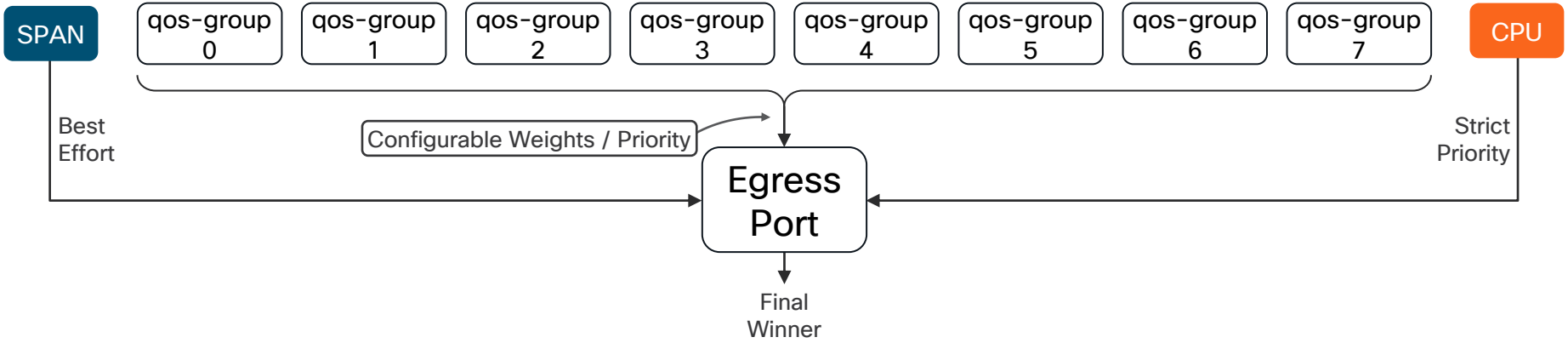
L12800GX2B
30MB/slice
(120MB total)

LS6400GX
20MB/slice
(80MB total)

LS3600FX2
20MB/slice
(40MB total)

LS1800FX/FX3
40.8MB/slice
(40.8MB total)

Queuing and Scheduling

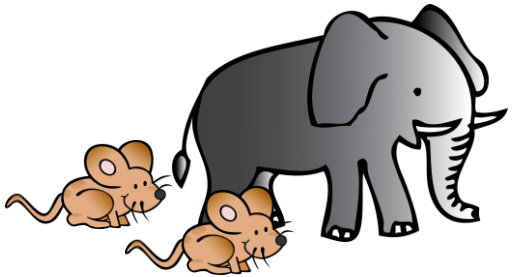


- 8 qos-groups per output port
- Egress queuing policy defines priority and weights
- Dedicated classes for CPU traffic and SPAN traffic

Intelligent Buffering

Innovative Buffer Management for Cloud Scale switches

- **Dynamic Buffer Protection** (DBP) – Controls buffer allocation for congested queues in shared-memory architecture
- **Approximate Fair Drop** (AFD) – Maintains buffer headroom per queue to maximize burst absorption
- **Dynamic Packet Prioritization** (DPP) – Prioritizes short-lived flows to expedite flow setup and completion



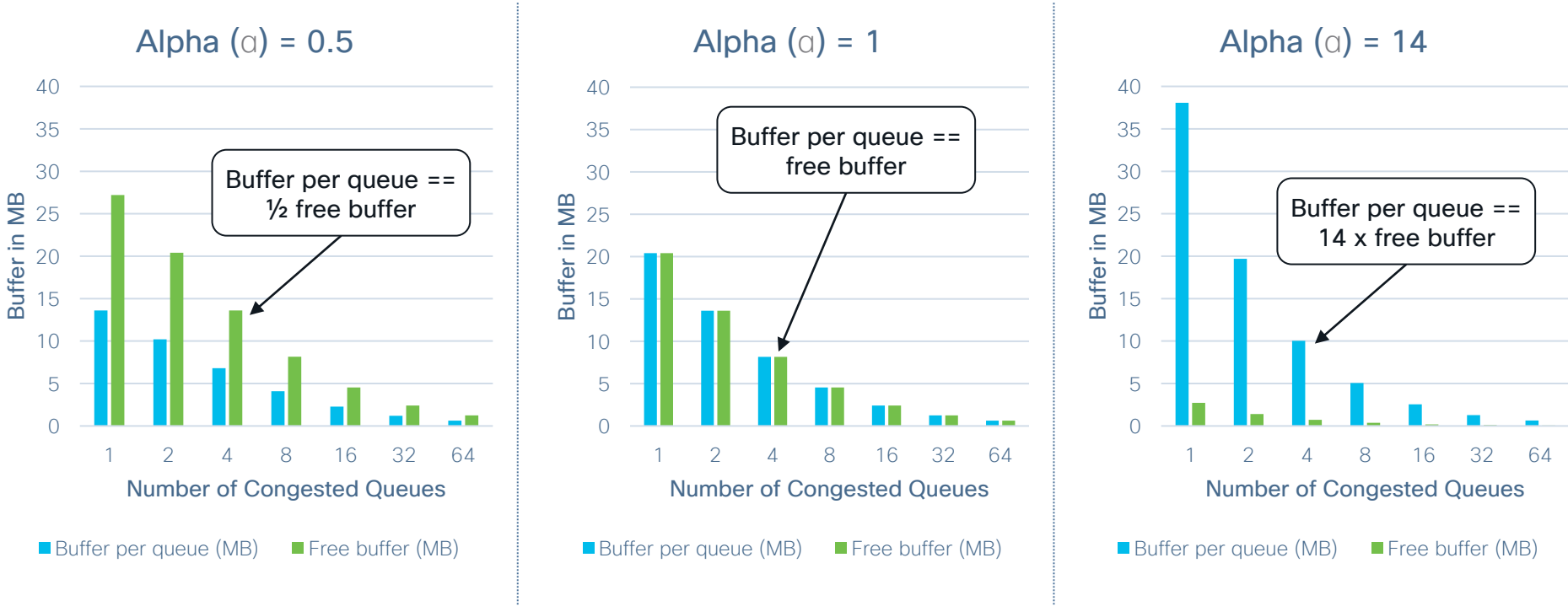
Miercom Report: Speeding Applications in Data Centre Networks
http://miercom.com/cisco-systems-speeding-applications-in-data-center-networks/

Dynamic Buffer Protection (DBP)

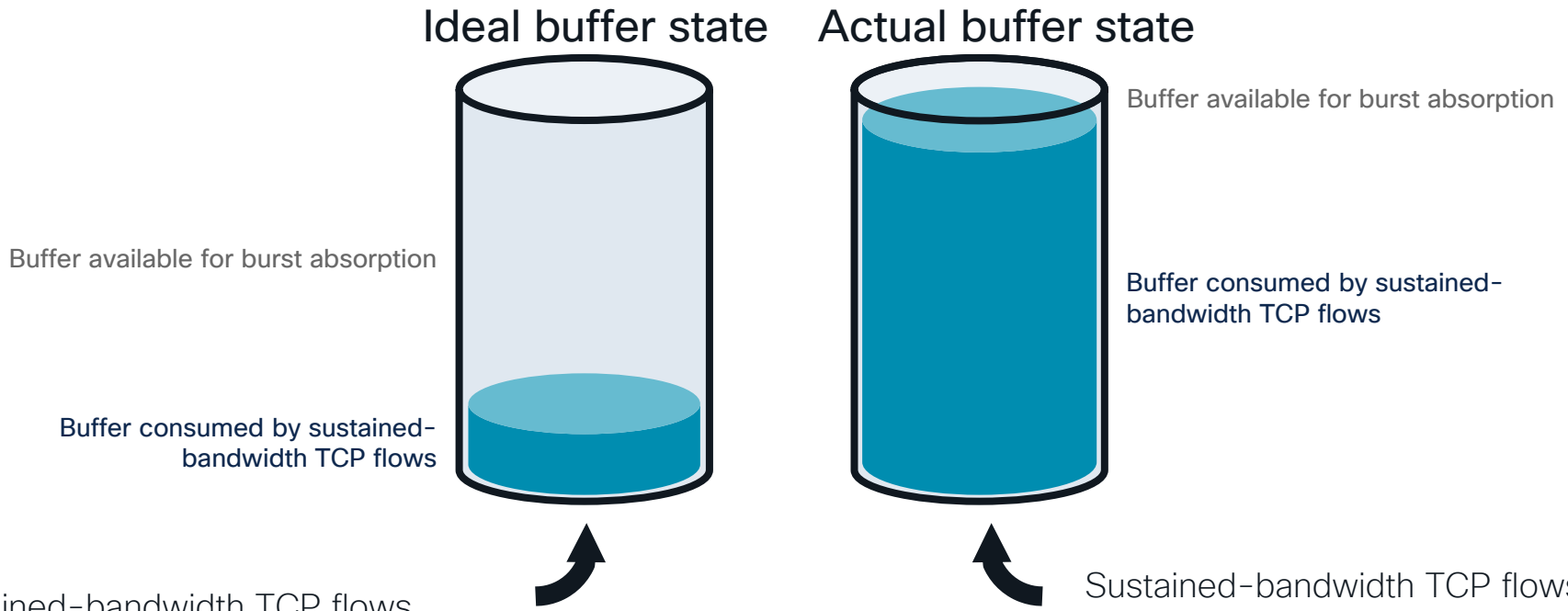
- Prevents any output queue from consuming more than its fair share of buffer in shared-memory architecture
- Defines dynamic max threshold for each queue
  - If queue length exceeds threshold, packet is discarded
  - Otherwise packet is admitted to queue and scheduled for transmission
- Threshold calculated by multiplying free memory by configurable, per-queue **Alpha** (α) value (weight)
  - Alpha controls how aggressively DBP maintains free buffer pages during congestion events

Alpha Parameter Examples

Default Alpha on Cloud Scale switches

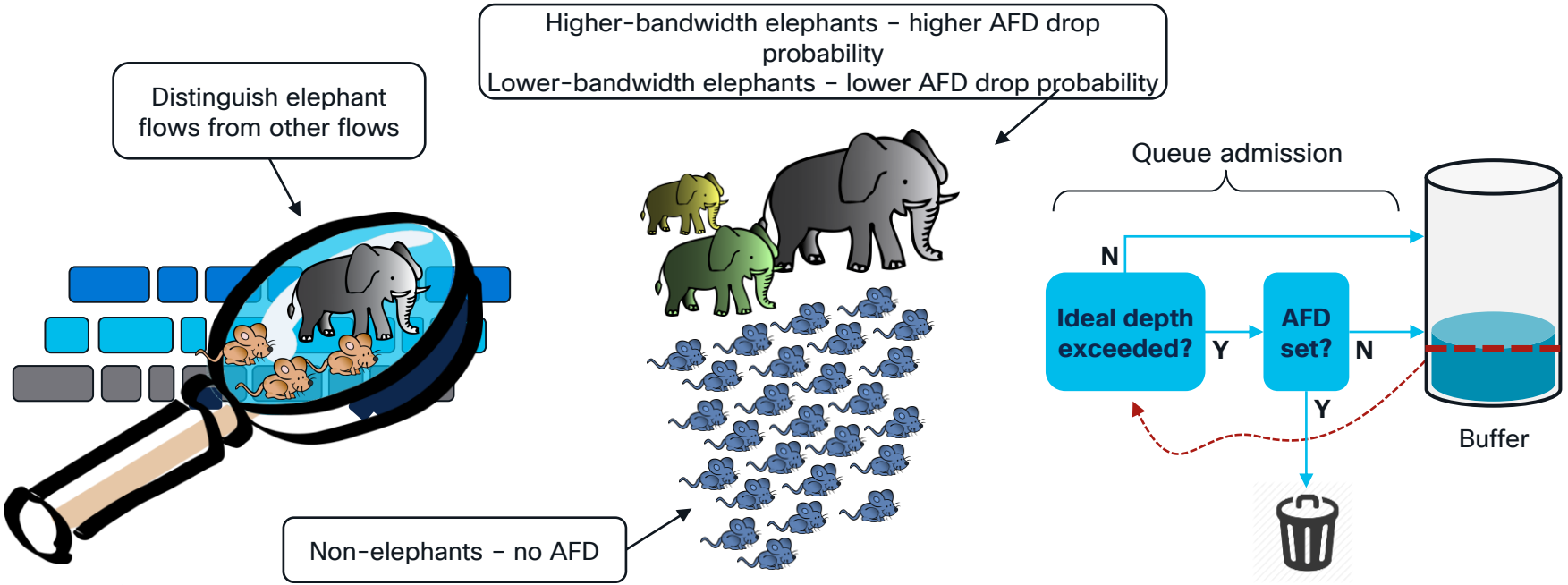


Buffering – Ideal versus Reality



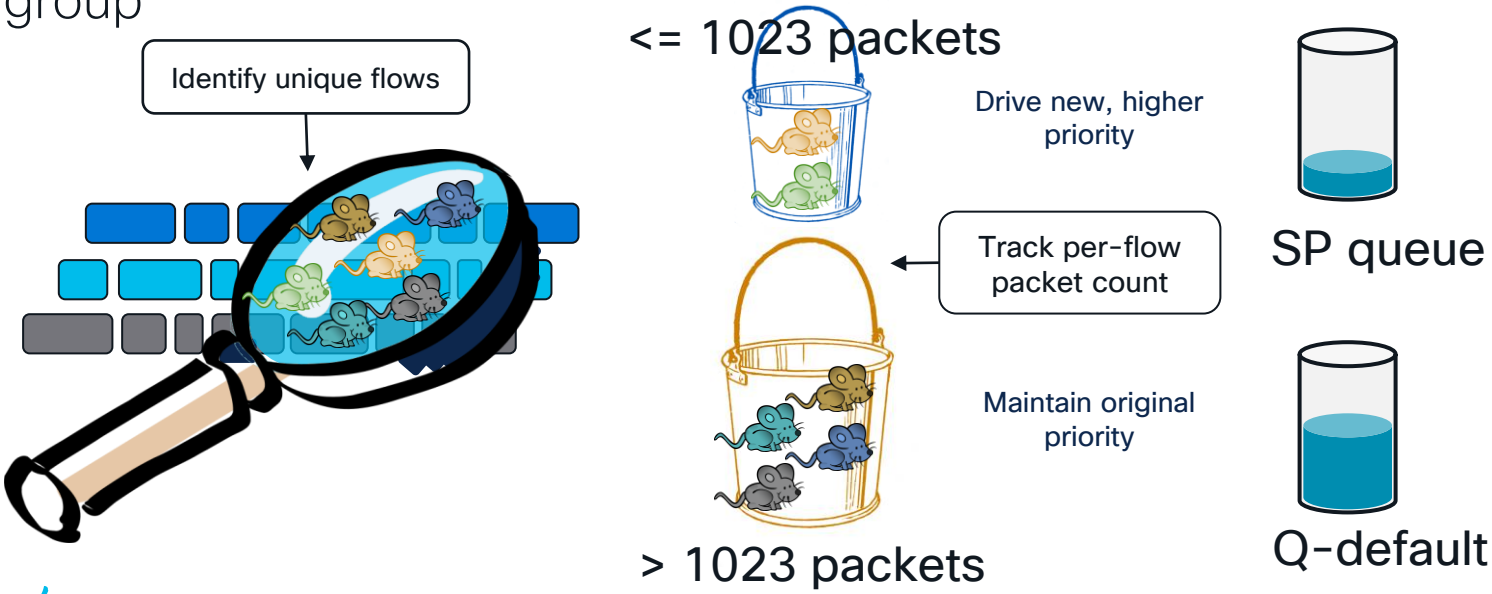
Approximate Fair Drop (AFD)

Maintain throughput while minimizing buffer consumption by elephant flows – **keep buffer state as close to the ideal as possible**



Dynamic Packet Prioritization (DPP)

- Prioritize initial packets of new / short-lived flows
- Up to first 1023 packets of each flow assigned to higher-priority qos-group



Configuration – Class-Map Type QoS

- Class-map type qos used to classify traffic based on
  - Access List
  - Priority (CoS, DSCP, IP Precedence)
- Match by singe criteria or match all criteria under class-map:
  - match-all: Traffic need to match all criteria under class map
  - match-any: Traffic needs to match any criteria under class map

```
class-map type qos match-all/match-any class-q1
 match access-group HTTP
 match cos 1
 match dscp 8
```

Configuration – Policy-Map Type QoS

- Policy-map type qos used to take action on class-map traffic
  - Set new priorities (COS, DSCP, IP Precedence)
  - Set a policer
- The policy-map sets qos-group

```
policy-map type qos Classification-Marking
  class class-q1
    set cos 1
    police cir 1000 mbps bc 200 ms conform transmit violate drop
    set qos-group 1
```

QoS-Group

- QoS group is used to reference classification for all the types class-maps
  - Class-map type queueing and type network qos have class-maps referencing qos-groups
  - Class-maps are present in system by default, no user interaction required
- Default class-map type queueing for Q1:

```
class-map type queuing match-any c-out-8q-q1
  match qos-group 1
```

- Default class-map type network-qos for Q1

```
class-map type network-qos c-8q-nq1
  description Default class on qos-group 1
  match qos-group 1
```

Configuration – Policy-Map Type Queuing

- Policy-map type queueing define queuing and scheduling options
  - Define queue limit – change alpha value
  - Define scheduling options, strict priority and weight for DWRR queues
- Default Queueing policy cannot be changed
  - User needs to define custom policy
- Shaping defined per queue in queueing policy

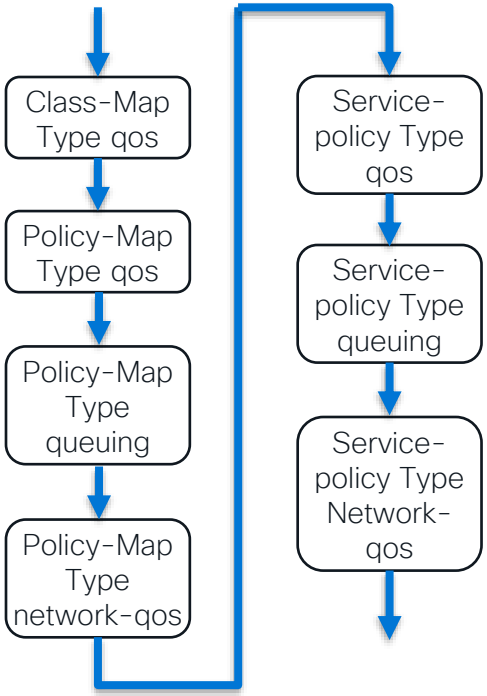
```
policy-map type queuing custom-8q-out-policy
  class type queuing c-out-8q-q7
    priority level 1
  class type queuing c-out-8q-q6
    bandwidth remaining percent 0
  class type queuing c-out-8q-q5
    bandwidth remaining percent 0
  class type queuing c-out-8q-q4
    bandwidth remaining percent 0
  class type queuing c-out-8q-q3
    bandwidth remaining percent 0
  class type queuing c-out-8q-q2
    bandwidth remaining percent 0
  class type queuing c-out-8q-q1
    bandwidth remaining percent 50
  class type queuing c-out-8q-q-default
    bandwidth remaining percent 50
```

Configuration – Policy-Map Type Network-QoS

- Policy-map type network-qos define:
  - Non-drop queue
  - End to end queueing policy (8 queue or 4 queue)
- Default Network-QoS policy cannot be changed
  - User needs to define custom policy

```
policy-map type network-qos custom-8q-nq-
policy
  class type network-qos c-8q-nq7
    mtu 1500
  class type network-qos c-8q-nq6
    mtu 1500
  class type network-qos c-8q-nq5
    mtu 1500
  class type network-qos c-8q-nq4
    mtu 1500
  class type network-qos c-8q-nq3
    mtu 1500
  class type network-qos c-8q-nq2
    mtu 1500
  class type network-qos c-8q-nq1
    mtu 1500
  class type network-qos c-8q-nq-default
    mtu 1500
```

Configuration - Putting it all together




```
class-map type qos match-any class-q1
 match access-group HTTP

policy-map type qos Classification-Marking
  class class-q1
    set cos 1
    set qos-group 1

policy-map type queuing custom-8q-out-policy
<snip>
  class type queuing c-out-8q-q1
    bandwidth remaining percent 50
  class type queuing c-out-8q-q-default
    bandwidth remaining percent 50

policy-map type network-qos custom-8q-nq-policy
<snip>
  class type network-qos c-8q-nq1
    mtu 1500
  class type network-qos c-8q-nq-default
    mtu 1500

interface Ethernet 1/1
  service-policy type qos input Classification-Marking

system qos
  service-policy type network-qos custom-8q-nq-policy
  service-policy type queuing output custom-8q-out-policy
```

Nexus 9000 QoS Golden Rules

- CoS and DSCP are TRUSTED by default
- Use QoS-Groups to tie policies together
- Nexus 9000 Cloud Scale – Egress Buffer
  - Queuing/scheduling policy attached in egress direction

Agenda

- Introduction
- QoS Basics
- QoS Implementation on Nexus
- **Nexus 9000 Cloud Scale QoS**
- Real World Configuration Examples
- Conclusion

What do we want to achieve?

Company XYZ's Business Goals

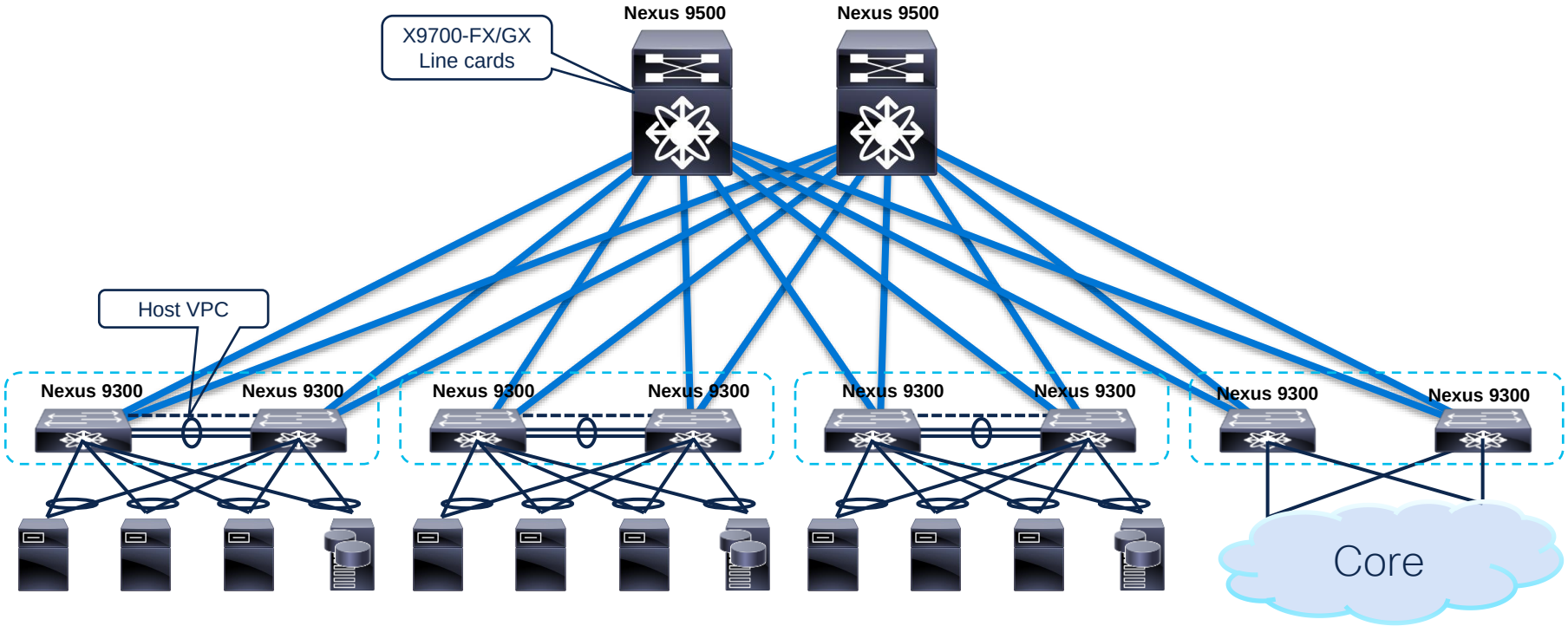
- Make sure no disruption in network services
  - Put control traffic in priority queue
- Video/voice hosting also a business objective
  - Put voice traffic in priority queue
  - Dedicated bandwidth to video traffic
- Flexibility in moving applications across servers
  - Dedicated bandwidth to vmotion/mobility
  - Everything else best-effort

Translating to the language of QoS

Application	CoS	DSCP	Queuing (Scheduling)	Character
Best Effort	0, 1	0, 8	BW remaining 40%	High Volume / Less Important
vMotion / Live Migration	2	N/A*	BW remaining 20%	Medium Volume / Important
Multimedia	3, 4	24, 32	BW remaining 30%	Medium Volume Very Important
Strict Priority	5	46	BW remaining 10%	Low Volume / Important / Delay Sensitive
Network Control	6,7	48, 56	Priority Queue	Low Volume / Very important

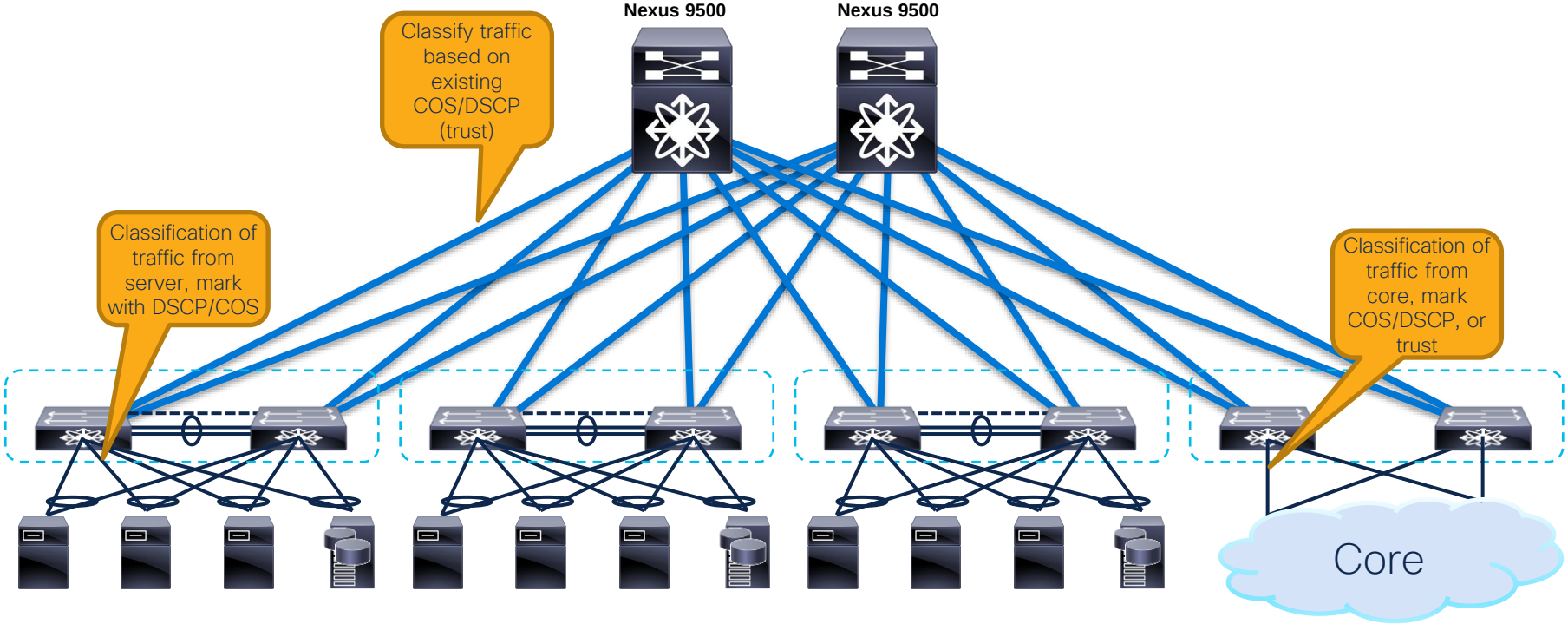
* Layer 2 traffic without IP header

Topology



Type:
QoS

Classification, Marking and Trust



Marking Definition

Application	CoS	DSCP	Character
Best Effort	0, 1	0, 8	High Volume / Less Important
vMotion / Live Migration	2	N/A*	Medium Volume / Important
Multimedia	3, 4	24, 32	Medium Volume Very Important
Strict Priority	5	46	Low Volume / Important / Delay Sensitive
Network Control	6,7	48, 56	Low Volume / Very important

Classification and Marking

Nexus 9300 Leaf (Host Interfaces)

```
ip access-list ACL_QOS_LOWPRIO
  10 permit …
ip access-list ACL_QOS_VMOTION
  10 permit …
ip access-list ACL_QOS_MULTIMEDIA
  10 permit …
!
class-map type qos match-any CM_QOS_LOWPRIO_COS1
  match access-group name ACL_QOS_LOWPRIO
!
class-map type qos match-any CM_QOS_VMOTION_COS2
  match access-group name ACL_QOS_VMOTION
!
class-map type qos match-any CM_QOS_MULTIMEDIA_COS4
  match access-group name ACL_QOS_MULTIMEDIA
!
class-map type qos match-any CM_QOS_STRICTPRIO_COS5
  match cos 5
```

```
policy-map type qos PM_QOS_MARK_COS_IN
  class CM_QOS_STRICTPRIO_COS5
    set qos-group 5
    set cos 5
    set dscp 46
  class CM_QOS_MULTIMEDIA_COS4
    set qos-group 4
    set cos 4
    set dscp 32
  class CM_QOS_VMOTION_COS2
    set qos-group 2
    set cos 2
class CM_QOS_LOWPRIO_COS1
    set qos-group 1
    set cos 1
    set dscp 8
!
interface Ethernet 1/1
  service-policy type qos input PM_QOS_MARK_COS_IN
!
vlan configuration 100
  service-policy input PM_QOS_MARK_COS_IN
```

Classification and Marking

Nexus 9300 Leaf (Uplink Interfaces) and Nexus 9500 (Spine Interfaces)

```
class-map type qos match-any CM_QOS_LOWPRIO_COS1
  match dscp 8
!
class-map type qos match-any CM_QOS_VMOTION_COS2
  match dscp 16
!
class-map type qos match-any CM_QOS_MULTIMEDIA_COS4
  match dscp 32
!
class-map type qos match-any CM_QOS_STRICTPRIO_COS5
  match dscp 46
```

```
policy-map type qos PM_QOS_MARK_COS_IN
  class CM_QOS_STRICTPRIO_COS5
    set qos-group 5
class CM_QOS_MULTIMEDIA_COS4
    set qos-group 4
class CM_QOS_VMOTION_COS2
    set qos-group 2
class CM_QOS_LOWPRIO_COS1
    set qos-group 1
!
interface Ethernet 1/1
  service-policy type qos input PM_QOS_MARK_COS_IN
```

Queueing and Scheduling

Nexus 9300, and 9500

Application	CoS	DSCP	Queuing (Scheduling)	Queue limit (Alpha)	Queue	Character
Best Effort	1	8	BW percent 30%	Default (9)	qos-group 1	High Volume / Less Important
vMotion / Live Migration	2,3	16	BW percent 20%	Default (9)	qos-group 2	Medium Volume / Important
Multimedia	4	24, 32	BW percent 30%	Default (9)	qos-group 4	Medium Volume Very Important
Strict Priority	5	46	BW percent 10%	Default (9)	qos-group5	Low Volume / Important / Delay Sensitive
Network Control	6,7	48, 56	Priority Queue	Default (9)	priority	Low Volume / Very important

Queueing and Scheduling

Nexus 9300, and 9500

- Class-maps type queueing are predefined
- Class-maps referring to qos-groups

```
policy-map type queuing custom-8q-out-policy
  class type queuing c-out-8q-q7
    priority level 1
  class type queuing c-out-8q-q6
    bandwidth remaining percent 0
  class type queuing c-out-8q-q5
    bandwidth remaining percent 10
  class type queuing c-out-8q-q4
    bandwidth remaining percent 30
  class type queuing c-out-8q-q3
    bandwidth remaining percent 0
  class type queuing c-out-8q-q2
    bandwidth remaining percent 20
  class type queuing c-out-8q-q1
    bandwidth remaining percent 30
  class type queuing c-out-8q-q-default
    bandwidth remaining percent 10

system qos
  service-policy type queuing output custom-8q-out-policy
```

Network-QoS

- Keep default Network-QoS:
  - Default 8 Queue model
  - No configuration for non-drop queue

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- **Real World Configuration Examples**
- Conclusion

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Why QoS in the Data Centre?

Assign Colour to Traffic

Manage Congestion

Maximise Throughput

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