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What You Make Possible

TOMORROW starts here.

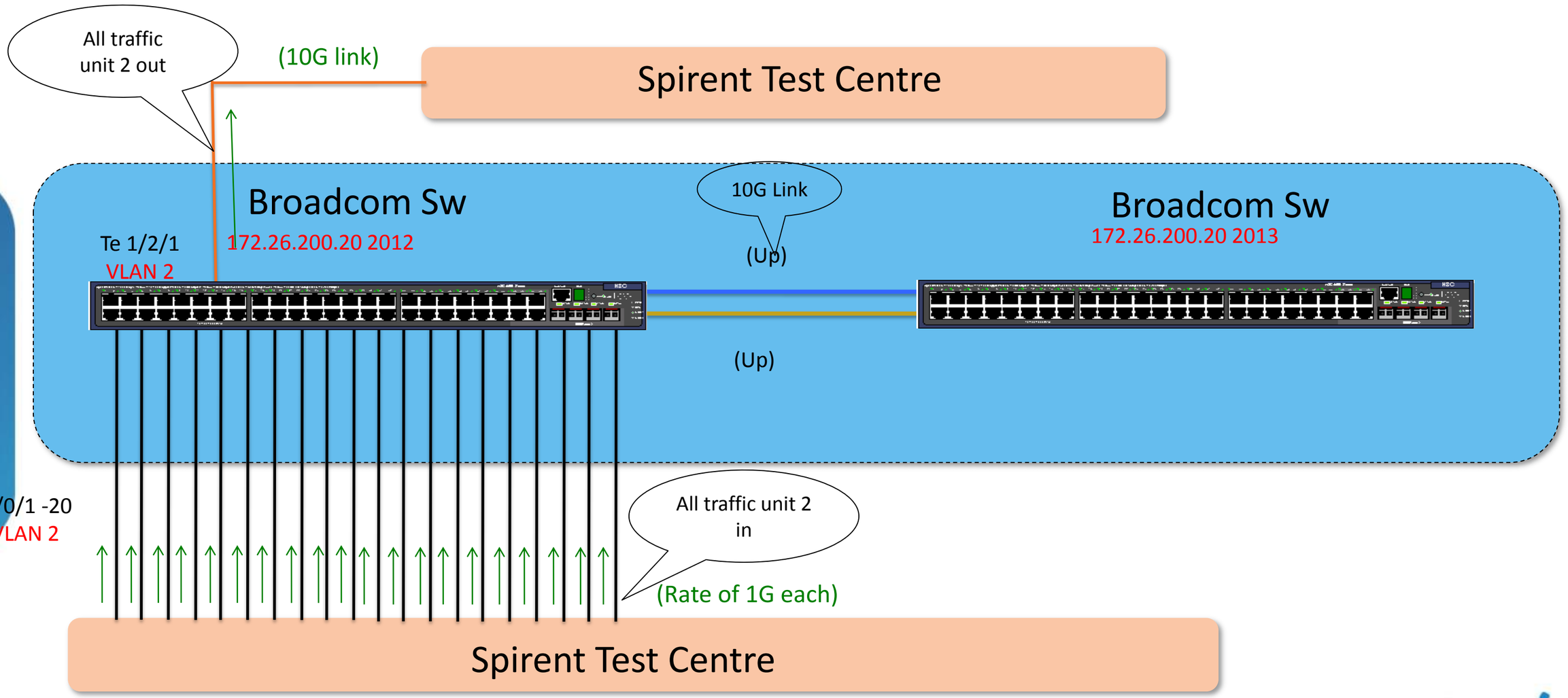
CISCO

Enterprise QoS

BRSRST-2501

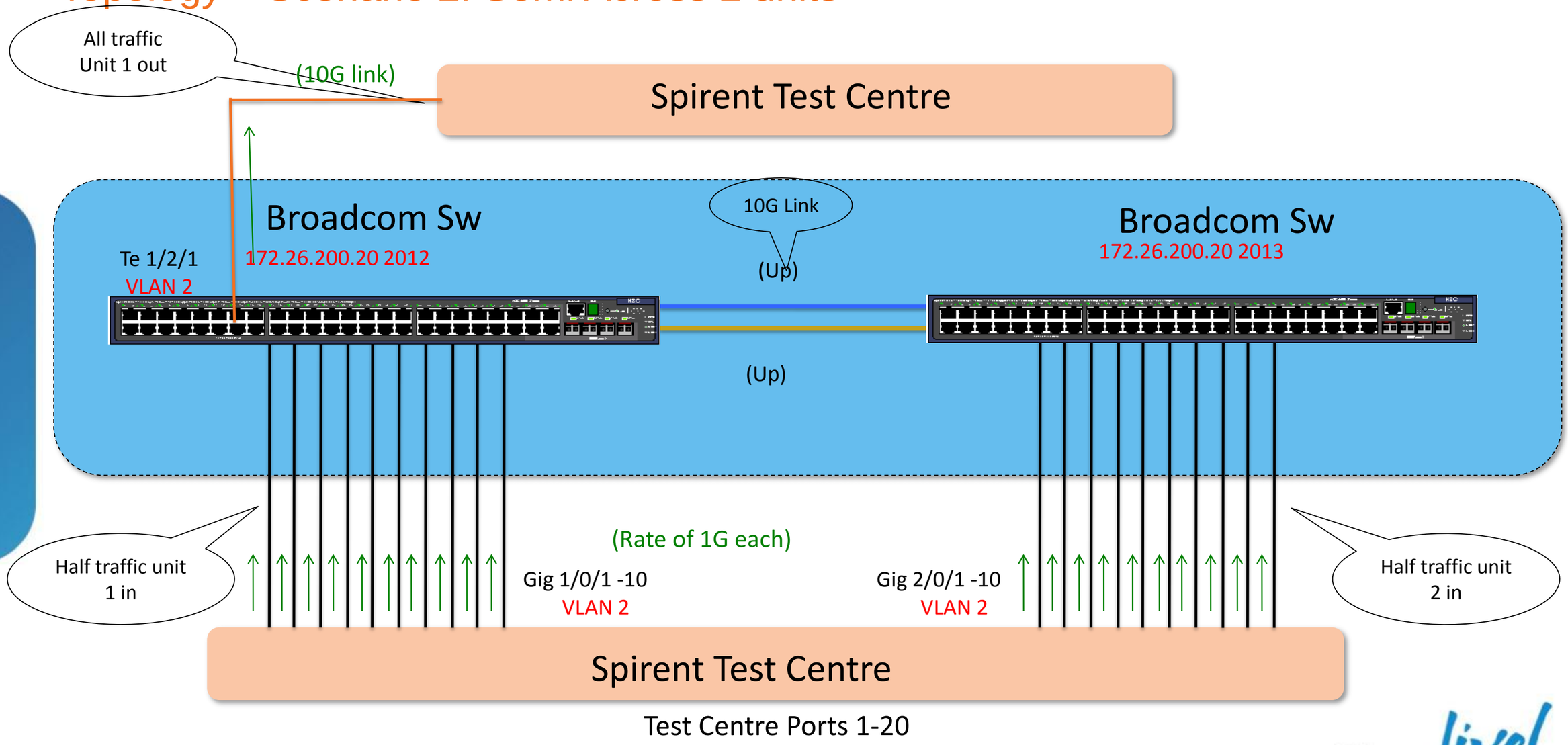
QoS Test – Based on Miercom Report Test

Topology – Scenario 1: Same Unit



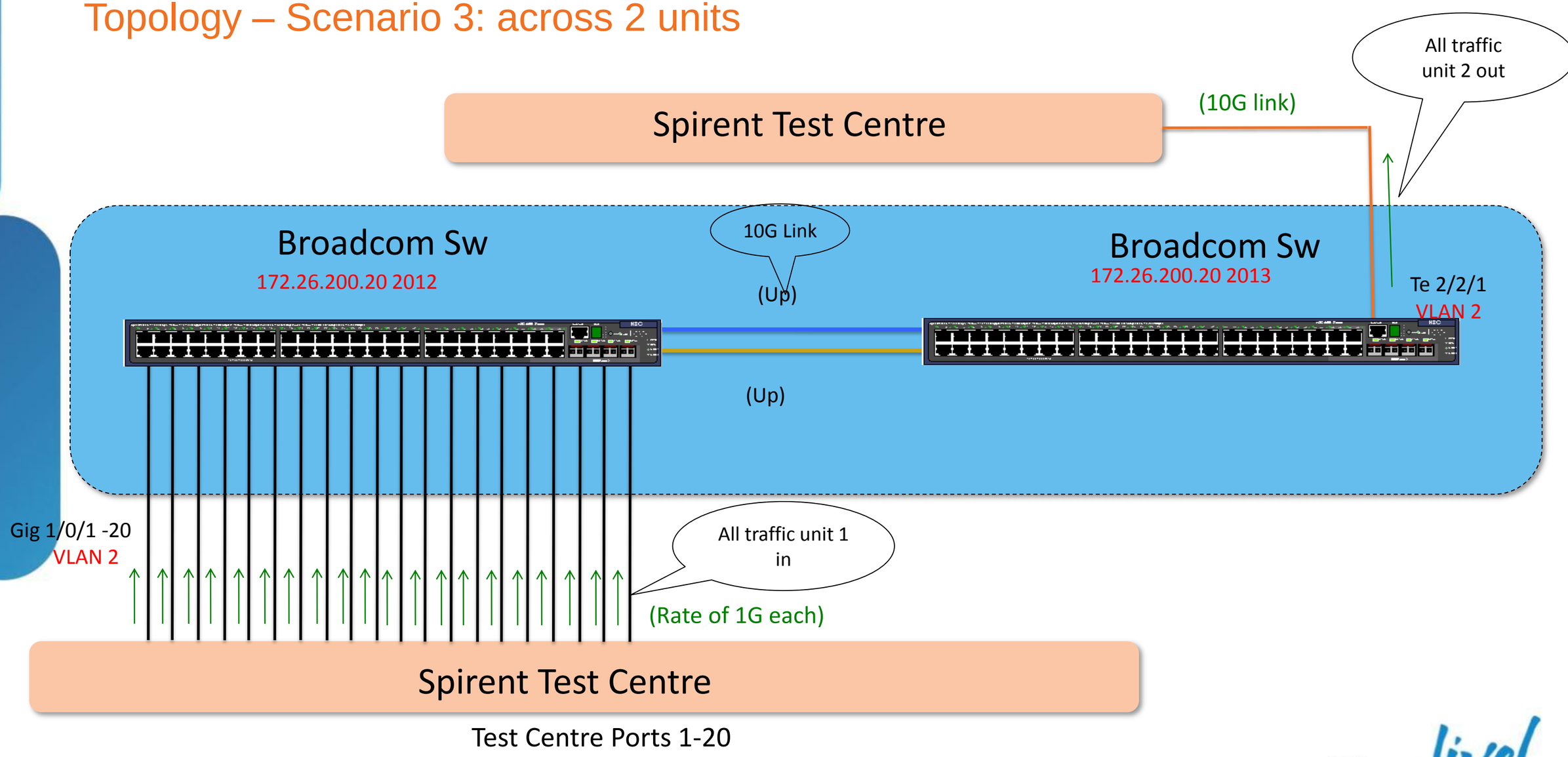
QoS Test

Topology – Scenario 2: Semi Across 2 units



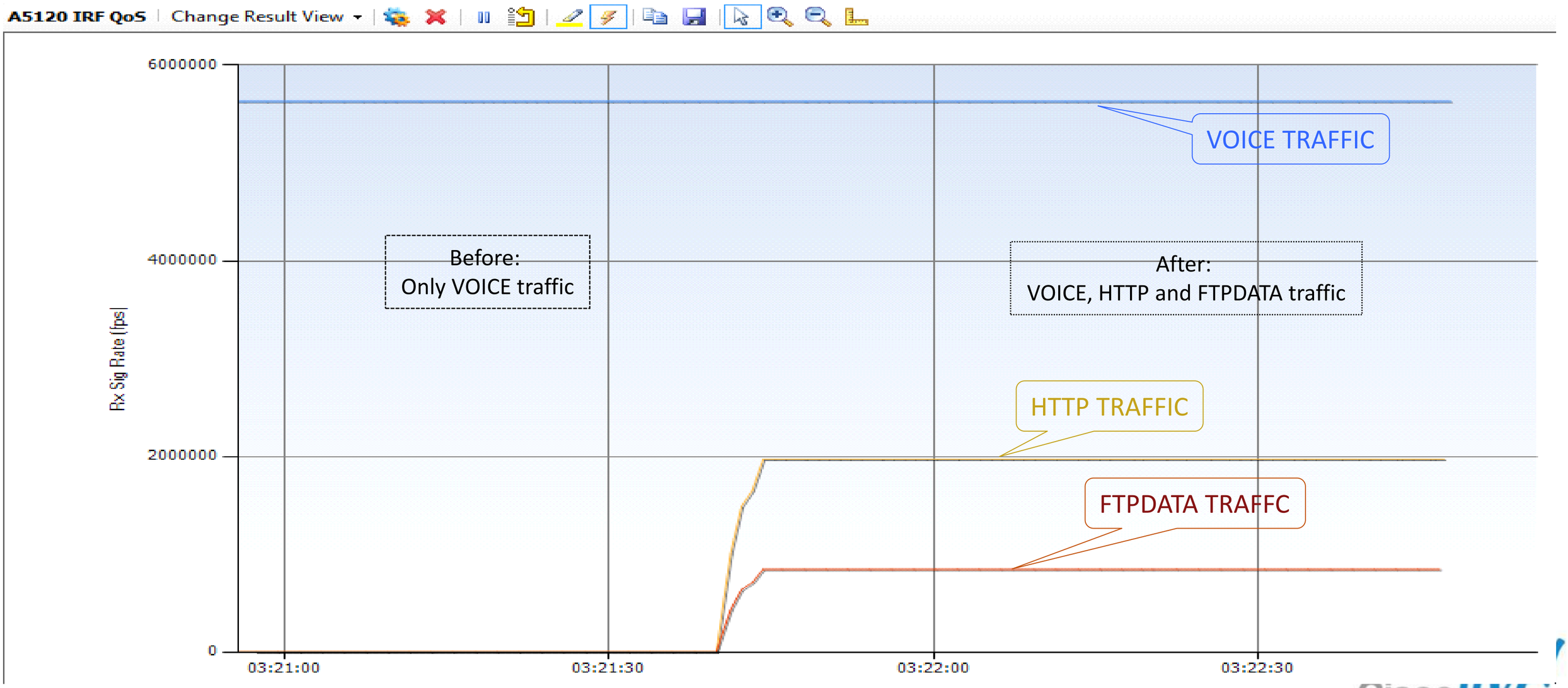
QoS Test

Topology – Scenario 3: across 2 units



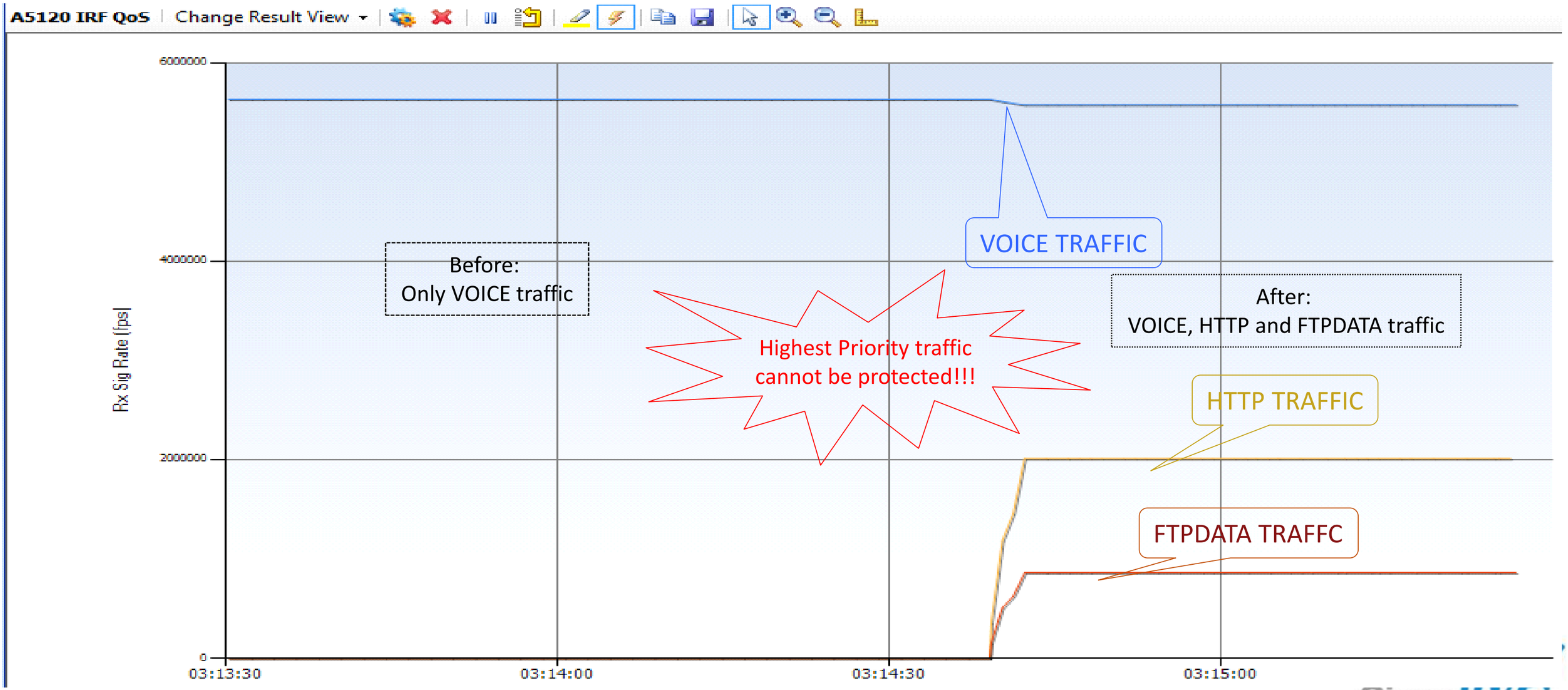
QoS Test – Other Vendor Broadcom Switch

Scenario 1: in the same unit – No DROP on VOICE Traffic



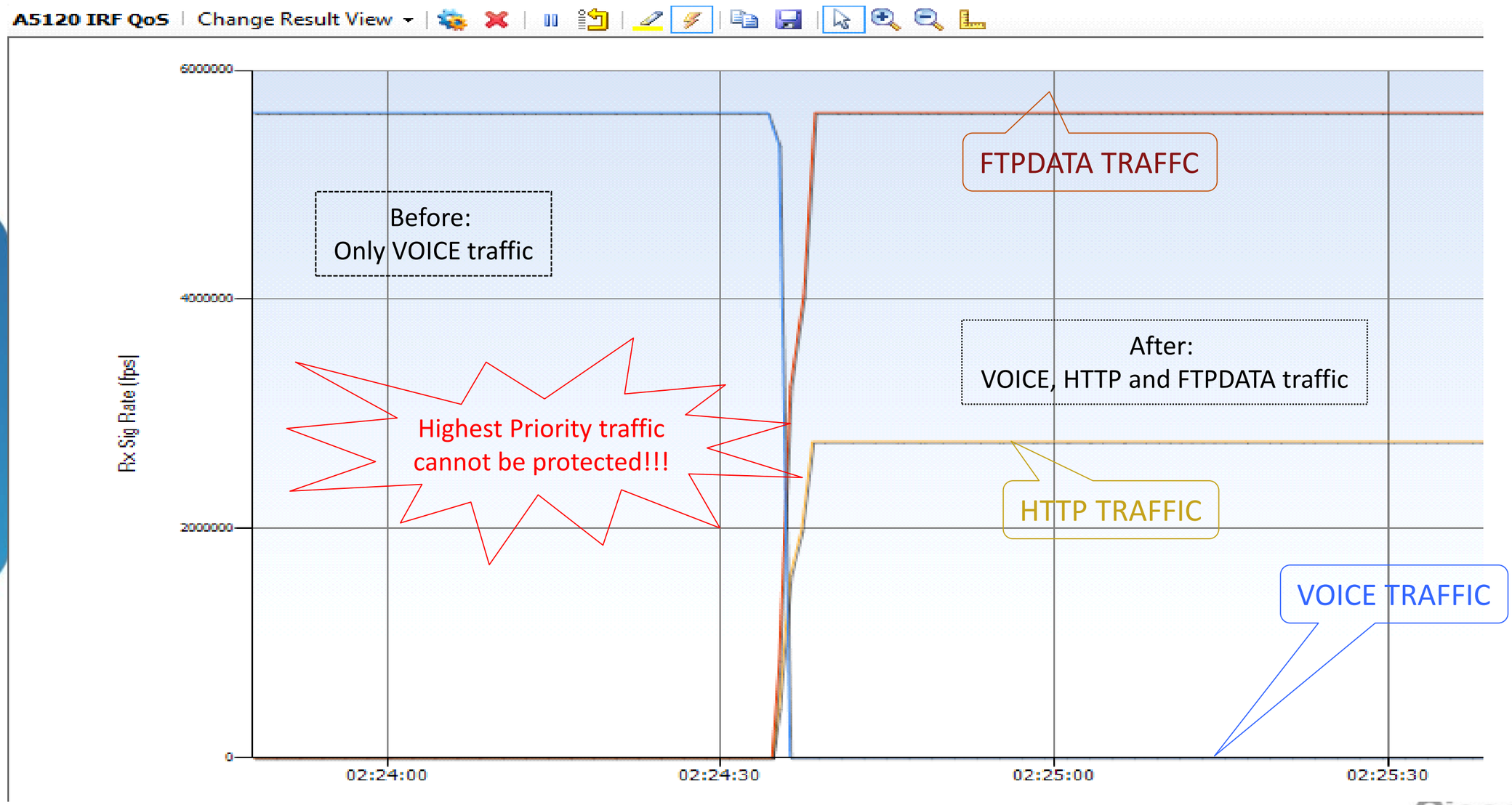
QoS Test – Other Vendor Broadcom Switch

Scenario 2: semi-across the units–DROP on VOICE Traffic



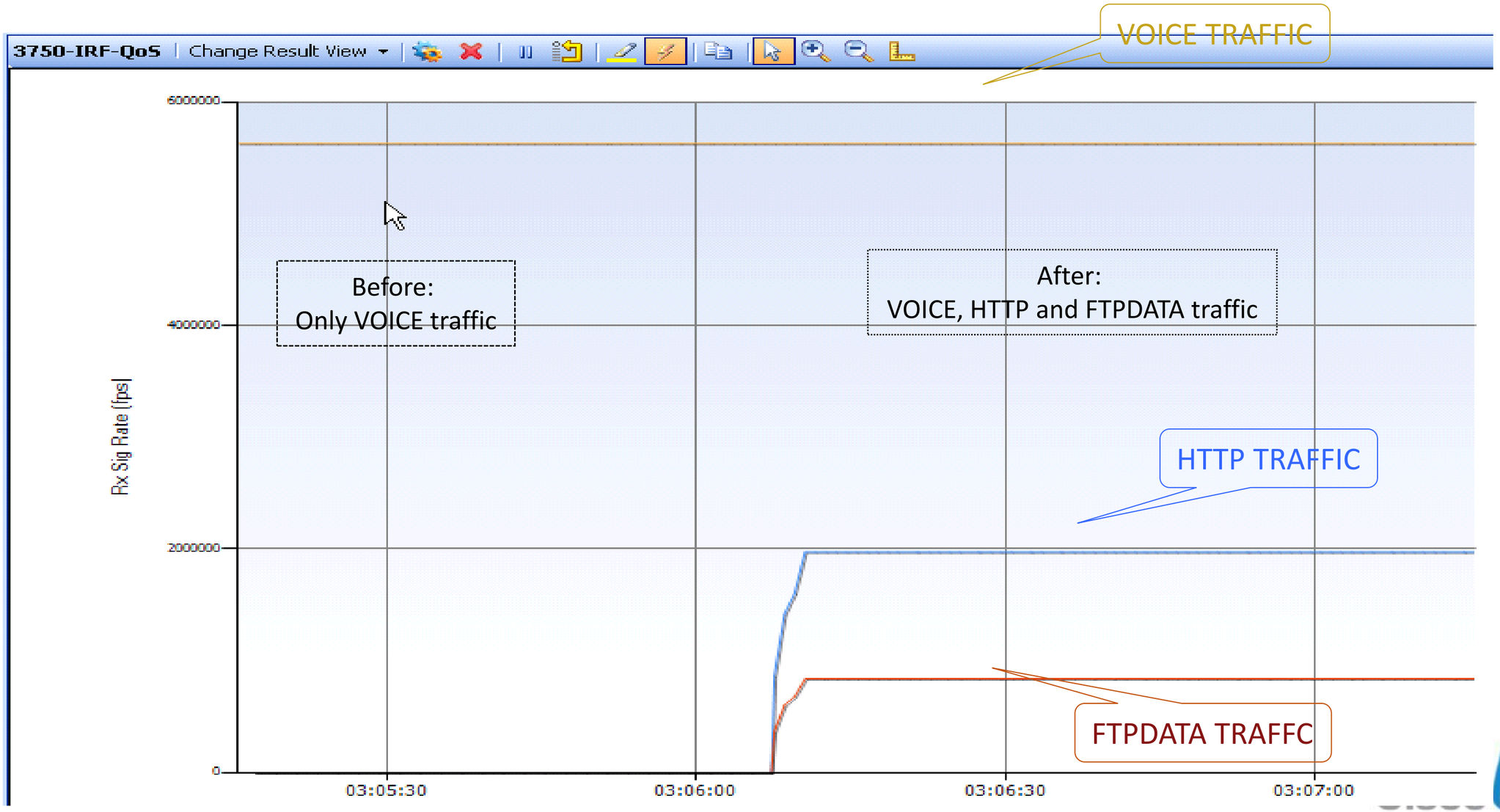
QoS Test – Other Vendor Broadcom Switch

Scenario 3: across different units –No VOICE Traffic!



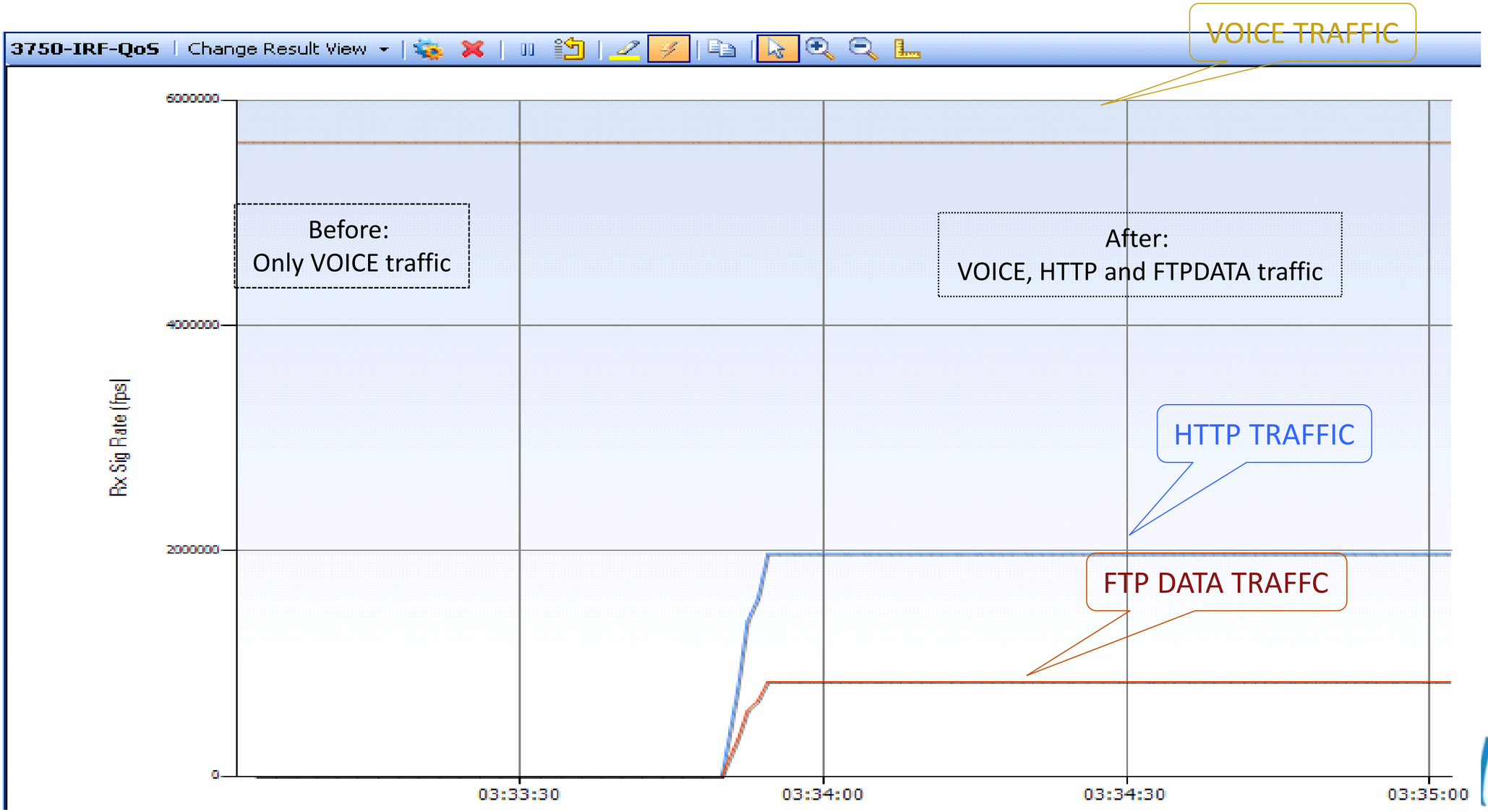
QoS Test – Equivalent Cisco Switch

Scenario 1: in the same unit –NO DROP on VOICE Traffic



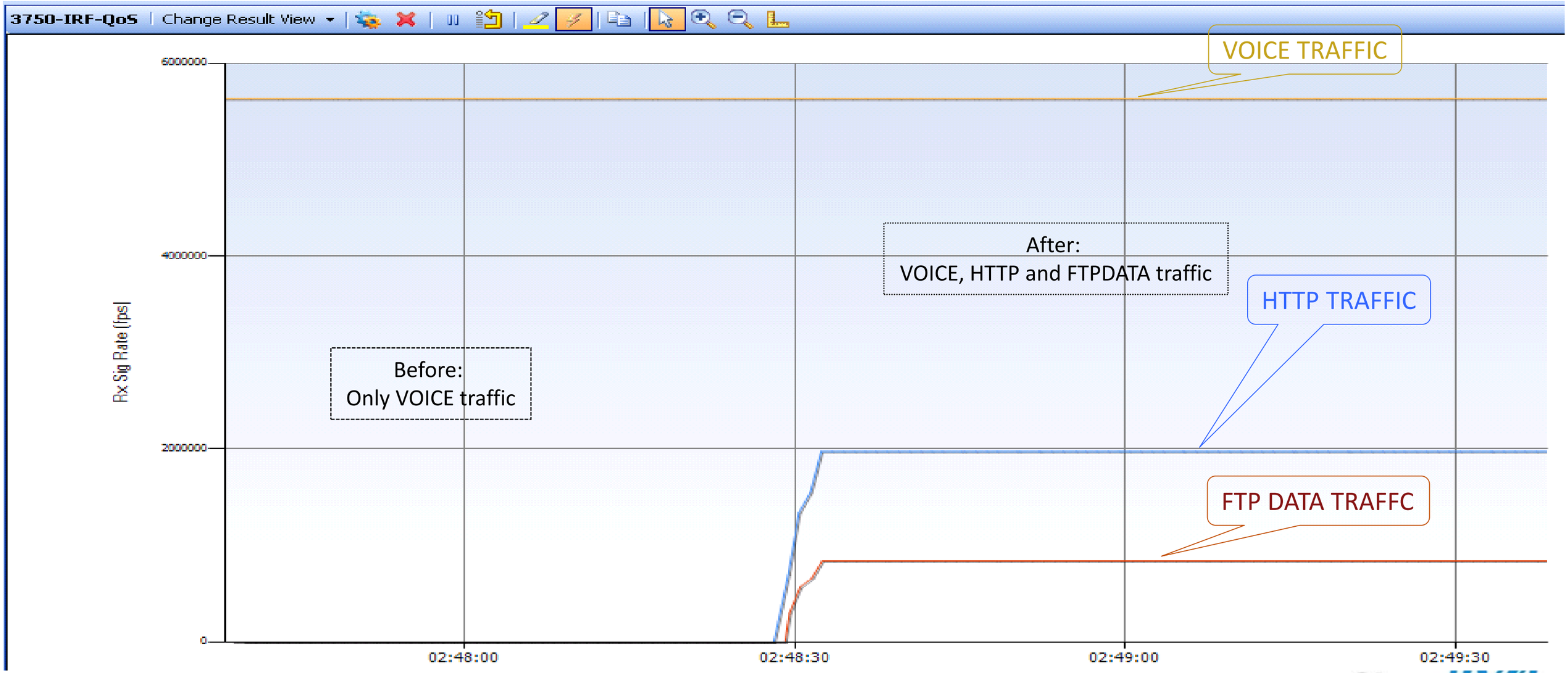
QoS Test – Equivalent Cisco Switch

Scenario 2: semi-across the units–No DROP on VOICE Traffic



QoS Test – Equivalent Cisco Switch

Scenario 3: across different units –No Drop on VOICE Traffic



Campus QoS Design

Agenda

- **Business and Technical Drivers for QoS Design Update**
- Components of QoS
- Campus QoS Design Considerations and Models
- Catalyst 2960/2975/3560/3750 **QoS Design**
- Catalyst 2960/2975/3560/3750 **AutoQoS**
- Catalyst 4500/4900 and 6500/6500-E QoS Design (Hidden)
- WAN and Branch QoS Design
- What about DC, Wireless and other areas where QoS is important?

This is what we want to get to…

Classify the Traffic

class-map match-any VOICE_CLASS

match dscp ef

Apply a Policy to the Traffic

policy-map QOS_POLICY

class VOICE_CLASS

priority 1000

Apply the Policy

interface GigabitEthernet0/0

service-policy output QOS_POLICY

Why Campus QoS Designs Is Important Business and Technical Drivers

- New Applications and Business Requirements
  - –Explosion of Video Apps
  - –Impact of HD
  - –Blurring of Voice/Video/Data application boundaries
- New Standards and RFCs
  - –RFC 4594, FCoE
- New Platforms and Technologies
  - –New Switches, Routers, Supervisors, Linecards, Features, Syntax

http://www.cisco.com/en/US/docs/solutions/Enterprise/WAN_and_MAN/QoS_SRND_40/QoSIntro_40.html#wp60730

New Business Requirements

Cisco Visual Networking Index Findings

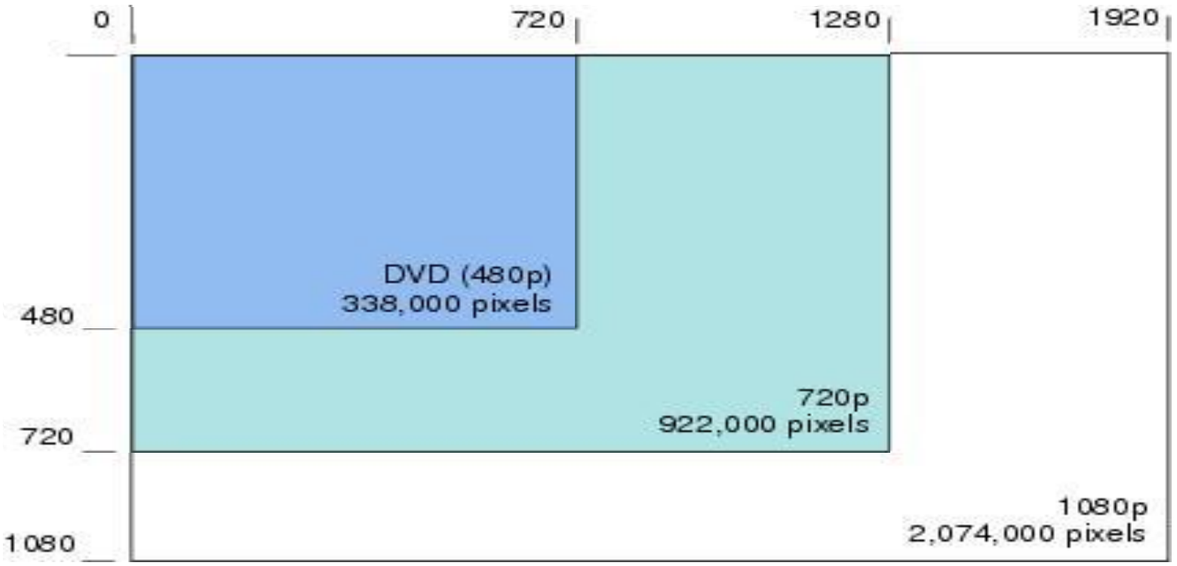
- By 2016, global IP traffic will reach 1.3 zettabytes annually (110 exabytes per month); growing 4-fold from 2011 to 2016.
- By 2016, wi-fi will account for nearly half of all IP traffic.
- **Globally, Internet video traffic will be 55 percent of all consumer Internet traffic in 2016, up from 51 percent in 2011**.
- **Internet video to TV doubled in 2011**. **Video-on-demand traffic will triple by 2016**. The amount of VoD traffic in 2016 will be equivalent to 4 billion DVDs per month.
- **High-definition video-on-demand surpassed standard definition by the end of 2011**.

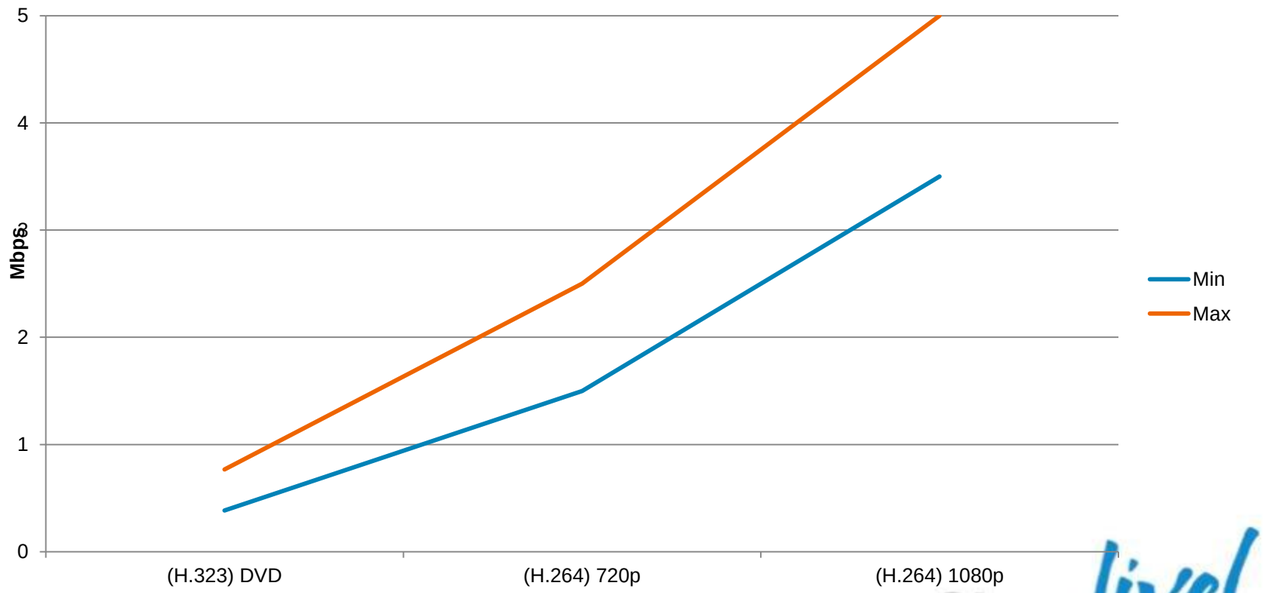
http://www.cisco.com/en/US/netsol/ns827/networking_solutions_sub_solution.html

New Application Requirements

The Impact of HD on the Network

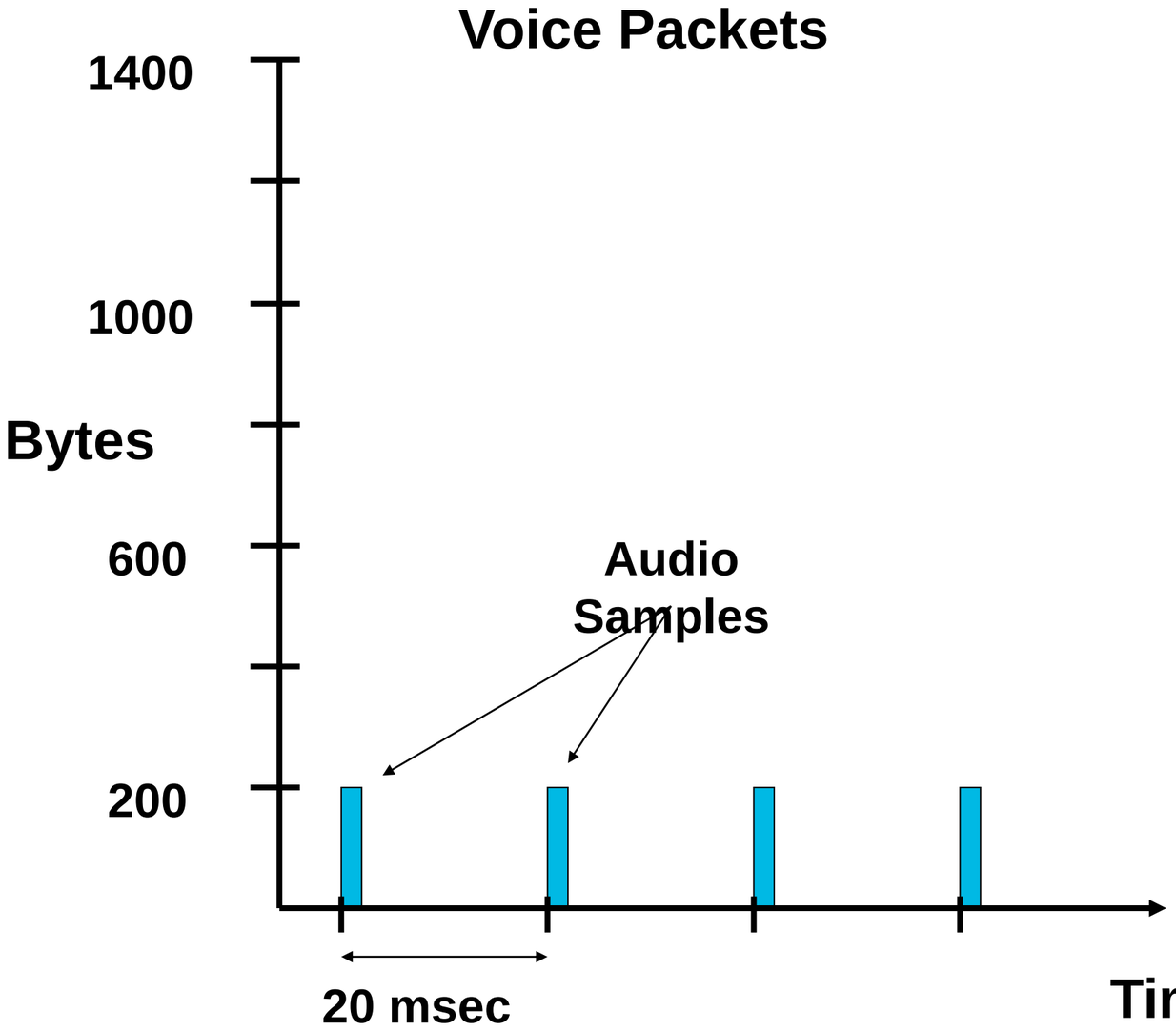
- User demand for HD video has a major impact on the network
  - –(H.264) 720p HD video requires twice as much bandwidth as (H.263) DVD
  - –(H.264) 1080p HD video requires twice as much bandwidth as (H.264) 720p
  - –Ultra HD 4320p video requires four times as much bandwidth as 1080p

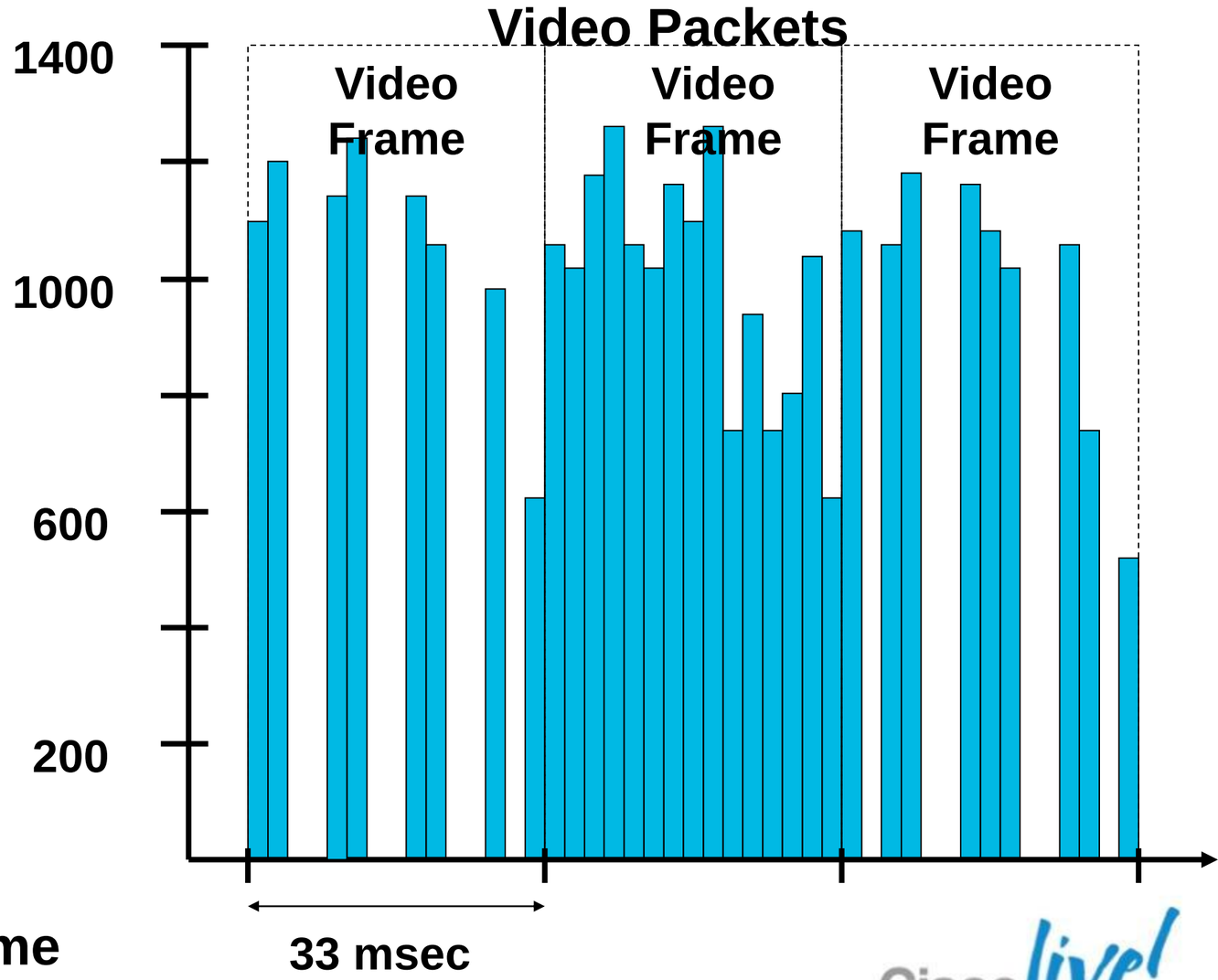




New Applications Requirements

VoIP vs. HD Video—At the Packet Level

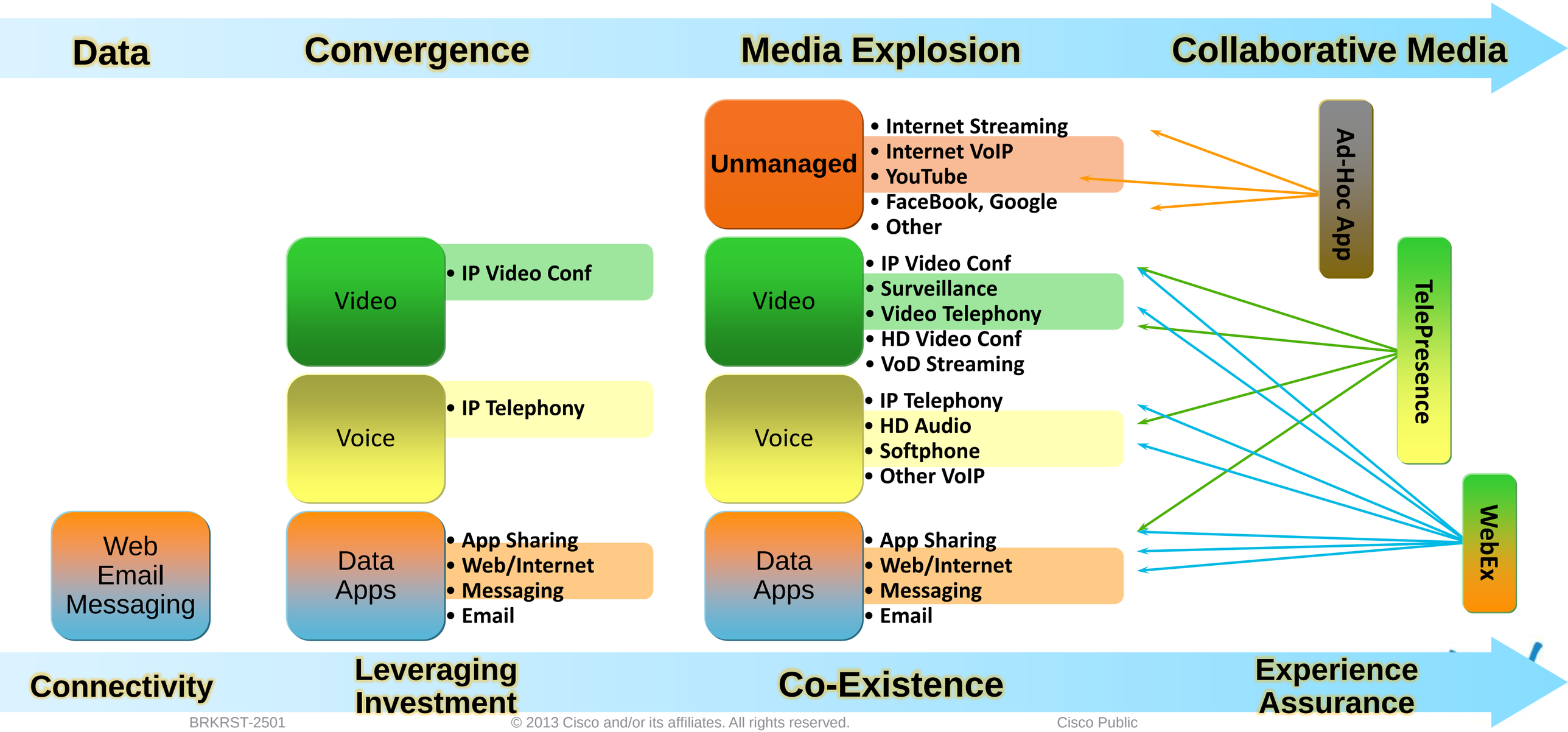




http://www.cisco.com/en/US/docs/solutions/Enterprise/WAN_and_MAN/QoS_SRND_40/QoSIntro_40.html#wp60774

Medianet Application Evolution

Trends in Voice, Video and Data Media Applications



Borderless Medianet Architecture

For Video & Collaboration – New Design Guide

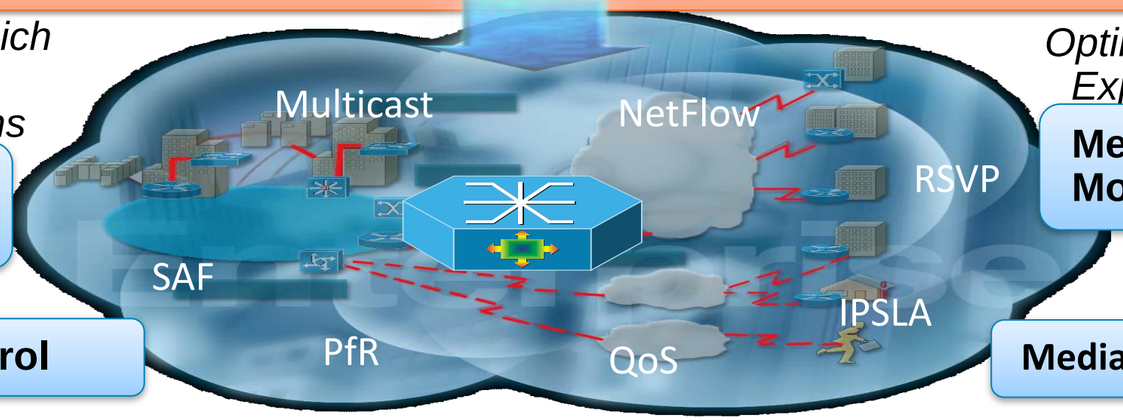
Deliver the network optimised for video anytime, anywhere, any device

Media Services Interface (MSI) APIs

Enable Rich Media Solutions

Media Aware Routing

Resource Control



Optimise User Experience

Media Monitoring

Media Optimisation

Seamless Security

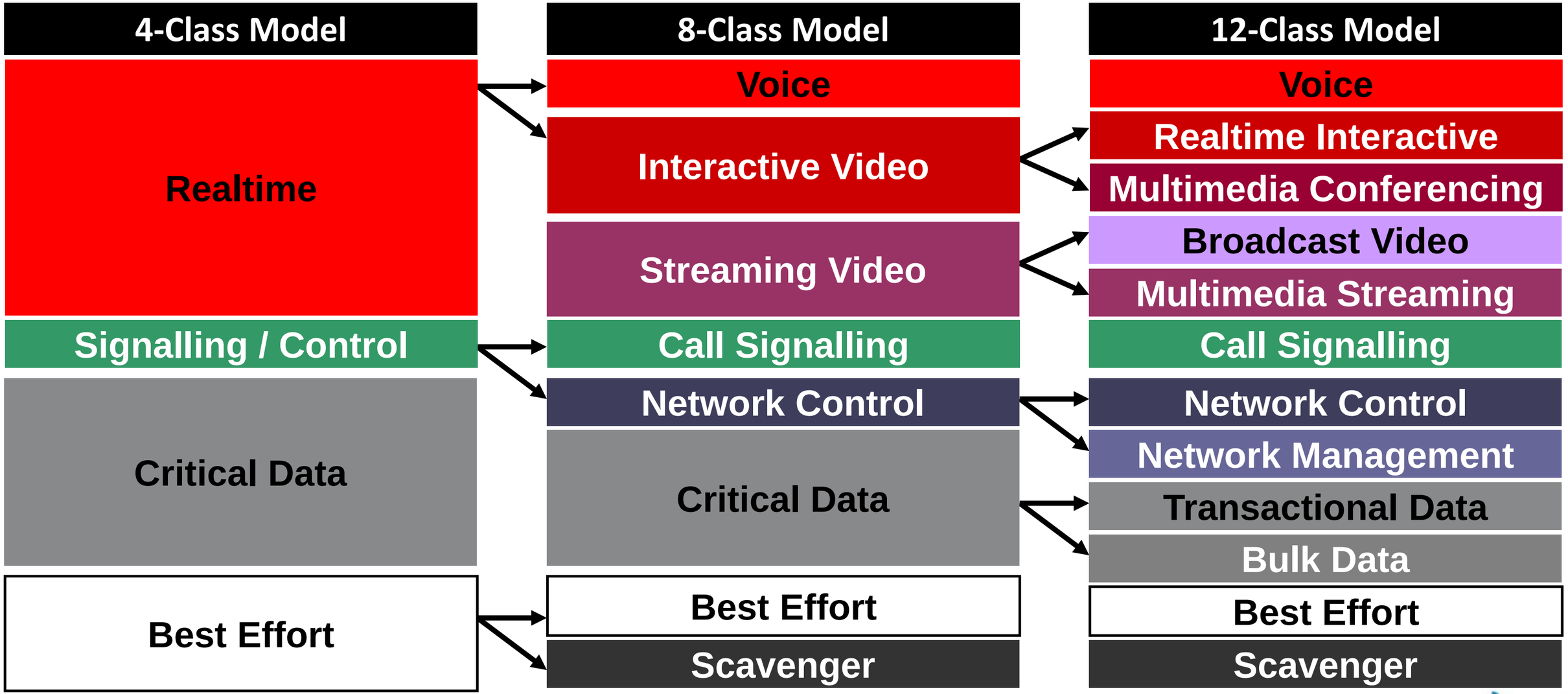
Management – Policy	Middleware/API
	SIP, ICE/STUN
	SAF/XMPP/Bonjour
	RTCP/SNMP/FNF
	RSVP/QoS
	IGMPv3
	802.1x
	CDP, LLDP-MED

Media Services Interface (resides at the video endpoint):

- API
- Middleware
- Host Stacks / Protocols

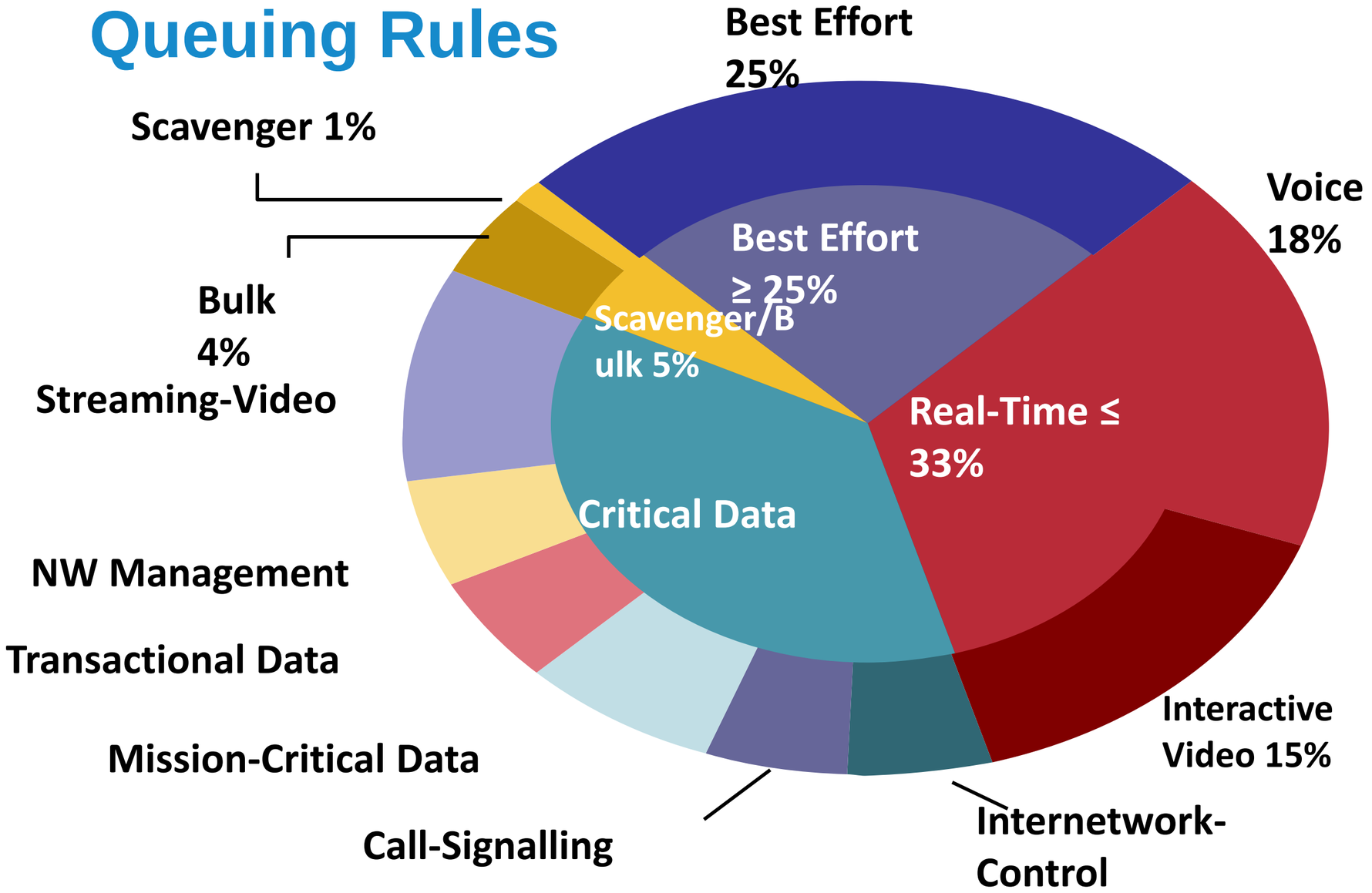
Evolving Business Requirements

Business Requirements Will Evolve and Expand over Time



http://www.cisco.com/en/US/docs/solutions/Enterprise/WAN_and_MAN/QoS_SRND_40/QoSIntro_40.html#wp61135

Compatible Four-Class and Eleven-Class Queuing Models Following Realtime, Best Effort, and Scavenger Queuing Rules



Recommended Guidelines:

Best Effort (BE) Class - 25% minimum

Priority Queue (PQ) – given maximum of 33% for all LLQs

Scavenger - minimal bw allocation ~ 5% (RFC 3662)
Less than best effort during congestion

Congestion Avoidance should be enabled on select TCP flows (eg WRED, DBL)

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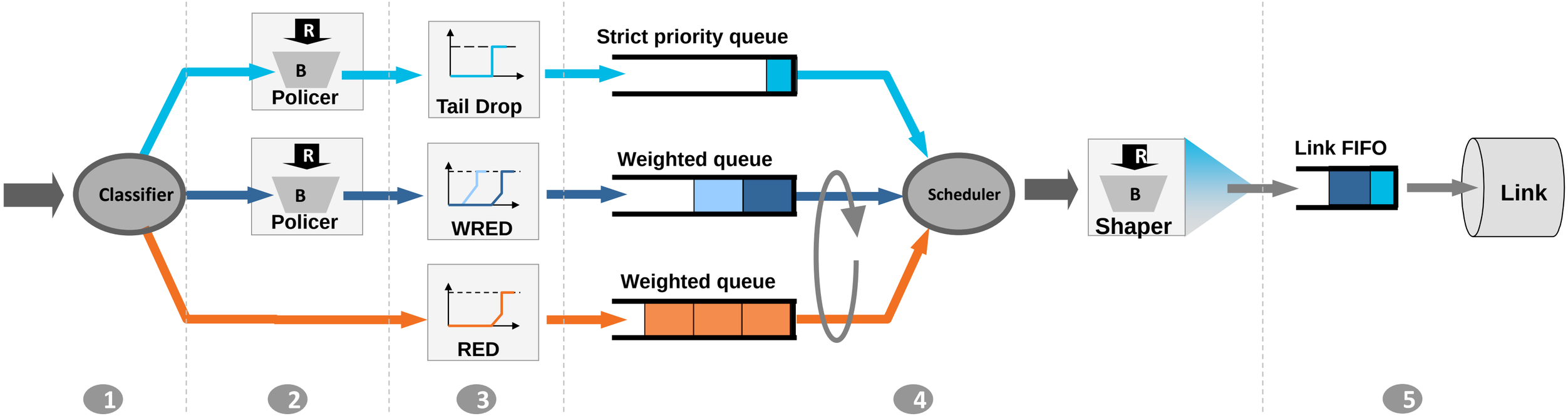
Components of QoS

Components of QoS



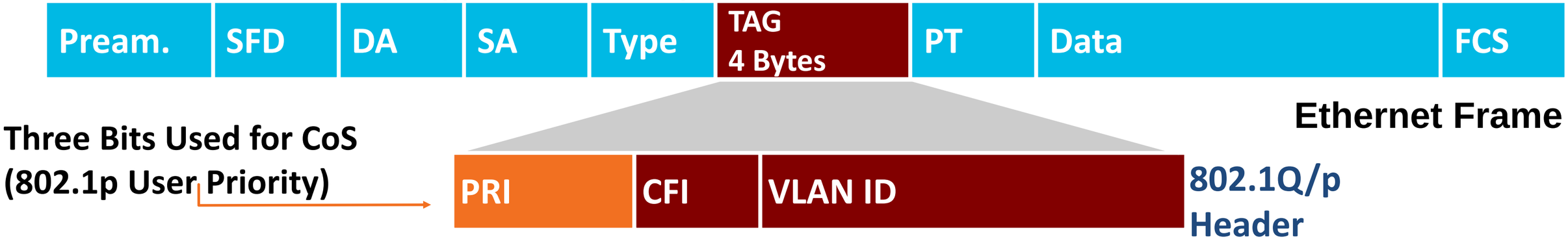
- Admission Control - Local, Measurement and Resource Based (CAC and RSVP).

1. Classification and Marking - CoS, DSCP, Port Num, Packet Len, Protocol, VLAN etc
2. Policing - Pre Queuing includes Marking, Policing, Dropping (Tail Drop and WRED)
3. Queuing and Scheduling – Priority, Queue Length (Buffers)
4. Shaping – generally outbound, also sharing.
5. Post Queuing – Fragmenting, Interleaving, Compression

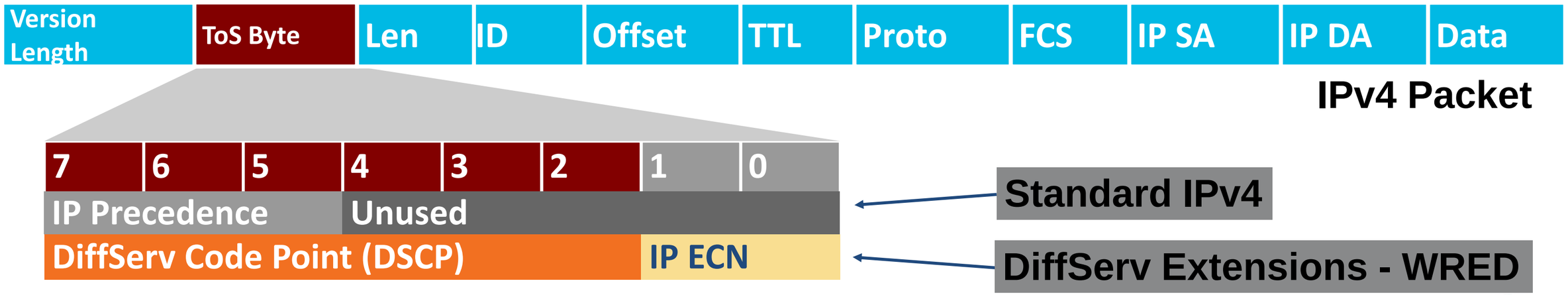
1. QoS Components - Classification

Layer 2- Ethernet 802.1Q Class of Service

DSCP is backward-compatible with IP precedence



Layer 3- IP Precedence and DiffServ Code Points



Standards and RFCs

Cisco Medianet DiffServ QoS Recommendations (RFC 4594-Based)

Application Class	Per-Hop Behaviour	Admission Control	Queuing & Dropping	Application Examples
VoIP Telephony	EF	Required	Priority Queue (PQ)	Cisco IP Phones (G.711, G.729)
Broadcast Video	CS5	Required	(Optional) PQ	Cisco IP Video Surveillance / Cisco Enterprise TV
Realtime Interactive	CS4	Required	(Optional) PQ	Cisco TelePresence
Multimedia Conferencing	AF4	Required	BW Queue + DSCP WRED	Cisco Unified Personal Communicator, WebEx
Multimedia Streaming	AF3	Recommended	BW Queue + DSCP WRED	Cisco Digital Media System (VoDs)
Network Control	CS6		BW Queue	EIGRP, OSPF, BGP, HSRP, IKE
Call-Signalling	CS3		BW Queue	SCCP, SIP, H.323
Ops / Admin / Mgmt (OAM)	CS2		BW Queue	SNMP, SSH, Syslog
Transactional Data	AF2		BW Queue + DSCP WRED	ERP Apps, CRM Apps, Database Apps
Bulk Data	AF1		BW Queue + DSCP WRED	E-mail, FTP, Backup Apps, Content Distribution
Best Effort	DF		Default Queue + RED	Default Class
Scavenger	CS1		Min BW Queue (Deferential)	YouTube, iTunes, BitTorent, Xbox Live, eDonkey

http://www.cisco.com/en/US/docs/solutions/Enterprise/WAN_and_MAN/QoS_SRND_40/QoSIntro_40.html#wp61104

2. QoS Components - Marking

Marking (a.k.a. colouring) is the process of settig the value of the DS field so that the traffic can easily be identified later, i.e. using simple classification techniques.

Marking occurs at L3 or L2 e.g. 802.1D user priority field

Traffic marking can be applied unconditionally, e.g. mark the DSCP to 34 for all traffic received on a particular interface, or as a conditional result of a policer

Conditional marking can be used to designate in- and out-of-contract traffic:

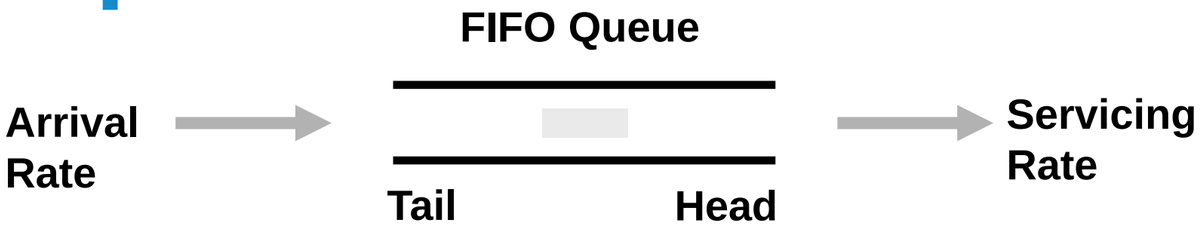
– Conform action is “mark one way”

– Exceed action is “mark another way”

Single rate Policer has 2 states – conform or exceed.

Dual Rate Policer has 3 states – conform, exceed and violate

QoS Components - Buffers and Queues



Congestion can occur whenever there are speed mismatches (oversubscription)

When routers receive more packets than they can immediately forward, they momentarily store the packets in “buffers” (full buffers = packets dropped)

Difference between buffers and queues

- –Buffers are physical memory locations where packets are temporarily stored whilst waiting to be transmitted
- –Queues do not actually contain packets but consist of an ordered set of pointers to locations in buffer memory where packets in that particular queue are stored
- –Buffer memory generally shared across different queues (so more Q’s is not necessarily better)

Routers generally use IOS-based software queuing

Catalyst switches generally use hardware queuing

Dropping- Congestion Avoidance Algorithms

Queuing algorithms manage the front of the queue (Which packets get sent first)

Congestion avoidance algorithms manage the tail of the queue (Which packets get dropped first when queuing buffers fill)

Variants based on Tail Drop and RED (Random Early Discard) based on weight

Weighted Tail-drop and Weighted RED

WRED - Drops packets according to their DSCP markings

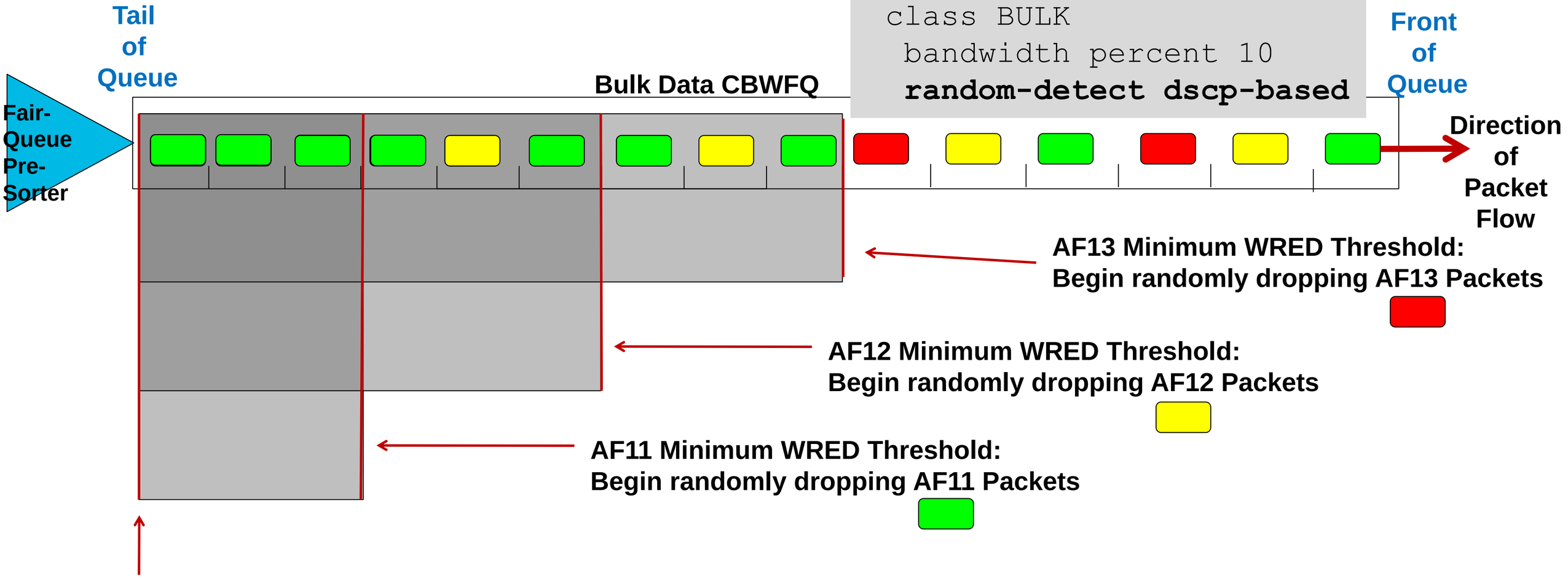
- WRED works best with TCP-based applications, like data

Congestion Avoidance helps prevent TCP Global Sync

QoS Components - Dropping

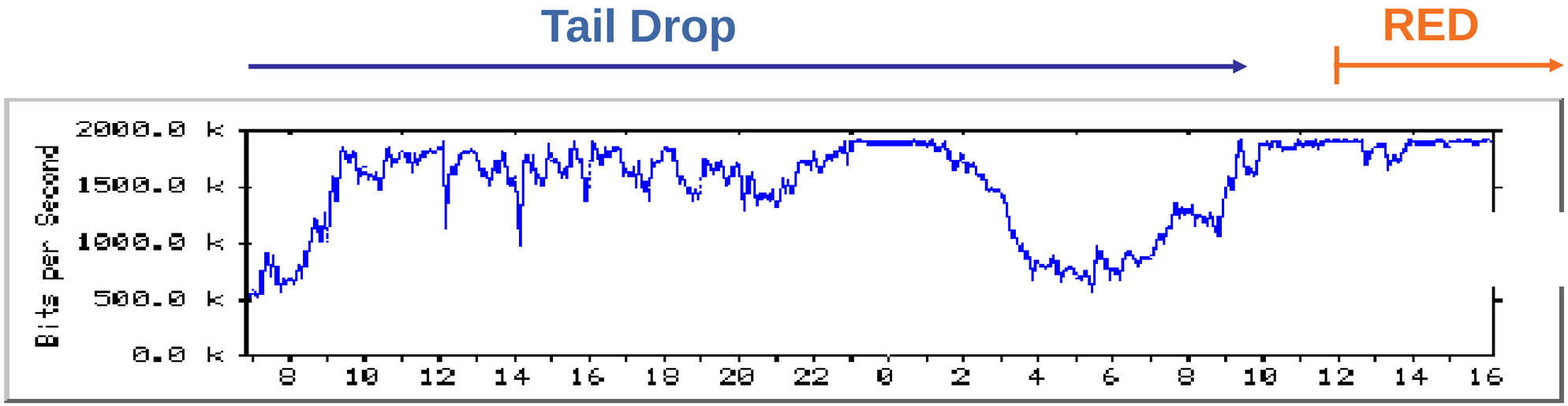
DSCP-Based WRED Operation

```
policy-map BULK-WRED
 class BULK
  bandwidth percent 10
  random-detect dscp-based
```



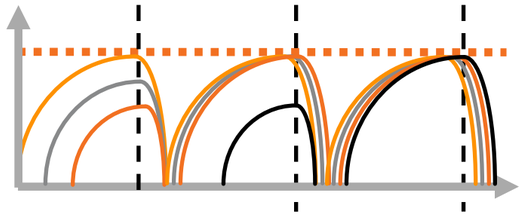
http://www.cisco.com/en/US/docs/solutions/Enterprise/WAN_and_MAN/QoS_SRND_40/QoSWAN_40.html#wp1294476

TCP Global Synchronisation and RED



[Courtesy of Sean Doran, then at Ebone]

Without RED, below 100% throughput

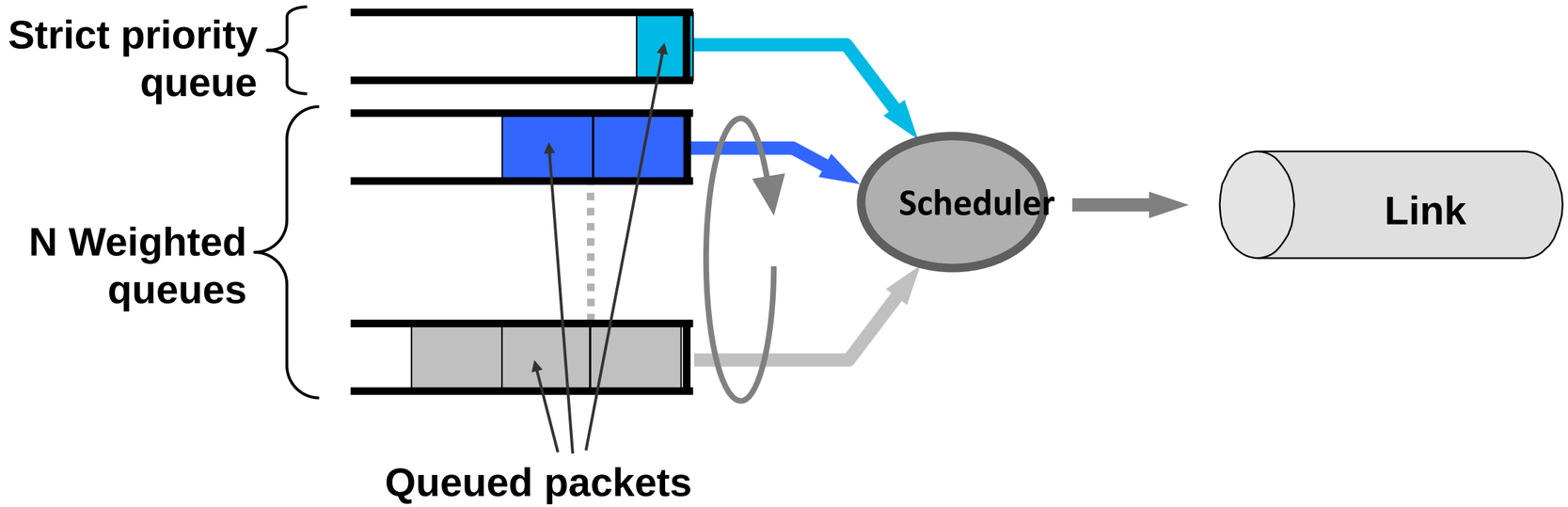


- –Simple FIFO with tail drop
- –Tail drop results in session synchronisation
- –RED enabled starting 10:00 second day, ~100% throughput

With RED - Session synchronisation reduced

- –RED distributes drops over various sessions to desynchronise TCP sessions improving average TCP session goodput

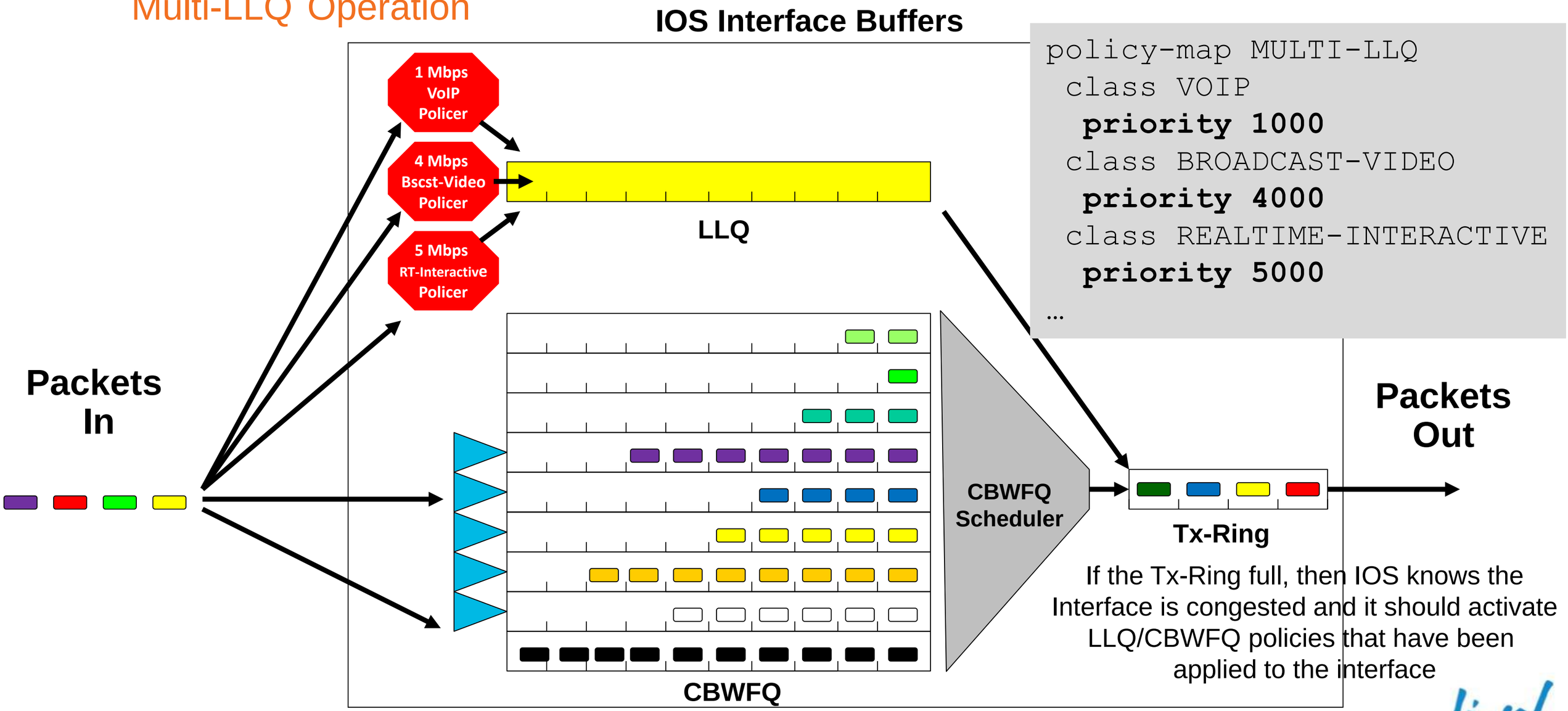
Queuing and Scheduling



- Schedulers determine which queue to service next - Different schedulers service queues in different orders
- Most common types of schedulers
  - –FIFO – is the most basic queuing type and is default when no QoS is enabled
  - –Priority scheduling – the queue is serviced if a packet is present
  - – Weighted bandwidth scheduling
  - – Weighted Round Robin (WRR), simple, each queue is weighted e.g. Custom Qing
  - – Weighted Fair Queuing e.g. (FB)WFQ, CBWFQ, LLQ (a.k.a. PQ-CBWFQ)

IOS QoS Mechanisms and Operation

Multi-LLQ Operation




```
policy-map MULTI-LLQ
 class VOIP
  priority 1000
 class BROADCAST-VIDEO
  priority 4000
 class REALTIME-INTERACTIVE
  priority 5000
…
```

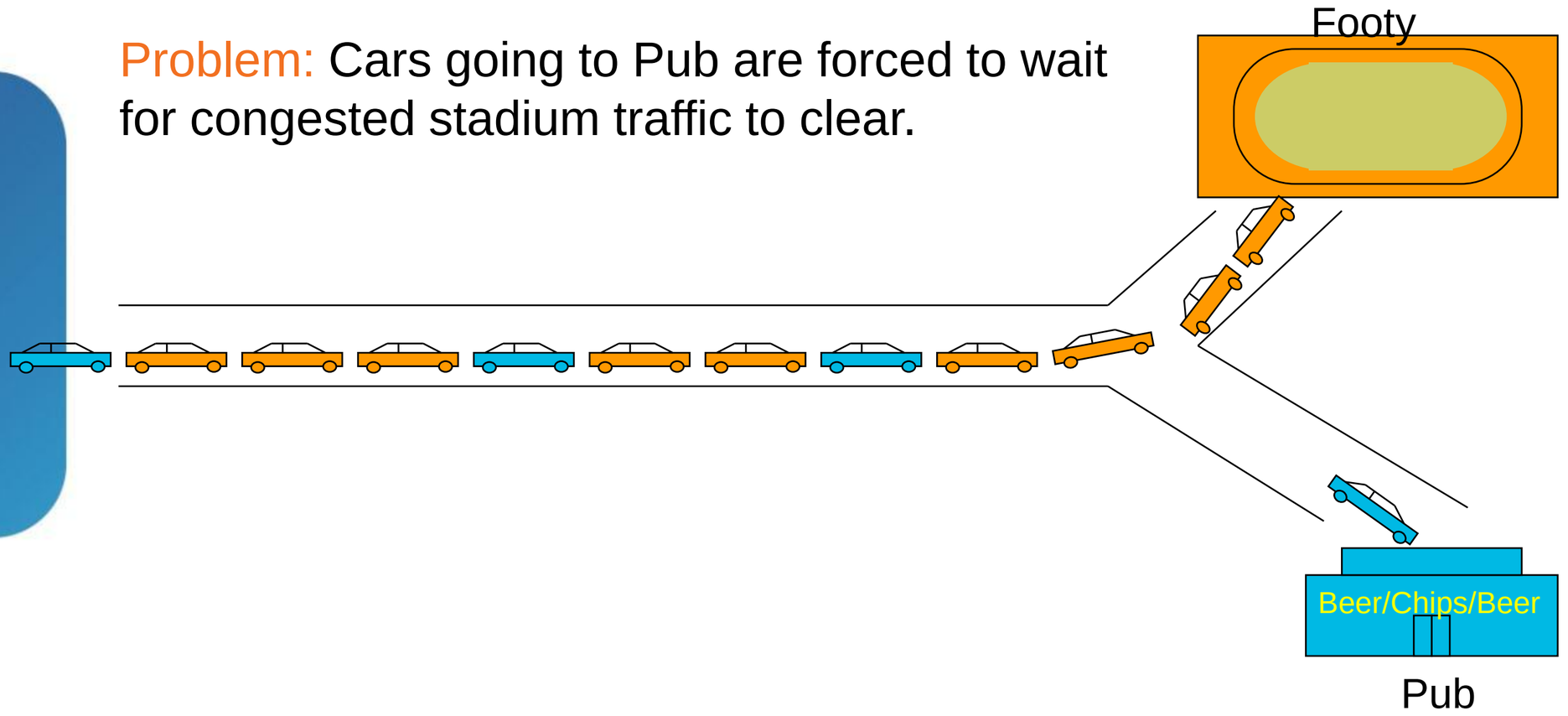
If the Tx-Ring full, then IOS knows the Interface is congested and it should activate LLQ/CBWFQ policies that have been applied to the interface

http://www.cisco.com/en/US/docs/solutions/Enterprise/WAN_and_MAN/QoS_SRND_40/QoSWAN_40.html#wp1294691

Virtual Output Queues

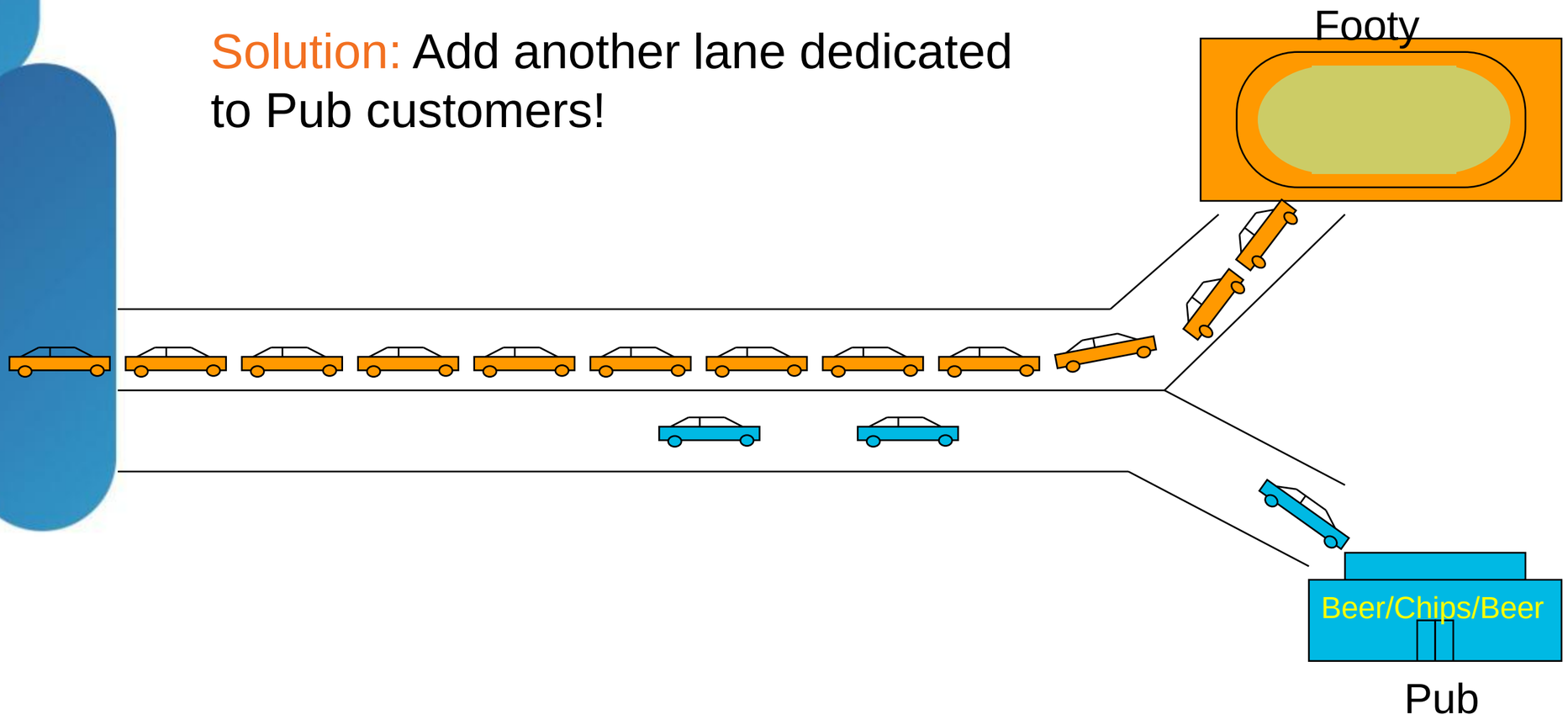
HOL Blocking

Problem: Cars going to Pub are forced to wait for congested stadium traffic to clear.



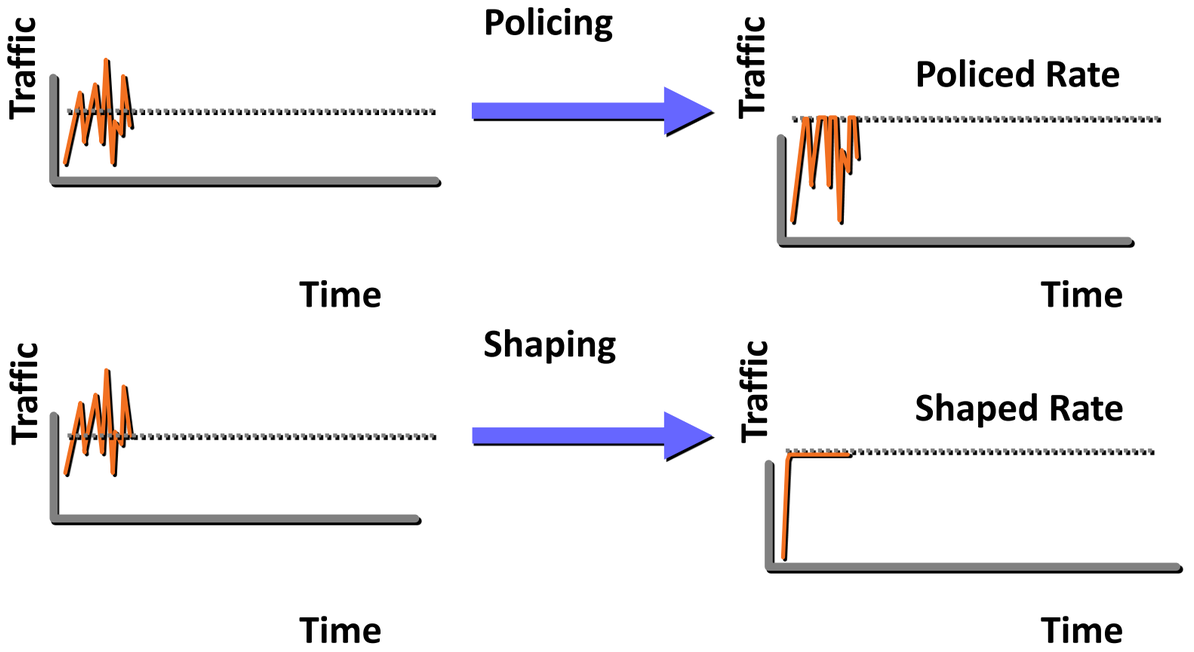
Virtual Output Queues (Cont.)

Solution: Add another lane dedicated to Pub customers!



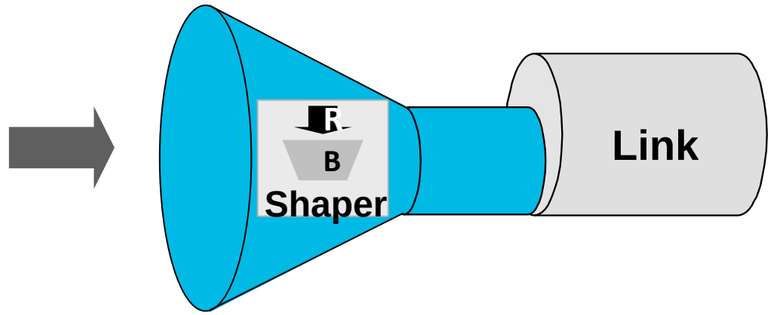
Policing vs. Shaping

- Policing typically drops out-of-contract traffic
- Effectively policing acts to cut the peaks off bursty traffic
- Shaping typically delays out of contract traffic
- Shaping acts to smooth the traffic profile by delaying the peaks
  - –Resulting packet stream is “smoothed” and net throughput for TCP traffic is higher with shaping
  - –Shaping delay may have an impact on some services such as voip and video

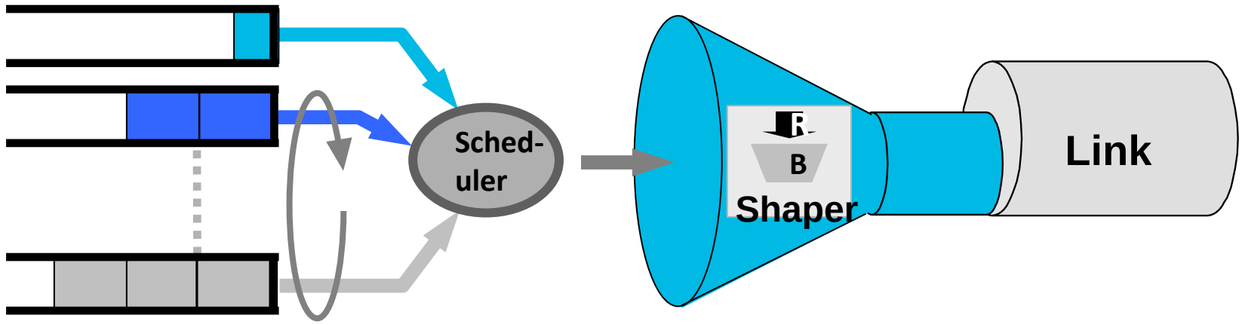


4. QoS Components - Shaping

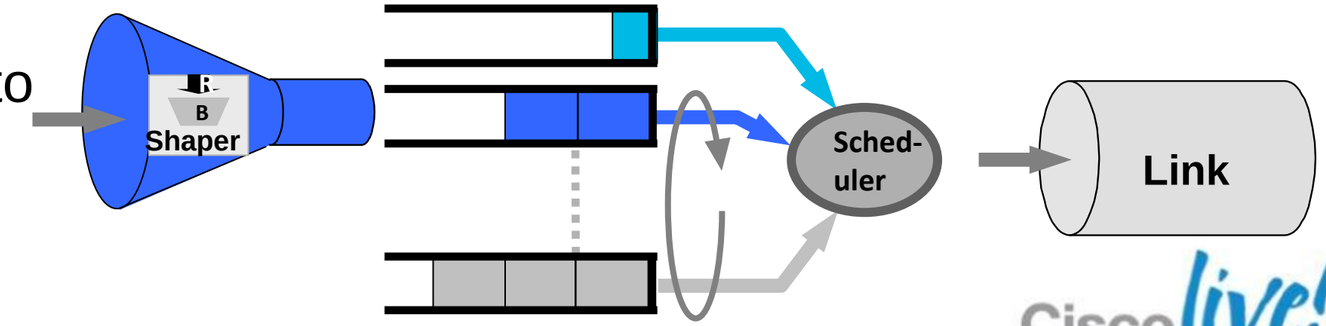
- Shapers can be applied in a number of ways, e.g. :
  - –To enforce a maximum rate across all traffic on a physical or logical interface



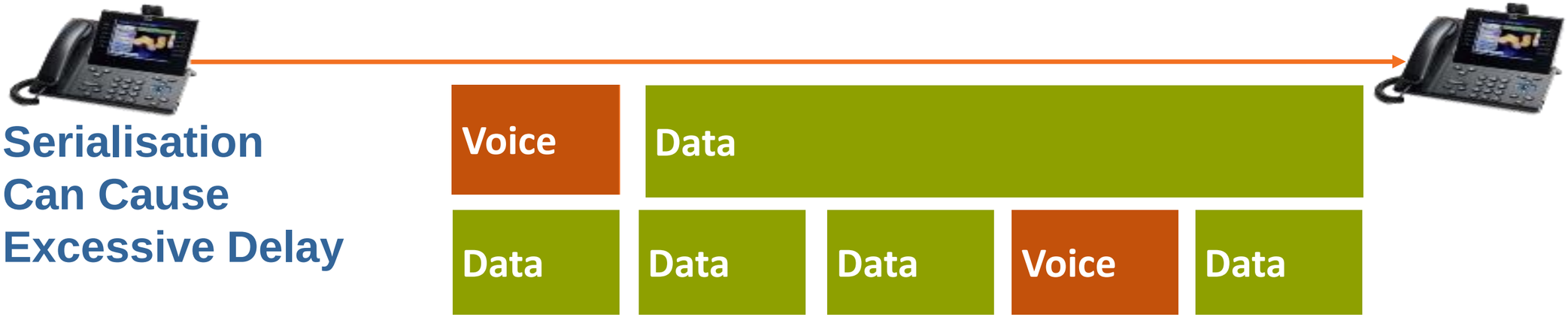
  - –To enforce a maximum rate across a number of traffic classes



  - –To enforce a maximum rate to an individual traffic class
  - – Hierarchical QoS



5. Link-Specific Operations- Compression and Link-Fragmentation / Interleaving

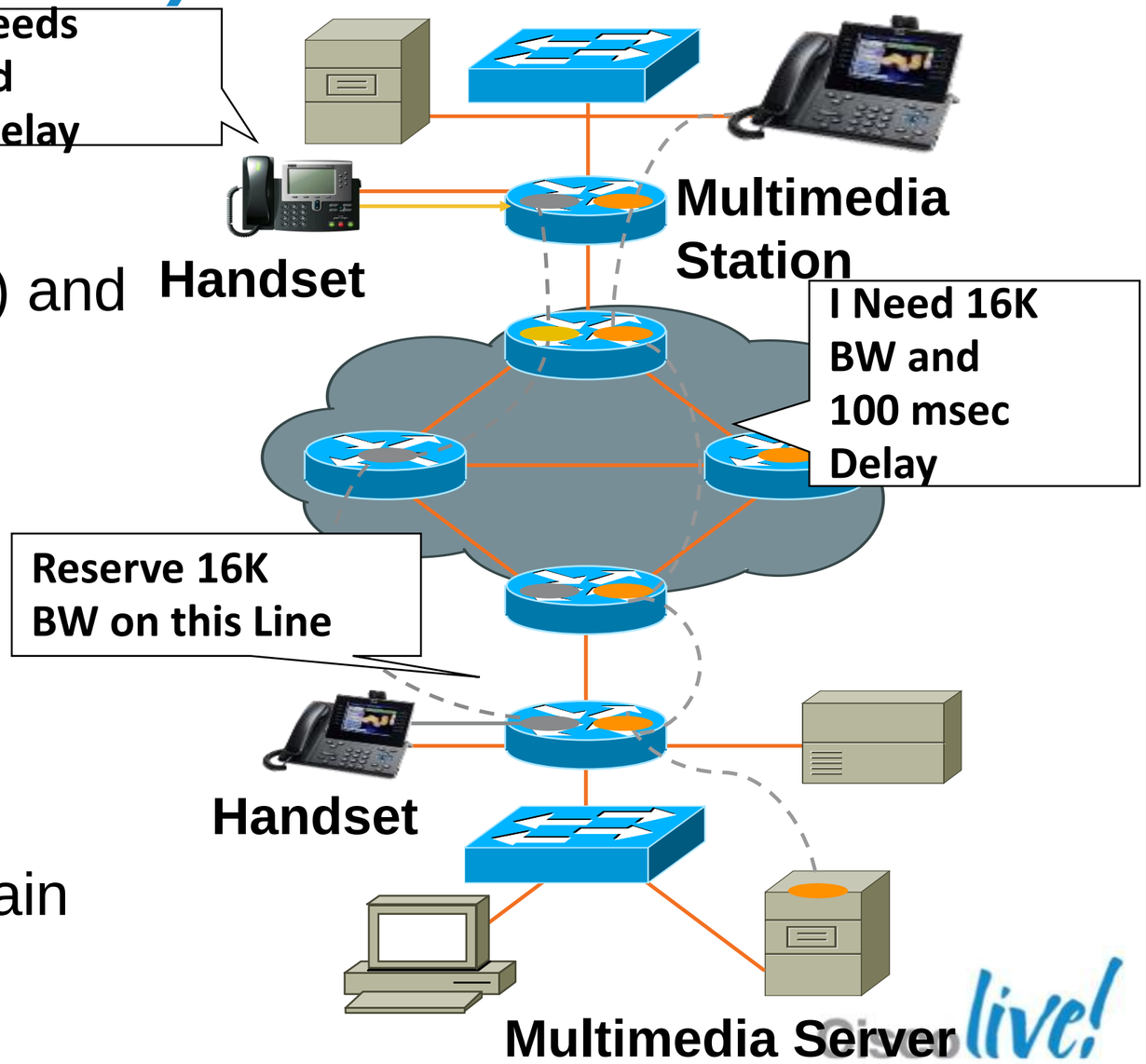


Serialisation Can Cause Excessive Delay

- **Fragmentation and Interleaving minimises Serialisation Delay**
  - Serialisation delay is the finite amount of time required to put frames on a wire
  - For links ≤ 768 kbps serialisation delay is a major factor affecting latency and jitter
  - For such slow links, large data packets need to be fragmented and interleaved with smaller, more urgent voice packets
- **Compression** – can reduce L3 VoIP BW by:
  - 20% with G.711 and 60% with G.729

Signalling and CAC – MediaNet Resource Reservation Protocol (RSVP)

- Protect Voice from Voice etc
- 3 Types – Gway, Probes (IPSLA) and RSVP.
- RSVP QoS services
  - Topology Aware CAC
  - Uses existing Routing Protocols
  - Dynamically adjusts to link and topology changes
- RSVP provides the policy to WFQ and LLQ to maintain Voice quality



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Campus QoS Design Considerations and Models

Campus Network Design

Infrastructure Services Required of the Campus

High Availability

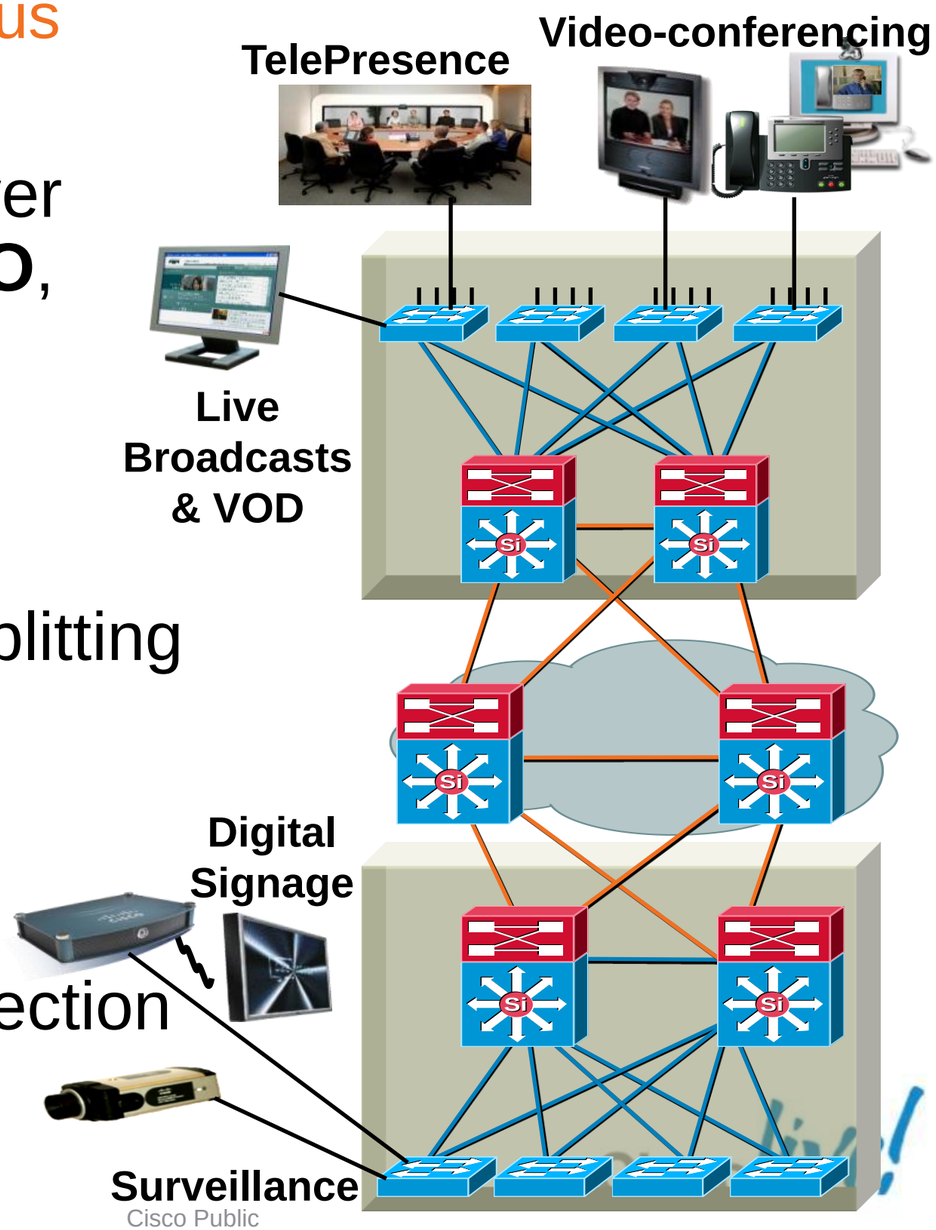
- Implement strategy for sub-second failover
- Implement HA architecture with **NSF/SSO**, **VSS**, VPC etc.

Latency and Bandwidth Optimisation

- **GigE** access
- **10GigE** distribution/core
- Implement **IP multicast** and/or stream splitting services

Confidentiality

- Authentication of endpoints and users (e.g. **802.1x**)
-Comply to security policies with data protection strategies,
-such as encryption (e.g. Cisco TrustSec)



Campus Network Design

Infrastructure Services Required of the Campus

Network Virtualisation

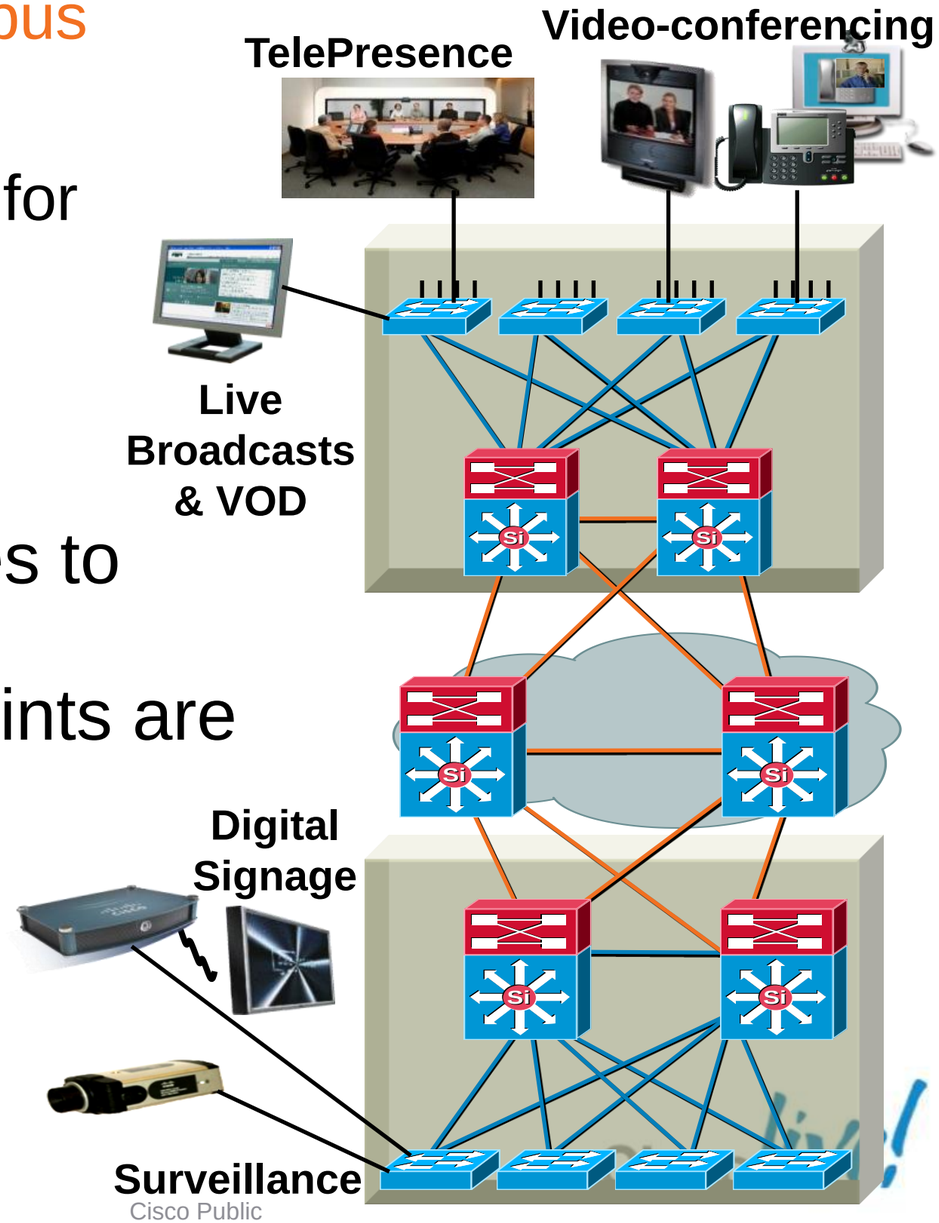
-Implement **VRF-Lite** (or other) Path Isolation for sensitive traffic

-video application segregation

Real-Time Application Delivery

- Implement granular **QoS** service policies to manage application service levels

- Access layer protection, ensures endpoints are fair consumers



Campus QoS Design

Strategic QoS Design Principles

- Always perform QoS in hardware rather than software when a choice exists (eg in Switches)
- Classify and mark applications as close to their sources as technically and administratively feasible
- Police unwanted traffic flows as close to their sources as possible (waste of resource)
- Enable queuing policies at every node where the potential for congestion exists (control Loss!)
- Have a QoS Policy Defined for your business

- http://www.cisco.com/en/US/docs/solutions/Enterprise/WAN_and_MAN/QoS_SRND_40/QoSCampus_40.html#wp1098008

Campus QoS Design

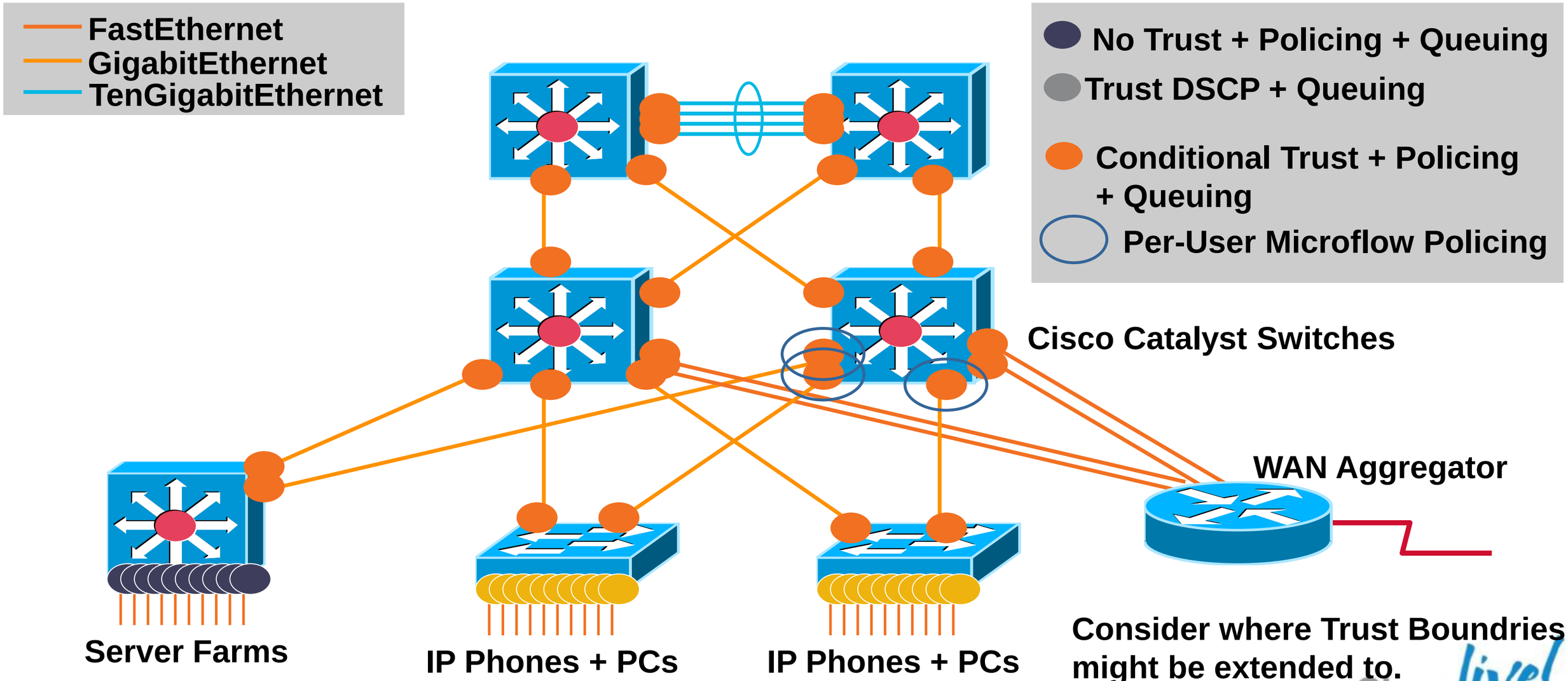
QoS Design Considerations

- Where is QoS Applied
- Internal DSCP
- Trust States and Operations
- Trust Boundaries
- Endpoint-Generated Traffic Classes
- AutoQoS

- http://www.cisco.com/en/US/docs/solutions/Enterprise/WAN_and_MAN/QoS_SRND_40/QoSCampus_40.html#wp1098008

Campus QoS Considerations

Where Is QoS Required Within the Campus?



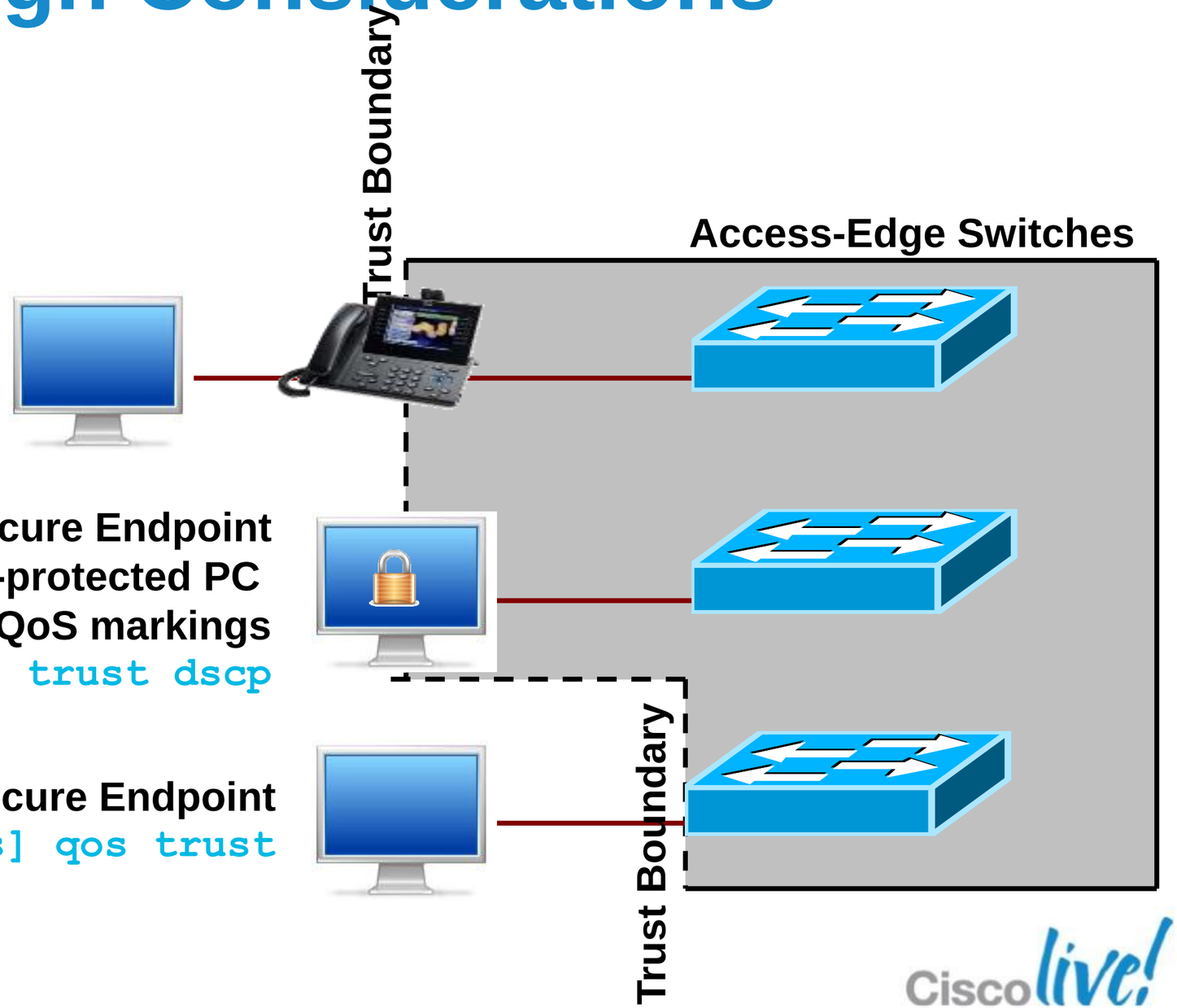
Campus QoS Design Considerations

Trust Boundaries

Conditionally Trusted Endpoints
Example: IP Phone + PC
`[mls] qos trust device cisco-phone`

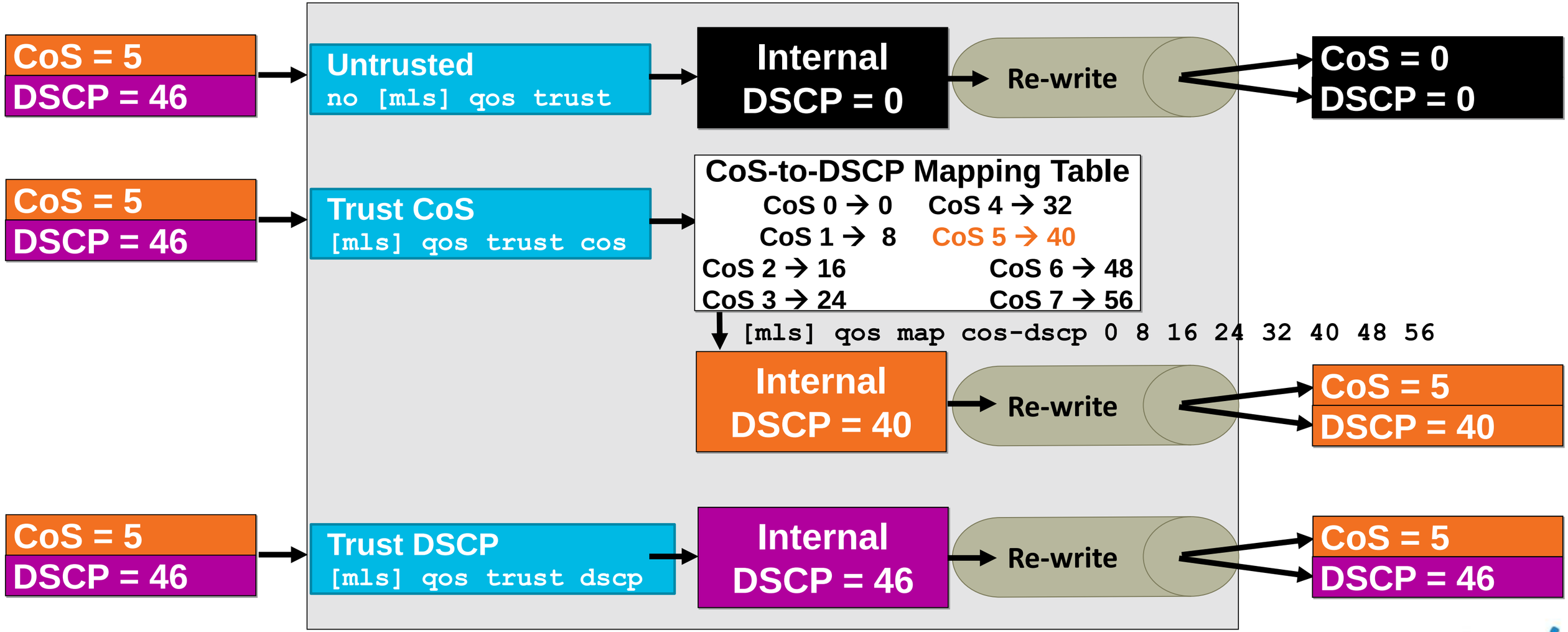
Secure Endpoint
Example: Software-protected PC
With centrally-administered QoS markings
`[mls] qos trust dscp`

Unsecure Endpoint
`no [mls] qos trust`



Campus QoS Design Considerations

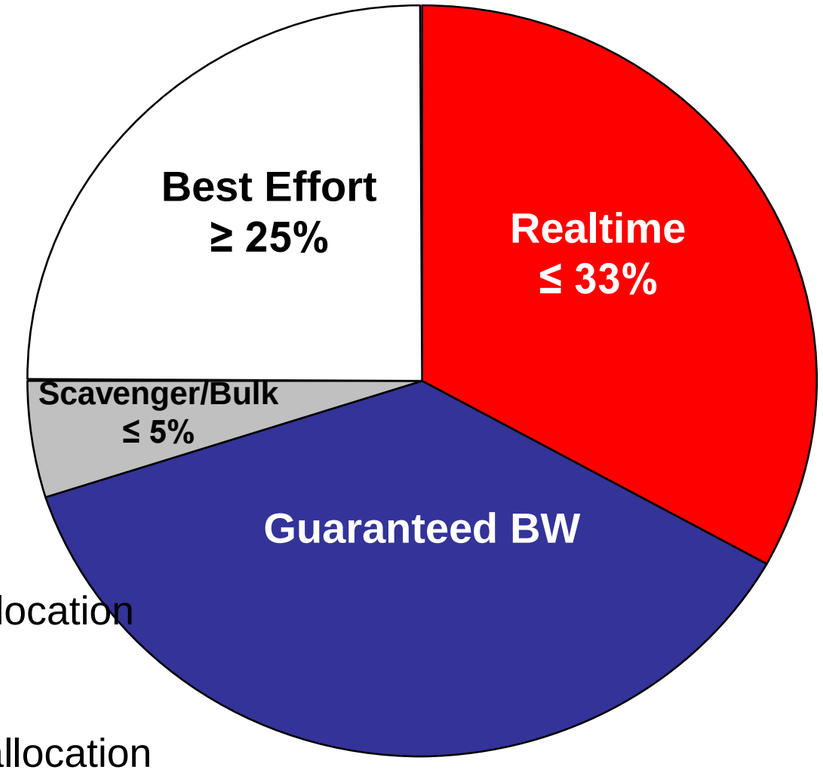
Internal DSCP Derivation by Trust Options



Campus Egress QoS Models

Queuing and Dropping and Buffer-Sizing Recommendations

- Catalyst Queuing is done in hardware and varies by platform/linecard and is expressed as: 1P*x*Q*y*T
  - Example: 1P3Q8T means: 1 PQ
  - 3 non-priority queues, each with
  - 8 drop-thresholds per queue
- Minimum queuing capabilities for medianet is 1P3QyT
- Realtime (PQ) should be less than 33% of link
- Best-Effort Queue should be guaranteed at 25% of link
- Scavenger/Bulk queue should be minimally provisioned
- WRED is preferred congestion-avoidance mechanism
- Buffers for BE and Guaranteed BW queues can be *directly* proportional to BW allocation
  - Example: 25% BW for BE Queue can be matched with 25% Buffer Allocation
- Buffers for PQ and Scavenger/Bulk Queue can be indirectly proportional to BW allocation
  - Examples: 30% BW for PQ can be complemented with 15% Buffer Allocation
  - 5% BW for Scavenger/Bulk queue can be complemented with 10%+ Buffer Allocation



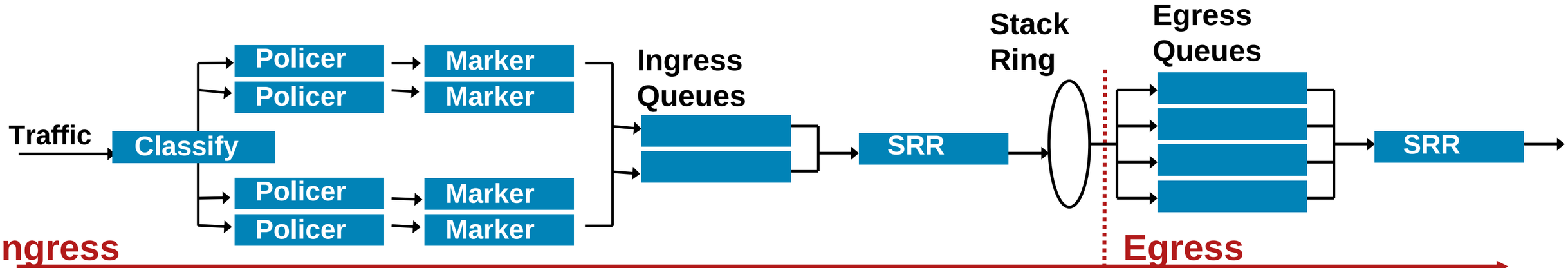
Campus QoS Design
Agenda

- Business and Technical Drivers for QoS Design Update
- Campus QoS Design Considerations and Models
- **Catalyst 2960/2975/3560/3750 G/E/X QoS Design**
- Catalyst 4500/4900 & 4500-E/4900M QoS Design (In Deck)
- Catalyst 6500/6500-E QoS Design (In Deck)

Catalyst 2960/2975/3560/3750 G/E/X QoS Design

Catalyst 2960/2975/3560/3750 G/E/X QoS Design

QoS Architecture



Classification	Policing	Marking	Ingress Queue/ Schedule Congestion Control	Egress Queue/ Schedule Congestion Control
• Inspect incoming packets • Based on ACLs or configuration, determine classification label	• Ensure conformance to a specified rate • On an aggregate or individual flow basis • Up to 256 policers per Port ASIC • Support for rate and burst	• Act on policer decision • Reclass or drop out-of-profile	• Two queues/port ASIC shared servicing • One queue is configurable for strict priority servicing • WTD for congestion control (three thresholds per queue) • SRR is performed	• Four SRR queues/port shared or shaped servicing • One queue is configurable for strict priority servicing • WTD for congestion control (three thresholds per queue) • Egress queue shaping • Egress port rate limiting

http://www.cisco.com/en/US/docs/solutions/Enterprise/WAN_and_MAN/QoS_SRND_40/QoSCampus_40.html#wp1098508

Catalyst 2960/2975/3560/3750 G/E/X QoS Design

Platform-Specific Considerations

- Traffic is classified on ingress, based on trust-states, access-lists, or class-maps.
- Because the total inbound bandwidth of all ports can exceed the bandwidth of the stack or internal ring, ingress queues are supported
- The Catalyst 2960 and 2975 can police to a minimum rate of 1 Mbps; all other platforms within this switch product family can police to a minimum rate of 8 kbps.
- The Catalyst 3560 and 3750 support multilayer switching and as such correspondingly support per-VLAN or per-port/per-VLAN policies.
- The Catalyst 3560 and 3750 support IPv6 QoS.
- The Catalyst 3560 and 3750 support policing on 10 Gigabit Ethernet interfaces.
- The Catalyst 2960/2975/3650/3750 support Shaped Round Robin (BW limits), Shared Round Robin (shares unused BW), as well as strict priority queue scheduling
- The Catalyst 3560-E/X and 3750-E/X support SRR shaping weights on 10 GE ints

Catalyst 2960/2975/3560/3750 G/E/X QoS Design

Enabling QoS and Trust Model Examples

Enabling QoS:

```
C3750-X(config)#mls qos          (I must, I must enable QoS!)
```

Verified with:

- **show mls qos**

Trust-CoS Model Example:

```
C3750-X(config)#mls qos map cos-dscp 0 8 16 24 32 46 48 56
! CoS 5 (the sixth CoS value, starting from 0) is mapped to 46
C3750-X(config)#interface GigabitEthernet 1/0/1
C3750-X(config-if)#mls qos trust cos
! The interface is set to statically trust CoS
```

Trust-DSCP Model Example:

```
C3750-X(config-if)#mls qos trust dscp
```

Conditional-Trust Model Example (can be combined with Trust-CoS/DSCP):

```
C3750-X(config-if)#mls qos trust device cisco-phone
```

Verified with:

- **show mls qos interface**
- **show mls qos map cos-dscp**

Catalyst 2960/2975/3560/3750 G/E/X QoS Design

Marking Model Example

```
C3750-E(config-cmap)# policy-map PER-PORT-MARKING
C3750-E(config-pmap)# class VVLAN-VOIP
C3750-E(config-pmap-c)# set dscp ef ! VoIP is marked EF

C3750-E(config-pmap-c)# class VVLAN-SIGNALING
C3750-E(config-pmap-c)#  set dscp cs3 ! Signaling (from the VVLAN) is marked CS3

C3750-E(config-pmap-c)# class MULTIMEDIA-CONFERENCING
C3750-E(config-pmap-c)#  set dscp af41 ! Multimedia-conferencing is marked AF41

C3750-E(config-pmap-c)# class SIGNALING
C3750-E(config-pmap-c)#  set dscp cs3 ! Signaling (from the DVLAN) is marked CS3

C3750-E(config-pmap-c)# class TRANSACTIONAL-DATA
C3750-E(config-pmap-c)#  set dscp af21 ! Transactional Data is marked AF21

C3750-E(config-pmap-c)# class BULK-DATA
C3750-E(config-pmap-c)#  set dscp af11 ! Bulk Data is marked AF11

C3750-E(config-pmap-c)# class SCAVENGER
C3750-E(config-pmap-c)#  set dscp cs1 ! Scavenger traffic is marked CS1

C3750-E(config-pmap-c)# class DEFAULT
C3750-E(config-pmap-c)#  set dscp default ! An explicit class-default marks all other IP traffic to
0
```

Catalyst 2960/2975/3560/3750 G/E/X QoS Design

Marking Model Example: Per-Port Application

```
C3750-E(config)#interface range GigabitEthernet 1/0/1-48
C3750-E(config-if-range)# switchport access vlan 10
C3750-E(config-if-range)# switchport voice vlan 110
C3750-E(config-if-range)# spanning-tree portfast
C3750-E(config-if-range)# mls qos trust device cisco-phone
! The interface is set to conditionally-trust Cisco IP Phones
C3750-E(config-if-range)# mls qos trust cos
! CoS-trust will be dynamically extended to Cisco IP Phones
C3750-E(config-if-range)# service-policy input PER-PORT-MARKING
! Attaches the Per-Port Marking policy to the interface(s)
```

Verified with:

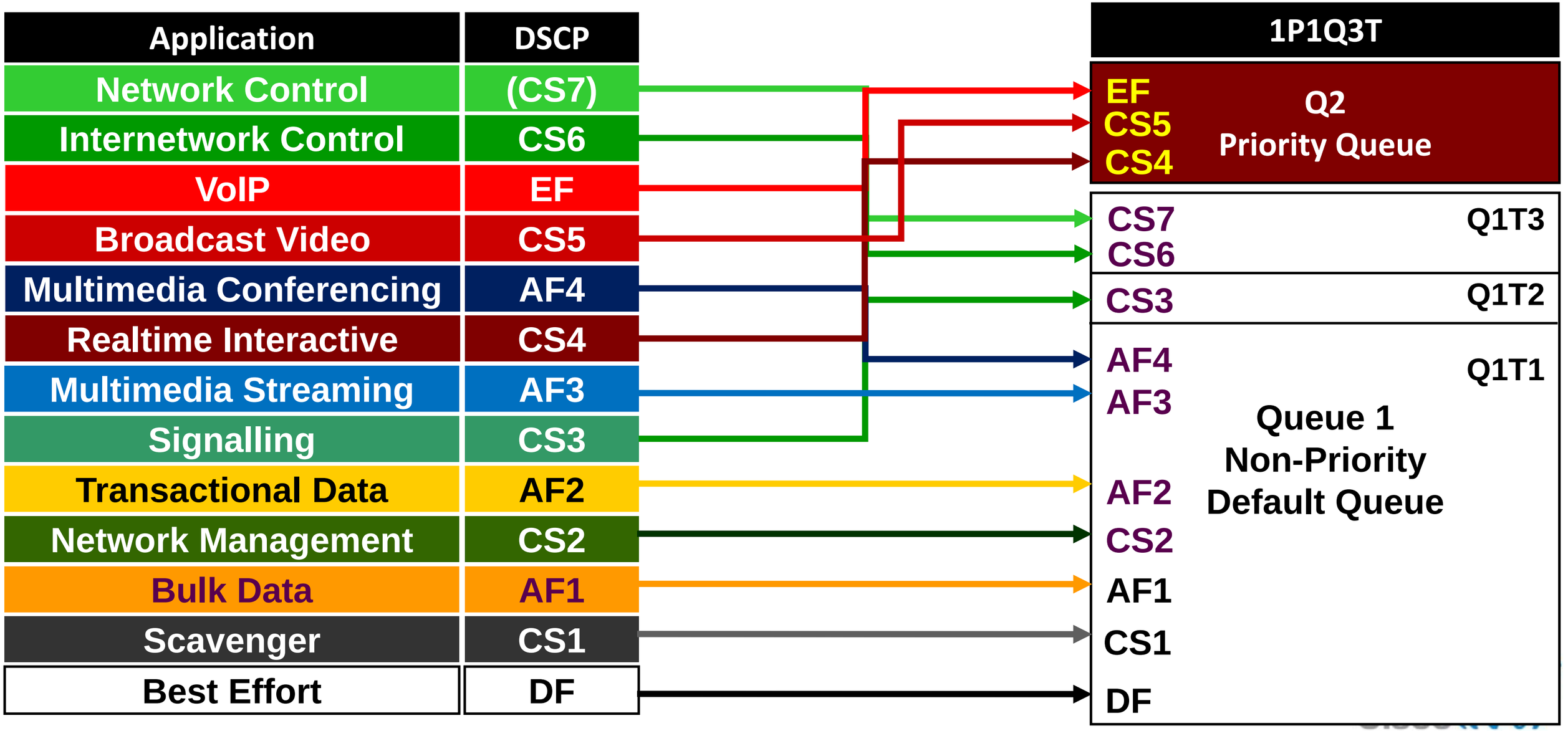
- show mls qos interface
- show class-map
- show policy-map
- show policy-map interface

Note: While the Catalyst 3750-E MQC syntax includes an implicit class-default, any policy actions assigned to this class are not enforced. Therefore, an explicit class DEFAULT is configured in the above example to enforce a marking/remarking policy to DSCP 0 for all other IP traffic.

Note: An explicit marking command (**set dscp**) is used even for trusted application classes (like VVLAN-VOIP and VVLAN-SIGNALING) rather than a **trust** policy-map action. The use of an explicit (but seemingly redundant) explicit marking command actually improves the policy efficiency from a hardware perspective.

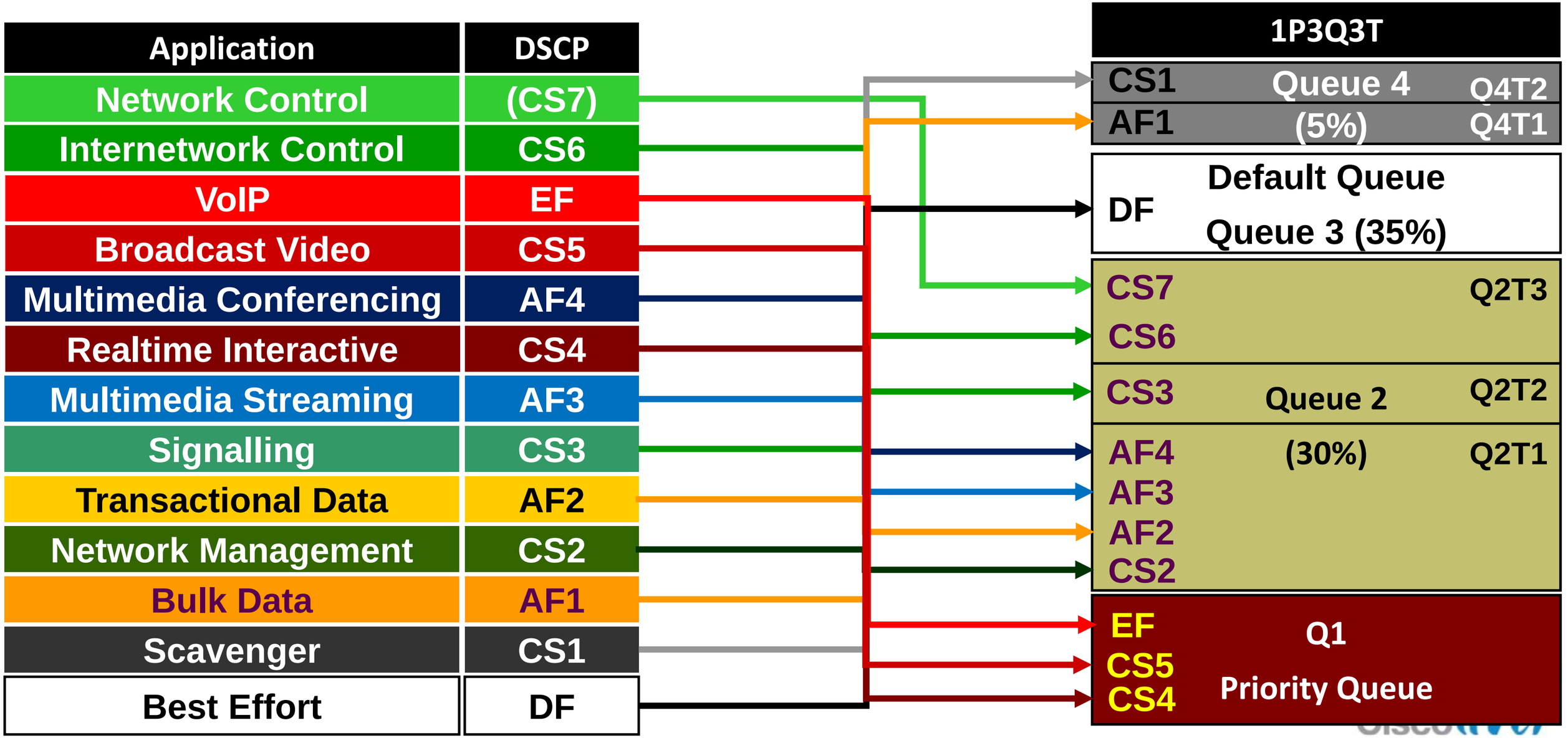
Catalyst 2960/2975/3560/3750 G/E/X QoS Design

1P1Q3T Ingress Queuing Model



Catalyst 2960/2975/3560/3750 G/E/X QoS Design

1P3Q3T Egress Queuing Model



Campus QoS Design
Agenda

- Business and Technical Drivers for QoS Design Update
- Components of QoS
- Campus QoS Design Considerations and Models
- Catalyst 2960/2975/3560/3750 G/E/X QoS Design
- **Catalyst 2960/2975/3560/3750 G/E/X AutoQoS**
- WAN and Branch QoS Design

Catalyst 2960/2975/3560/3750 G/E/X AutoQoS

AutoQoS

- Simplifies the deployment of QoS Policies
- Uses a set of Standard configurations that can be modified
- Currently all switch platforms support AutoQoS-VoIP
  - –Best practice QoS designs for IP Telephony deployments
- Catalyst 2K/3K now supports AutoQoS for Medianet
  - –AutoQoS SRND4
  - –Supports not only IP Phones, but also TelePresence & IPVS cameras
  - –Autoprovisions ingress trust, classification, marking & policing
  - –Autoprovisions ingress queuing (as applicable)
  - –Autoprovisions egress queuing

http://www.cisco.com/en/US/docs/solutions/Enterprise/WAN_and_MAN/QoS_SRND_40/QoSCampus_40.html#wp1098289

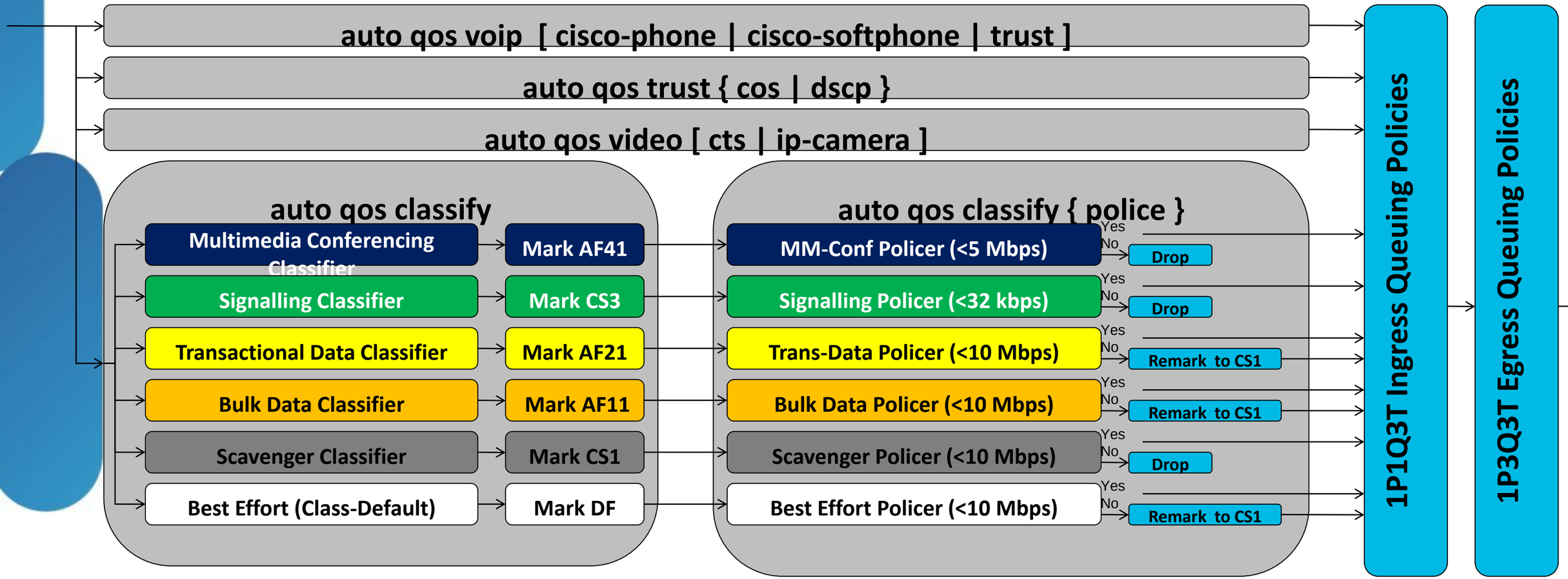
Catalyst 2960/2975/3560/3750 G/E/X/S QoS Design

AutoQoS for Medianet

- QoS auto-configuration for 12 application classes
  - RFC 4594-based
- Ingress trust (static or conditional)
  - Includes policers for best effort to prevent misuse
- Ingress & Egress Buffer & Threshold configuration
  - Includes modifications from existing AutoQoS-VoIP to new
- Ingress & Egress CoS- & DSCP-to-Queue Mappings
  - Includes modifications from existing AutoQoS-VoIP to new
- Feature will include a method to retain legacy Auto-QoS (AutoQoS-VoIP) configuration
  - An upgrade will not force a configuration change
- Released in 12.2(55)SE (since 2010)

Catalyst 2960/2975/3560/3750 G/E/X QoS Design

AutoQoS SRND4 Models



http://www.cisco.com/en/US/docs/solutions/Enterprise/WAN_and_MAN/QoS_SRND_40/QoSCampus_40.html#wp1144082

Catalyst 2960/2975/3560/3750 G/E/X QoS Design

AutoQoS SRND4 – auto qos voip cisco-phone

```
C3750-X(config-if)#auto qos voip cisco-phone
```

Class-maps omitted for brevity

```
! This section defines the AutoQoS-VoIP-Cisco-Phone (SRND4) Policy-Map
policy-map AUTOQOS-SRND4-CISCOPHONE-POLICY
 class AUTOQOS_VOIP_DATA_CLASS
  set dscp ef
  police 128000 8000 exceed-action policed-dscp-transmit
  ! Voice is marked to DSCP EF and policed (to remark) if exceeding 128 kbps
 class AUTOQOS_VOIP_SIGNAL_CLASS
  set dscp cs3
  police 32000 8000 exceed-action policed-dscp-transmit
  ! Signaling is marked to DSCP CS3 and policed (to remark) if exceeding 32 kbps
 class AUTOQOS_DEFAULT_CLASS
  set dscp default
  police 10000000 8000 exceed-action policed-dscp-transmit
  ! An explicit default class marks all other IP traffic to DF
  ! and polices all other IP traffic to remark (to CS1) at 10 Mbps
!
```

http://www.cisco.com/en/US/docs/solutions/Enterprise/WAN_and_MAN/QoS_SRND_40/QoSCampus_40.html#wp1144685

Additional AutoQoS Links

- AutoQoS 1P1Q3T Ingress Queuing Policies
  - –http://www.cisco.com/en/US/docs/solutions/Enterprise/WAN_and_MAN/QoS_SRND_40/QoSCampus_40.html#wp1144932
- AutoQoS Egress 1P3Q3T Queuing Policies
  - –http://www.cisco.com/en/US/docs/solutions/Enterprise/WAN_and_MAN/QoS_SRND_40/QoSCampus_40.html#wp1144981
- AutoQoS on EtherChannel
  - –http://www.cisco.com/en/US/docs/solutions/Enterprise/WAN_and_MAN/QoS_SRND_40/QoSCampus_40.html#wp1145082
- Removing AutoQoS
  - –http://www.cisco.com/en/US/docs/solutions/Enterprise/WAN_and_MAN/QoS_SRND_40/QoSCampus_40.html#wp1145119
- AutoQoS At-A-Glance
  - –http://www.cisco.com/en/US/docs/solutions/Enterprise/Video/autoqosmediacampus.pdf

Catalyst 4500/4900 & 4500-E/4900M QoS Design

Catalyst 6500/6500-E QoS Design

Campus QoS Design

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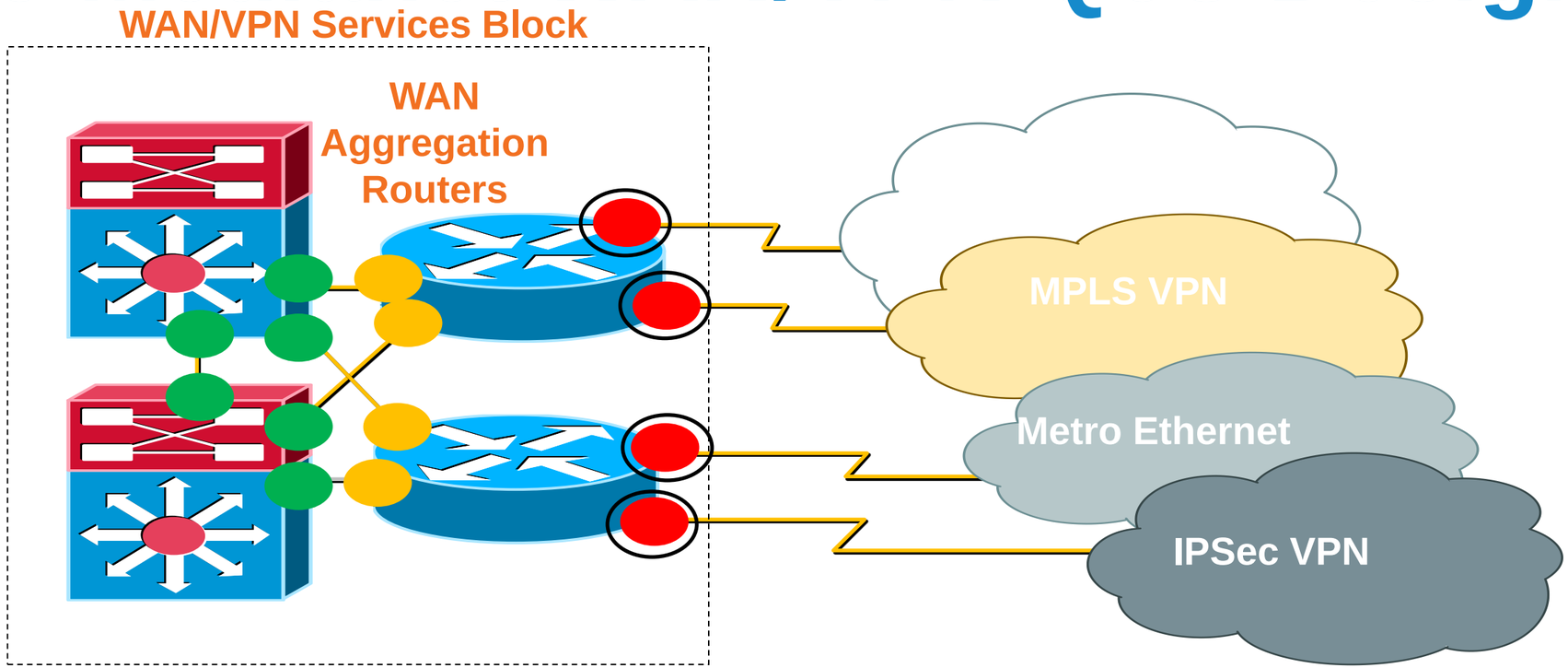
- **WAN and Branch QoS Design**

WAN and Branch QoS Design

Cisco Medianet WAN/VPN QoS Design



Switch Port to Switch Port or Router Interface:

- Trust-DSCP
- 1P3Q*y*T or 1P7Q*y*T Queuing

WAN/VPN Edge Router Interface:

- No Trust (IOS default)
- LLQ/CBWFQ policies
- Additional VPN-specific QoS policies (as required)

Router Interface to Switch Port :

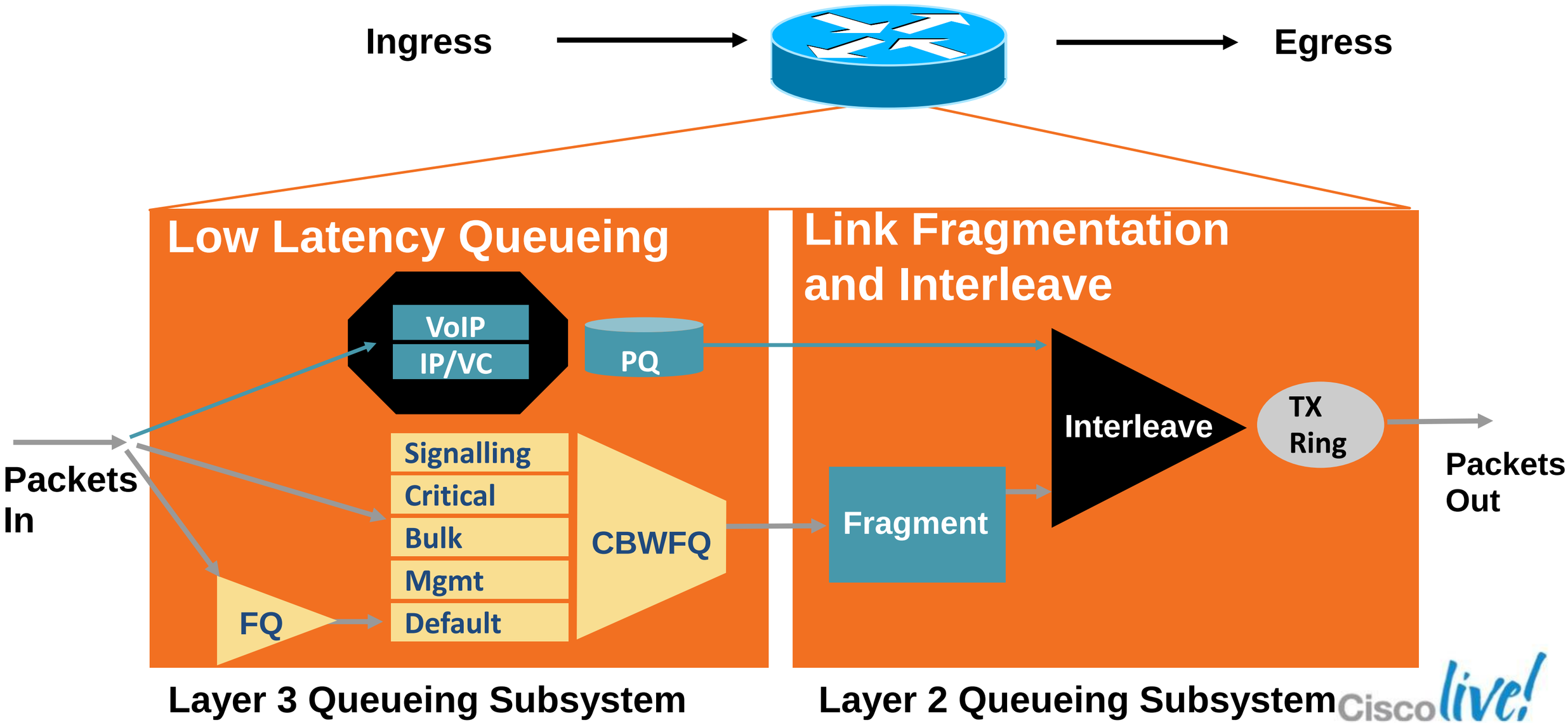
- No Trust (IOS Default)
- (Optional) LLQ/CBWFQ policies (only if potential for congestion exists in WAN-to-LAN direction)

RSVP-Enabled WAN/VPN Edge Router Interface

+ RSVP policies

+ (Optional) Application ID RSVP policies

Scheduling Tools - LLQ/CBWFQ Subsystems

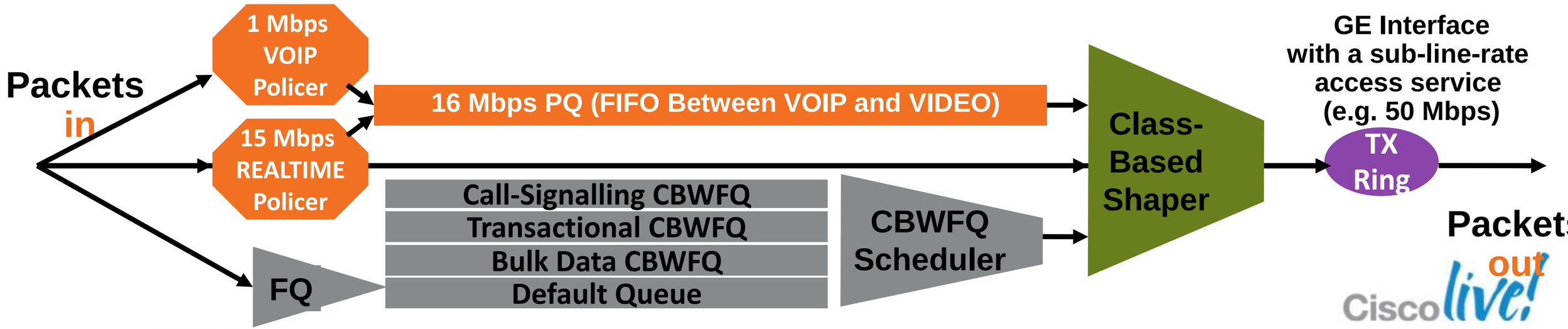


WAN/VPN QoS Mechanisms and Operation

Hierarchical QoS (Queuing & Shaping) Operation

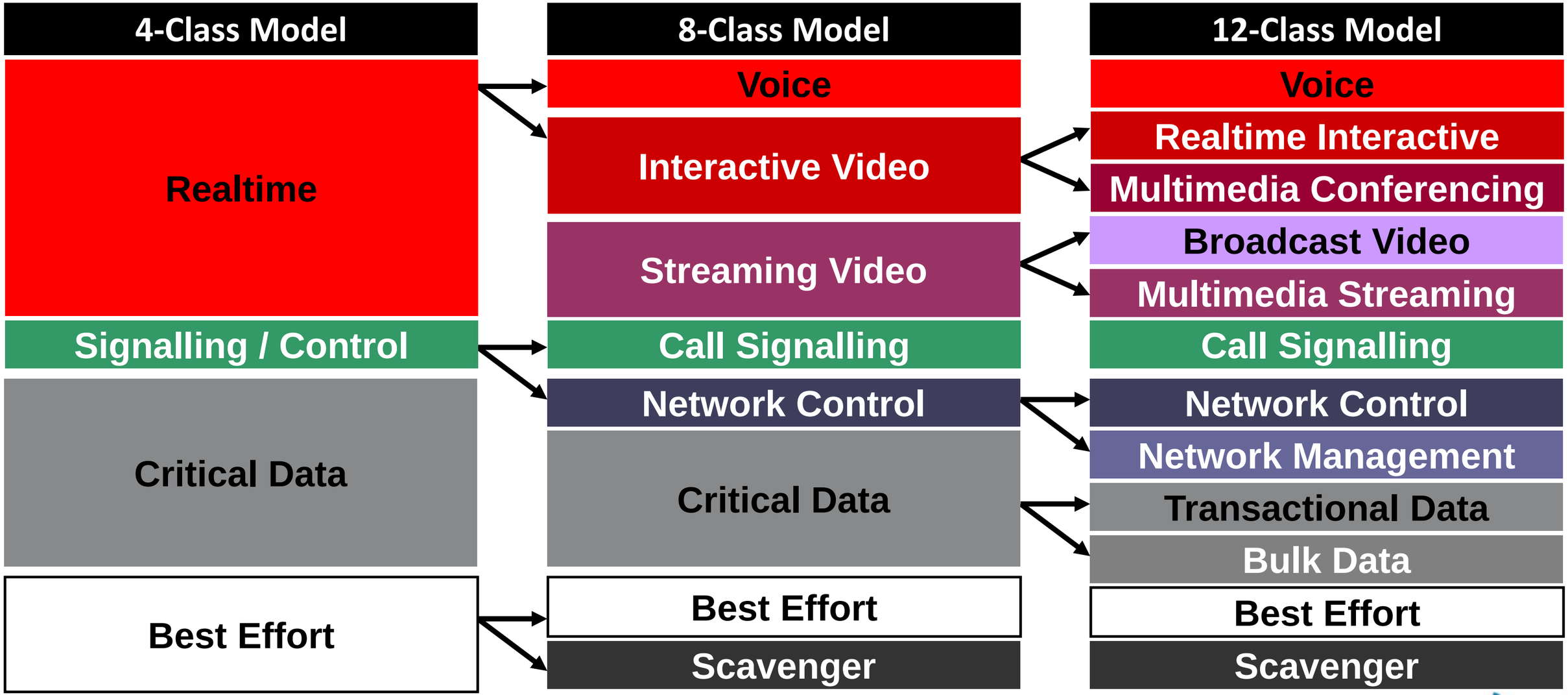
```
policy-map ACCESS-EDGE
 class VOIP
  priority 1000
 class REALTIME
  priority 15000
 class CALL-SIGNALING
  bandwidth x
 class TRANSACTIONAL
  bandwidth y
 class BULK-DATA
  bandwidth z
 class class-default
  fair-queue
```

- Queuing policies *will not* engage unless the interface is congested
- A shaper will guarantee that traffic will not exceed the contracted rate
- Traffic sharing the Priority Queue is Services on FIFO basis



Cisco Medianet WAN & Branch Design

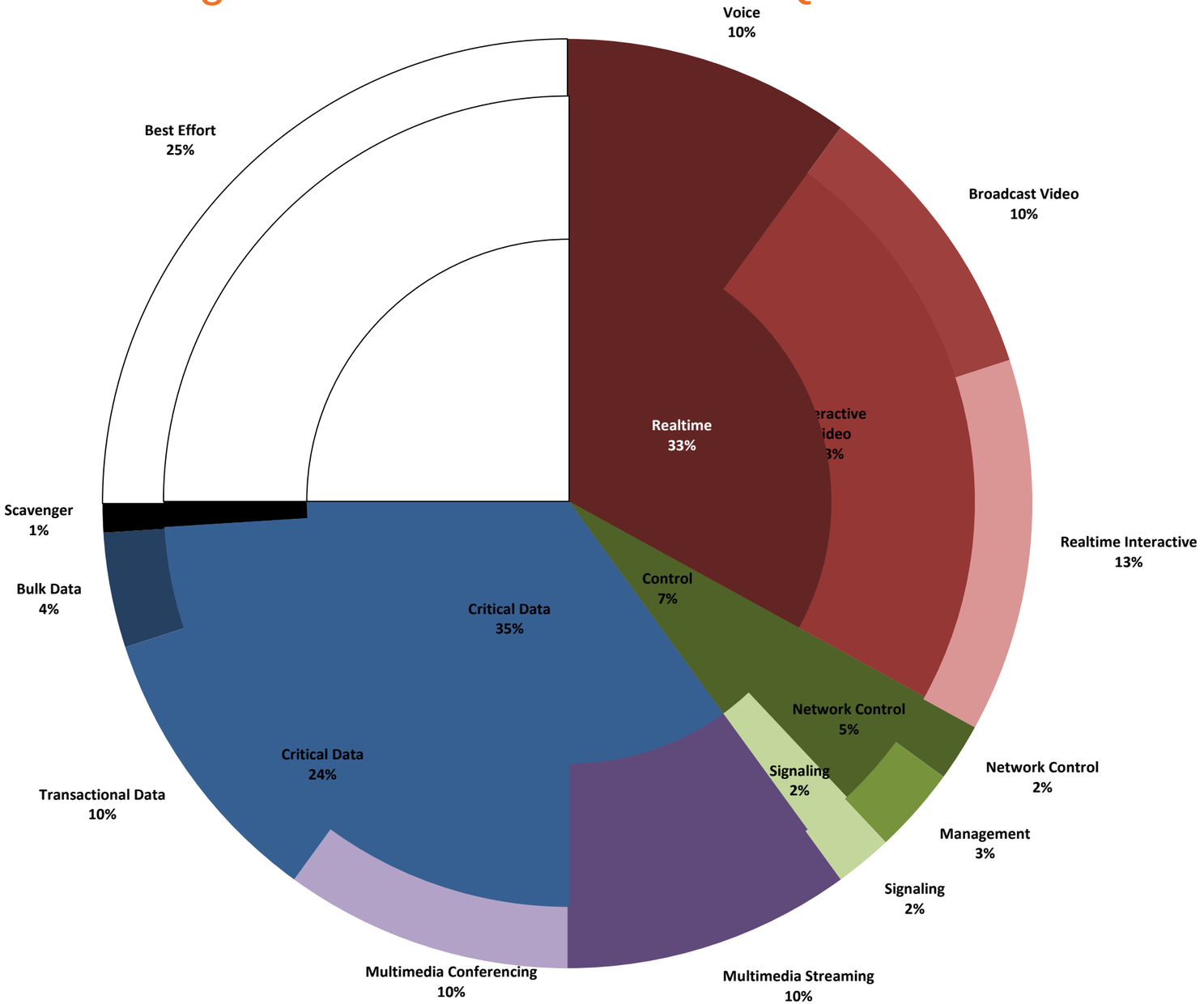
WAN Edge Models Are Not Restricted By Hardware Queues



http://www.cisco.com/en/US/docs/solutions/Enterprise/WAN_and_MAN/QoS_SRND_40/QoSIntro_40.html#wp61135

Cisco Medianet WAN & Branch Design

RFC 4594-Based WAN Edge Models – No Hardware Q Restriction



Modular QoS and the Hierarchical Queuing Framework (HQF)

1. Traffic classification
   - "class-map"
   - identify traffic and assign to classes
2. Define the Policy
   - "policy-map"
   - Assign classes to a policy
   - Define the Treatment for each class
3. Attach the Policy to a logical/physical interface
   - "service-policy"
   - The point of application of a QOS policy

```
class-map match-any VOICE_CLASS
  match ip dscp 40
  match access-group 100
class-map match-any BUS
  match access-group 101
class-map match-all CTRL
  match access-group 103
  match access-group 104
!
policy-map QOS_POLICY
  class VOICE_CLASS
    priority
    police 64000
  class BUS
    bandwidth remaining percent 90
!
interface Gi 0/0
 ip address 192.168.2.2 255.255.255.0
 service-policy output QOS_POLICY
```

Campus QoS Design

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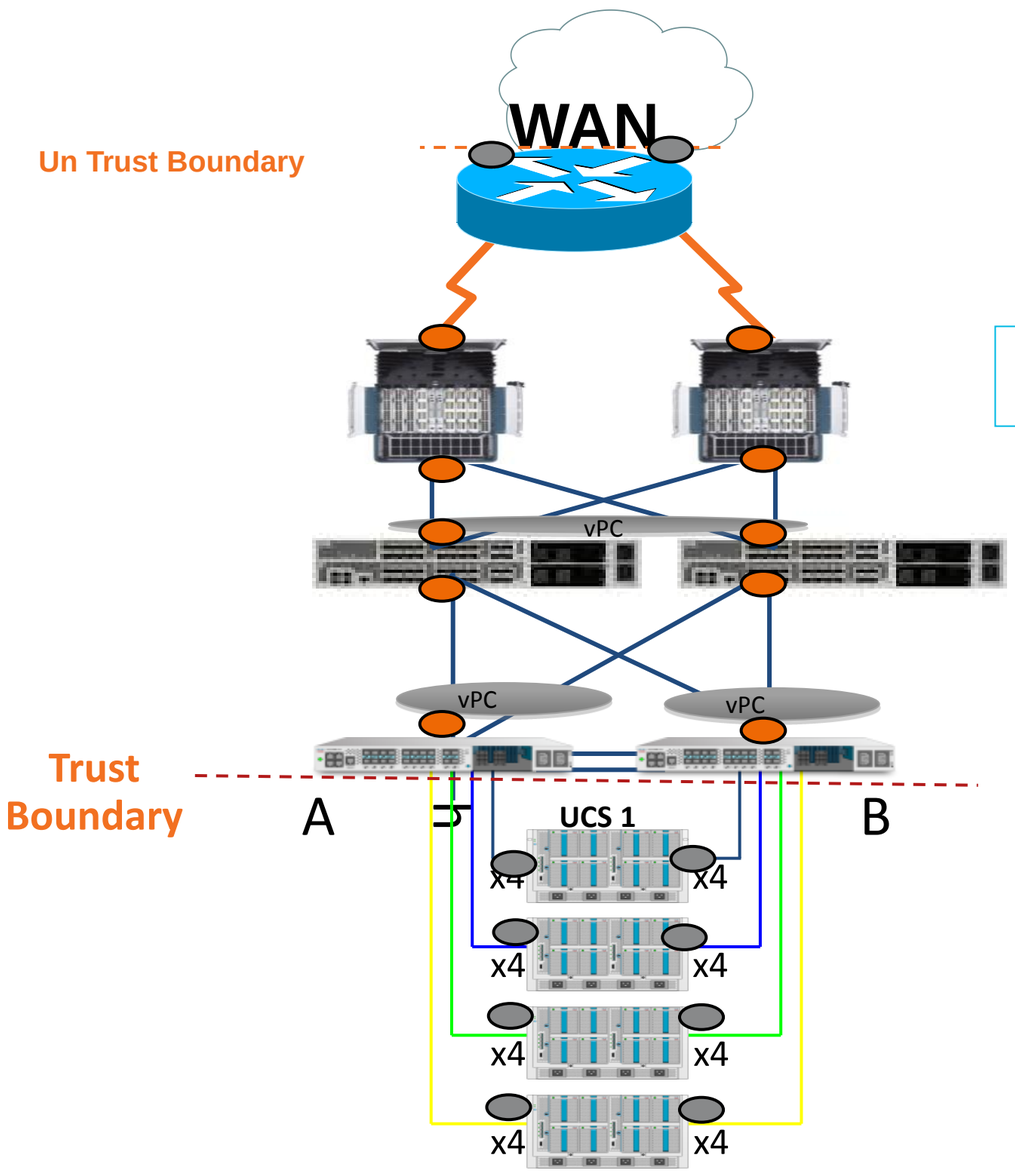
- **What about DC, Wireless and other areas where QoS is important?**

Comment on DC QoS

The Requirements for QoS are the Same

- Nexus 1000V provides traffic classification, marking and policing at the edge
- Nexus 7000/5000 have some hardware dependencies and provide ingress and egress classification, marking, mutations (Cos – DSCP Maps)
- Consider requirements for FC where UCS and FEX are deployed
- Are built to support FCoE requirements
- Understanding of Oversubscription Ratios is critical eg iSCSI and FC deployments
- High performance QoS implementation, all done in hardware
- Hardware supports up to 8 queues per physical interface
- Priority Queue support

End-to-end QoS



QOS Classification & Marking:

Classify and mark traffic at the compute and WAN edge layer .

QOS Trust

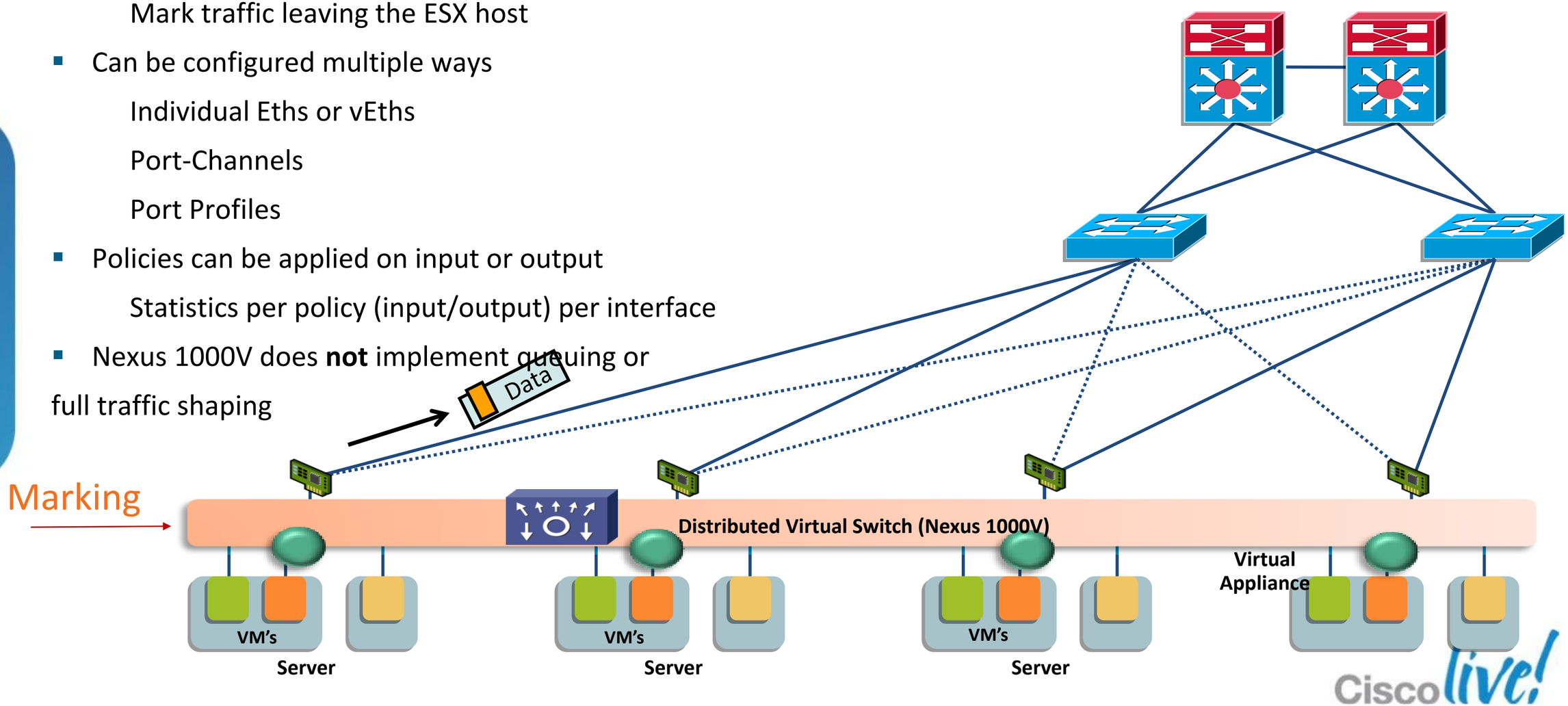
Subsequent points in the network can now “trust” the marked values and queue.

QOS queuing and BW guarantee:

Bandwidth based DWRR queuing on uplinks

QoS Marking At Compute Layer

- Nexus 1000V provides traffic classification, marking and policing
  - Police traffic to/from VMs
  - Mark traffic leaving the ESX host
- Can be configured multiple ways
  - Individual Eths or vEths
  - Port-Channels
  - Port Profiles
- Policies can be applied on input or output
  - Statistics per policy (input/output) per interface
- Nexus 1000V does **not** implement queuing or full traffic shaping



Wireless QoS and Visibility and Control of Applications

Wireless Integration

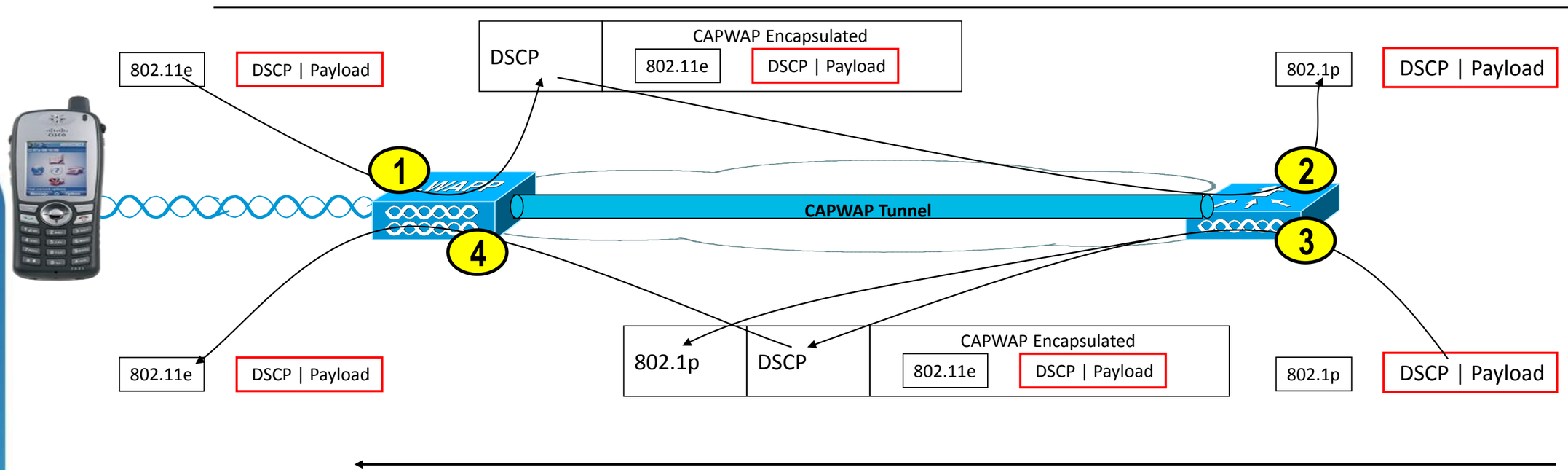
Considerations:

- Location of the WLC (Wireless LAN Controller)
- Distributed WLC terminates CAPWAP tunnel locally and allows granular marking of traffic toward WAN
- CAPWAP tunnel provides DSCP based marking in header
- WMM (Wireless Multimedia) does not mark data applications
- Data applications can be marked on wired side and continue to WAN

Approach:

- WMM and CAC (Call Admission Control) used on controller
- Access switch will trust marking from AP (controller based marking)
- Switch port attached to Controller will be marked with custom policy
- WLC is used to mark WMM based traffic, all other traffic will be marked BE

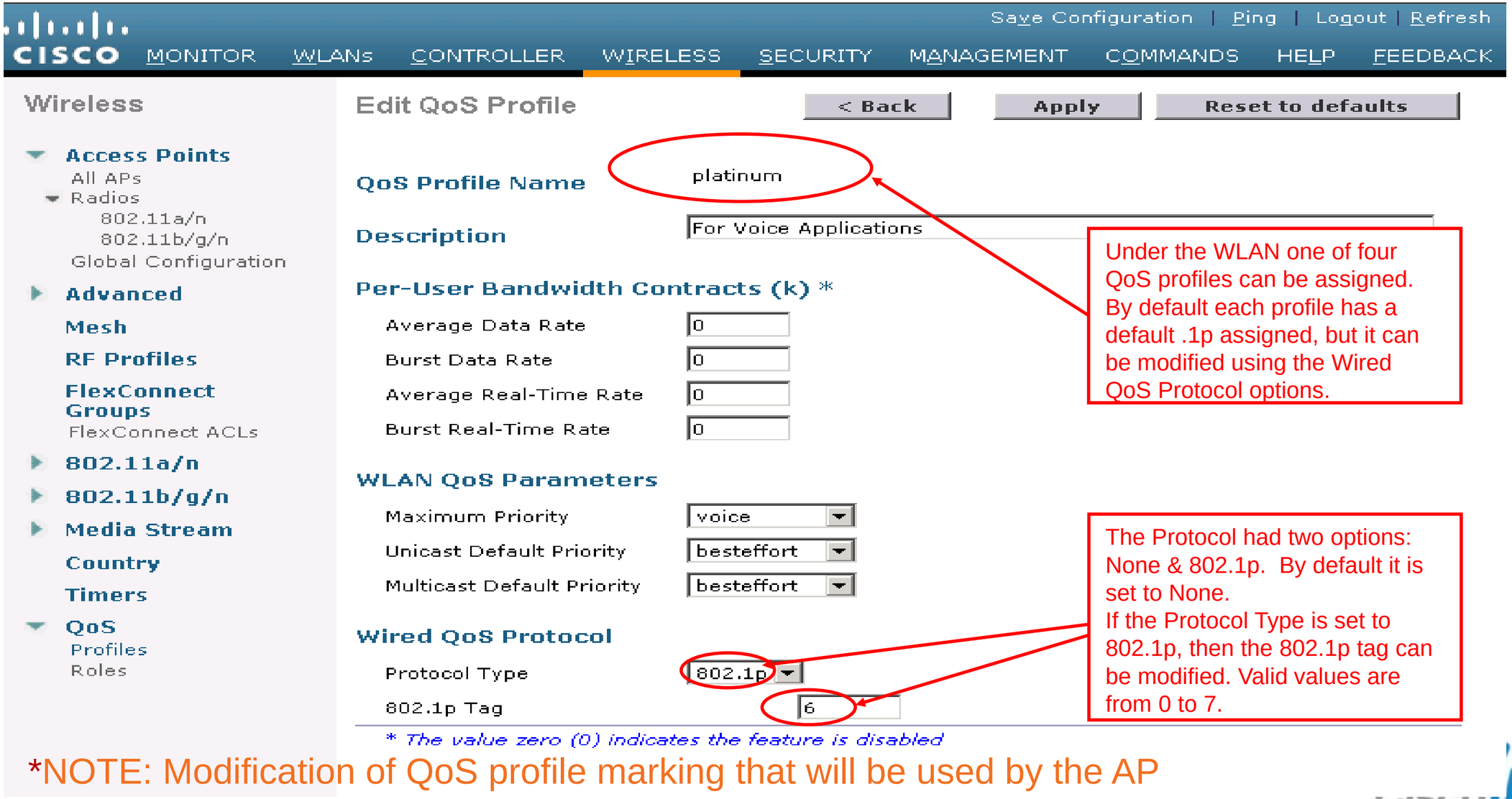
WLAN QoS mapping



1. Upper value of mapped DSCP constrained automatically based on WLAN QoS Profile
2. Upper value of mapped 802.1p value constrained by “Wired QoS Protocol” setting
3. Upper value of mapped 802.1p value constrained by “Wired QoS Protocol” setting
   DSCP directly mapped from arriving packet DSCP
4. Upper value of mapped 802.11e UP constrained automatically by WLAN QoS profile

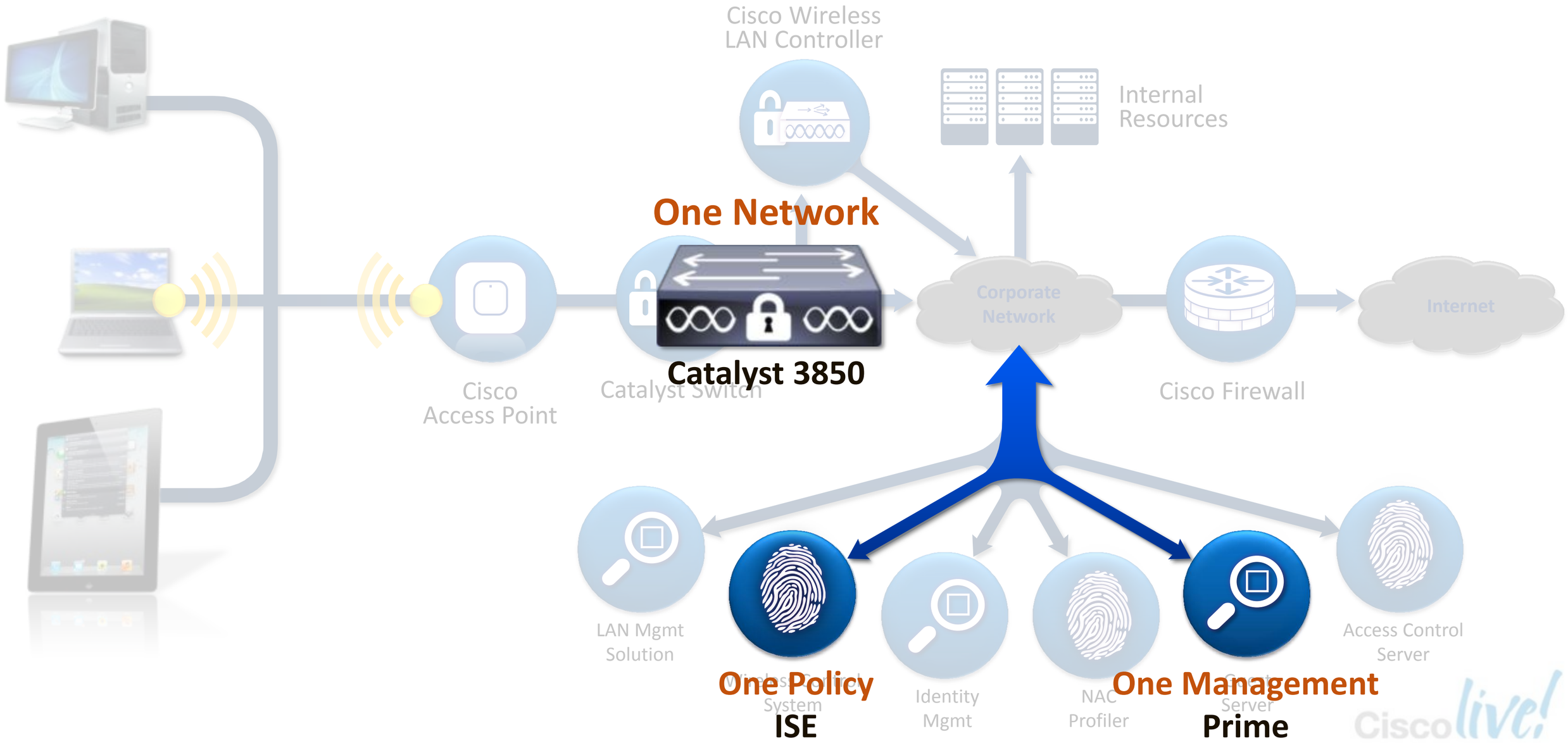
How is QoS enabled?

Wireless



*NOTE: Modification of QoS profile marking that will be used by the AP

Converged Access with the Cat 3850



Quality of Service on the 3850 for wired/wireless

- Alignment with 4500E series
- Class-based Queuing, Policing, Shaping, Marking

New QoS features

- Hierarchical Bandwidth Management (HBM) - Per AP-Radio-SSID-Client upstream and downstream
- Approximate Fair Drop (AFD) – Fair sharing of bandwidth
- Per-user-per-application-level policing and marking in SW roadmap

QoS Capabilities

- Queues/port for Wired traffic : 8 (Up to 2P6Q3T queuing capabilities)
- Queues/port for Wireless traffic : 4
- Buffers - 12 MB/48 port model
- 2000 Aggregate & 48k Microflow Policers

Application Visibility and Control

Today's network needs to be aware of applications

Gain visibility into applications running in the network, performance trend, and user experiences

Intelligently prioritise and control application traffic to maximise user experience

Application and Network Visibility

Application-aware Control

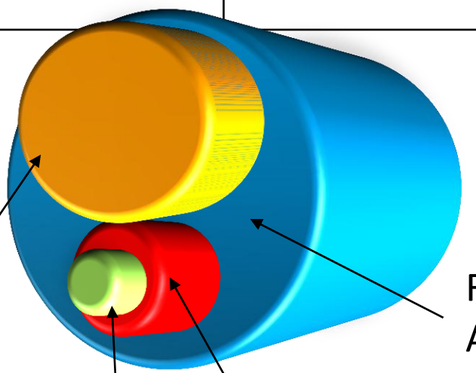
Application Aware QoS

IOS XE 3.4 S
15.2(2)T

Update to Wan policy for Browsing traffic

```
class-map match-any browsing
        match protocol attribute category browsing

class-map match-any Business-browsing
        match protocol http url “*myserver.com*”
        match protocol http url “*salesforce.com*”

policy-map Business-browsing-policy
        class Business-browsing
                bandwidth remaining percent 80
                set dscp af 21
        class class-default
                bandwidth remaining percent 20
                set dscp default

policy-map wan_remaining%
<snip>
        class Business
                 bandwidth remaining percent 11
                queue-limit 250
        class browsing
                bandwidth remaining percent 5
                service-policy Business-browsing-policy
        class class-default
                 bandwidth remaining percent 24
                 queue-limit 400

interface Gig X/Y
        service-policy output wan_remaining%
```

Application	BW	Priority
Browsing	5% (Remaining BW)	N/A
Business Browsing	80% (Out of Browsing)	Business
Other Browsing	20% (Out of Browsing)	Default



Class-Default:
Low Priority
25% committed

Business-Browsing:
80% of all Browsing

Browsing:
5% BW

Remaining
Allocations are
shown in original
policy

***Remove 4% from Business and 1% from class-default based on remarking**

References and Key Takeaways

Campus QoS Design for Medianet

References

- **Cisco Business Video Solutions**
  http://www.cisco.com/en/US/netsol/ns813/networking_solutions_solution_segment_home.html
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Why Do We Need QoS?

- QoS is necessary where ever there is the possibility of congestion
- Explosion of video and rich-media applications are requiring a re-engineering of network QoS policies
- Cisco has a RFC 4595-based SRND for end-to-end QoS strategy for Cross Platform Medianet

Q & A

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