



You make **possible**



Webex Bandwidth Management

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CISCO *Live!*

Barcelona | January 27-31, 2020



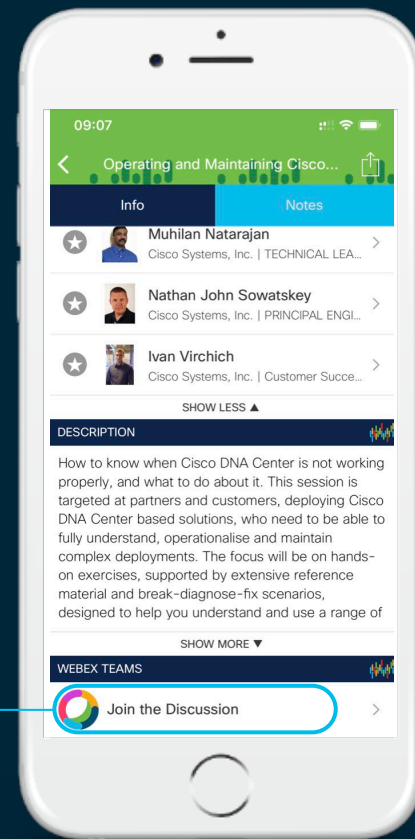
Cisco Webex Teams

Questions?

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

How

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

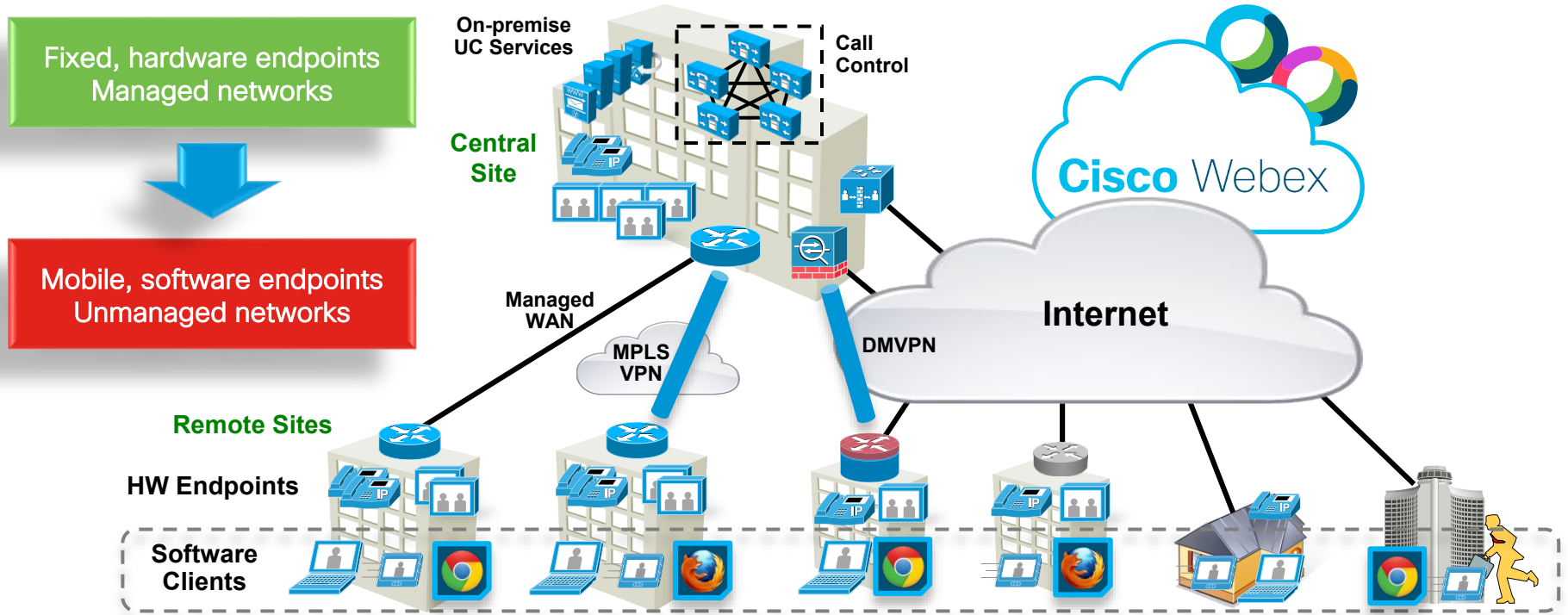


Agenda

- Introduction
- QoS Strategy Overview
- QoS Marking for Webex Media
- Bandwidth Provisioning for Webex Media

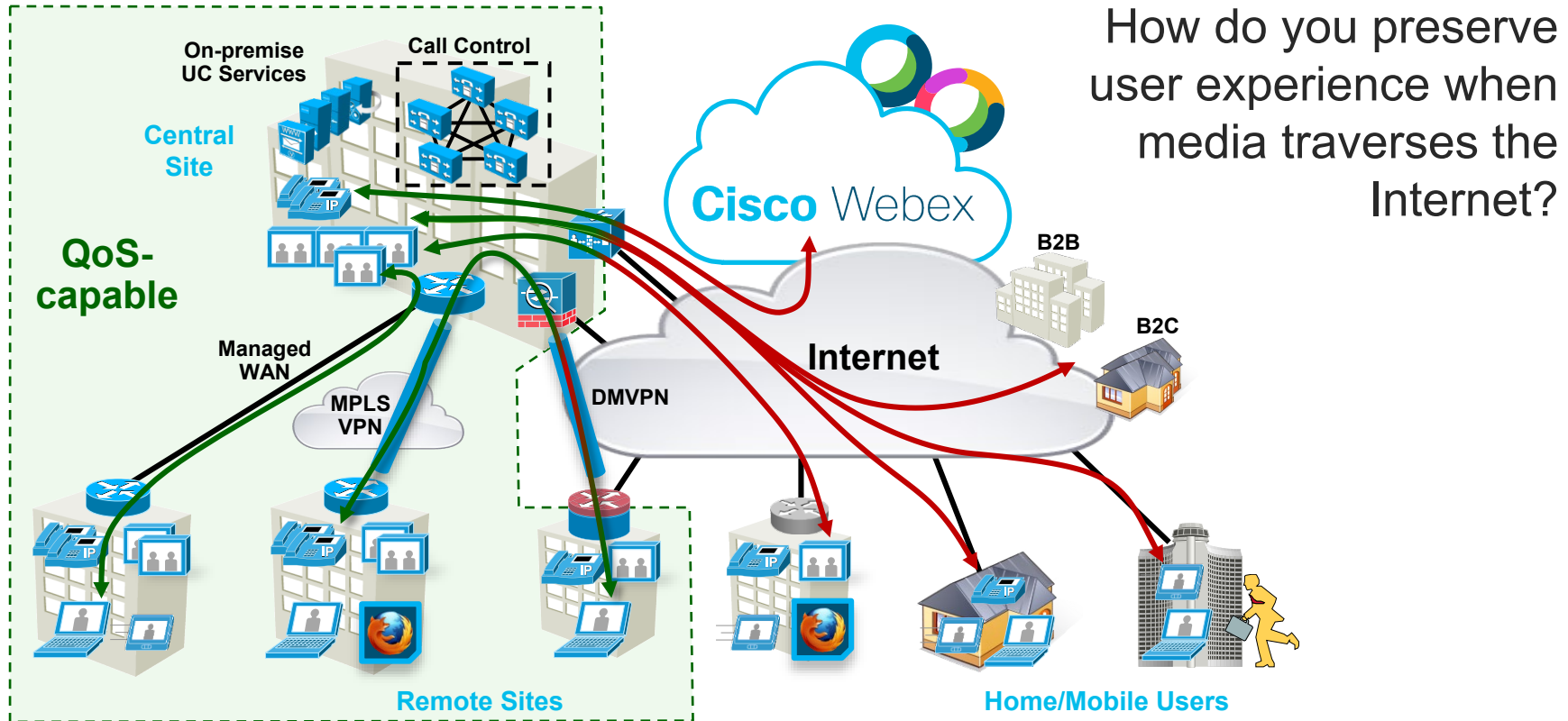
Introduction

Evolution of Collaboration Landscape



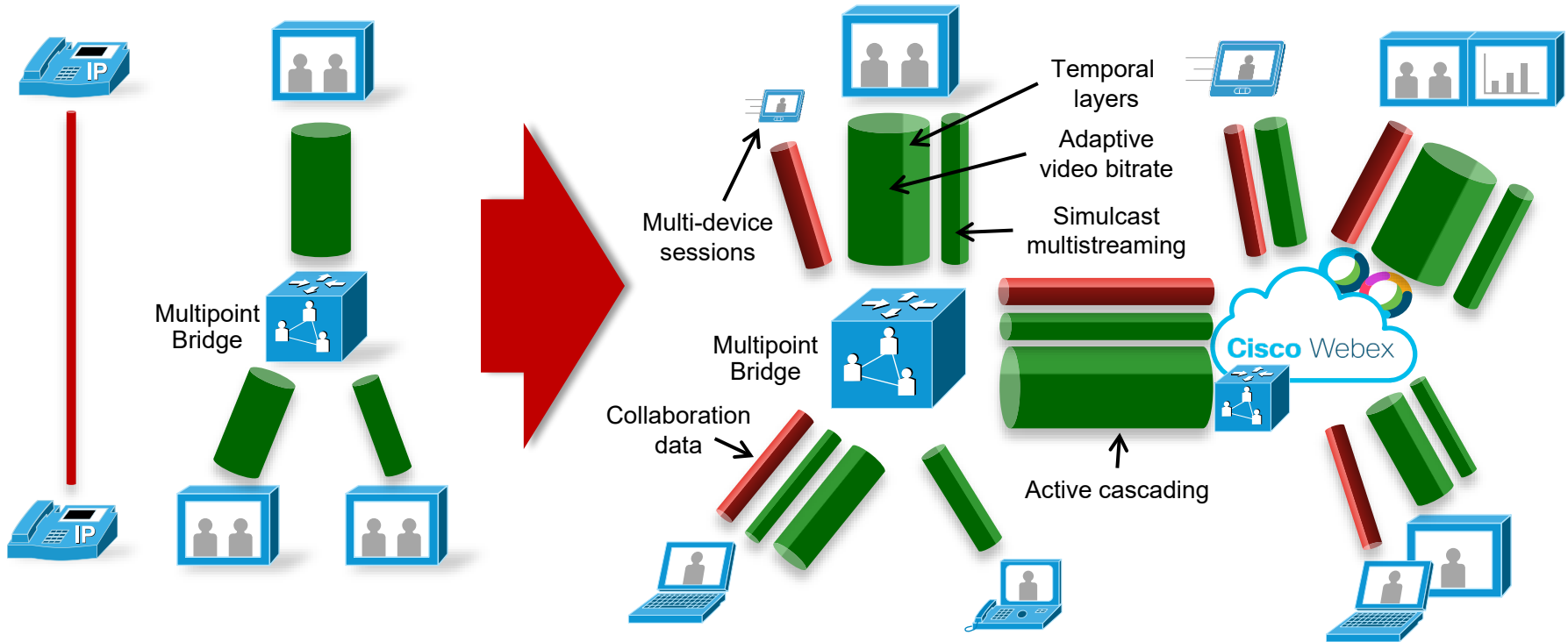
Managed vs. Unmanaged Networks

Where do your media packets go?



How do you preserve user experience when media traverses the Internet?

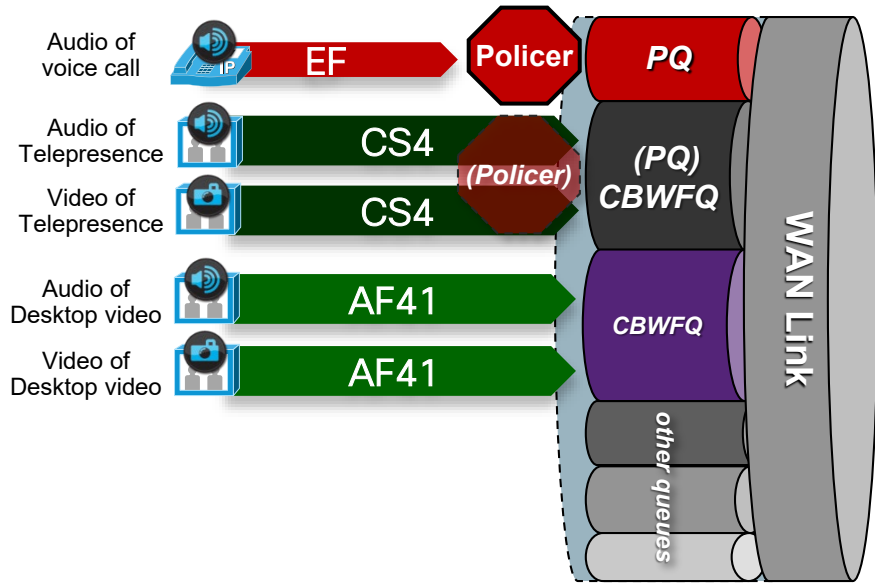
Evolution of Collaboration Media Streams



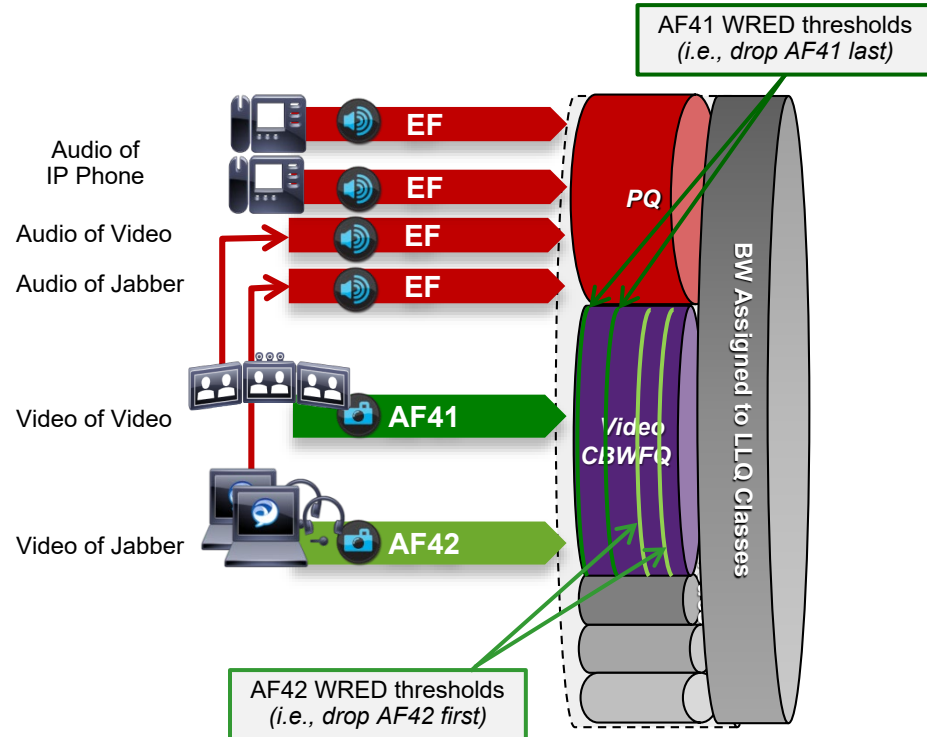
QoS Tools

Evolution of Queuing Recommendations

Previous

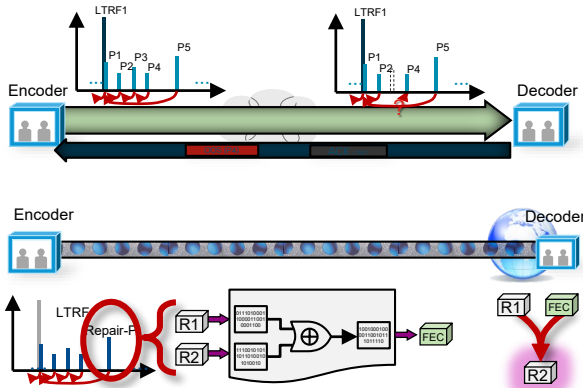


New



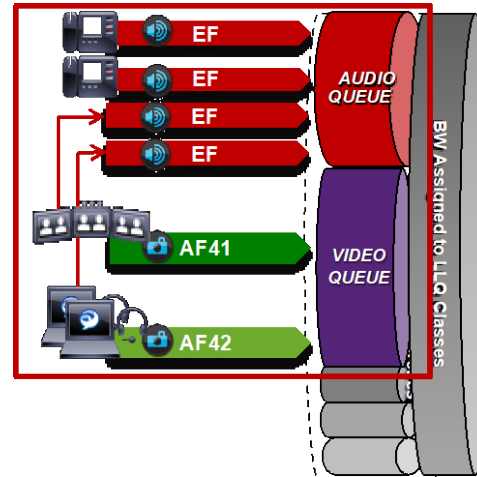
Our Strategy

“Smart” Media Techniques



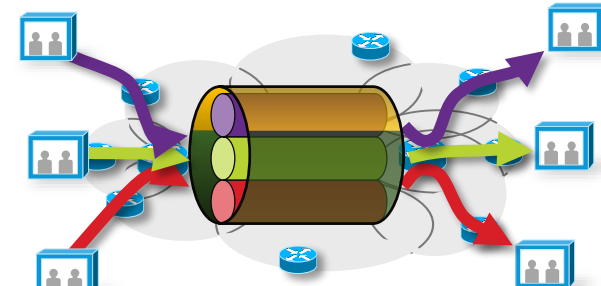
- Use media resilience to reduce impact of packet loss
- Apply rate adaptation to reduce network congestion

Commonly Deployed QoS Tools



- Consolidate mechanisms to identify Collaboration media
- Evolve classification and scheduling recommendations

New Design & Deployment Guidelines



Leverage media resilience and rate adaptation to enable pervasive video deployments through:

- simplified provisioning
- optimized bandwidth utilization



S Strategy Overview

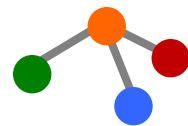
Classification: DSCP Classes

- EF: Expedited Forwarding (PQ)
 - Used for voice media
- AF: Assured Forwarding (CWBFQ)
 - Used for video media
- CS: Class Selector
 - Used for signaling

DSCP Class	DSCP	ToS Prec.
none	0	0
CS1	8	1
AF11	10	1
AF12	12	1
AF13	14	1
CS2	16	2
AF21	18	2
AF22	20	2
AF23	22	2
CS3	24	3
AF31	26	3
AF32	28	3
AF33	30	3
CS4	32	4
AF41	34	4
AF42	36	4
AF43	38	4
CS5	40	5
EF	46	5
CS6	48	6
CS7	56	7

Trust and Enforcement

Devices and Places in the Network



Multiple Access Policies
NOT IDEAL

Conditionally-Trusted Endpoints

Room system Endpoints
Mac/PC

CDP Support required

Trusted Endpoints / Devices

PC/GPO MAC Handheld WiFi AP

Untrusted Endpoints / Devices

PC MAC Handheld

Trusted Devices

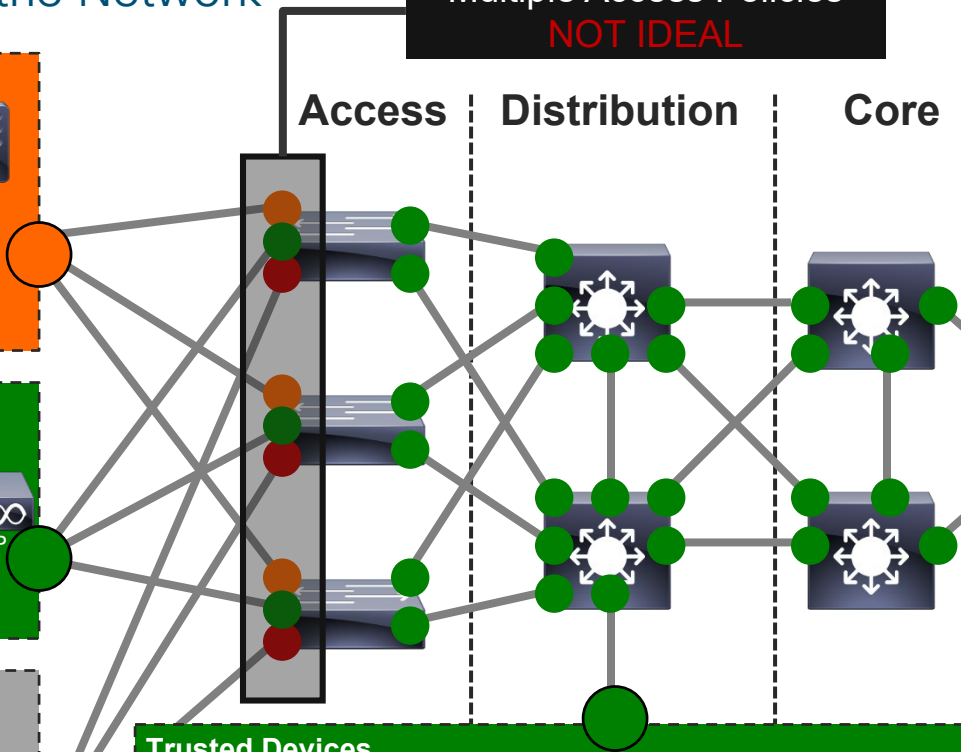
Unified CM Unity Connection Instant Messaging And Presence Expressway Cisco Meeting Server

Access Distribution Core

WAN Edge

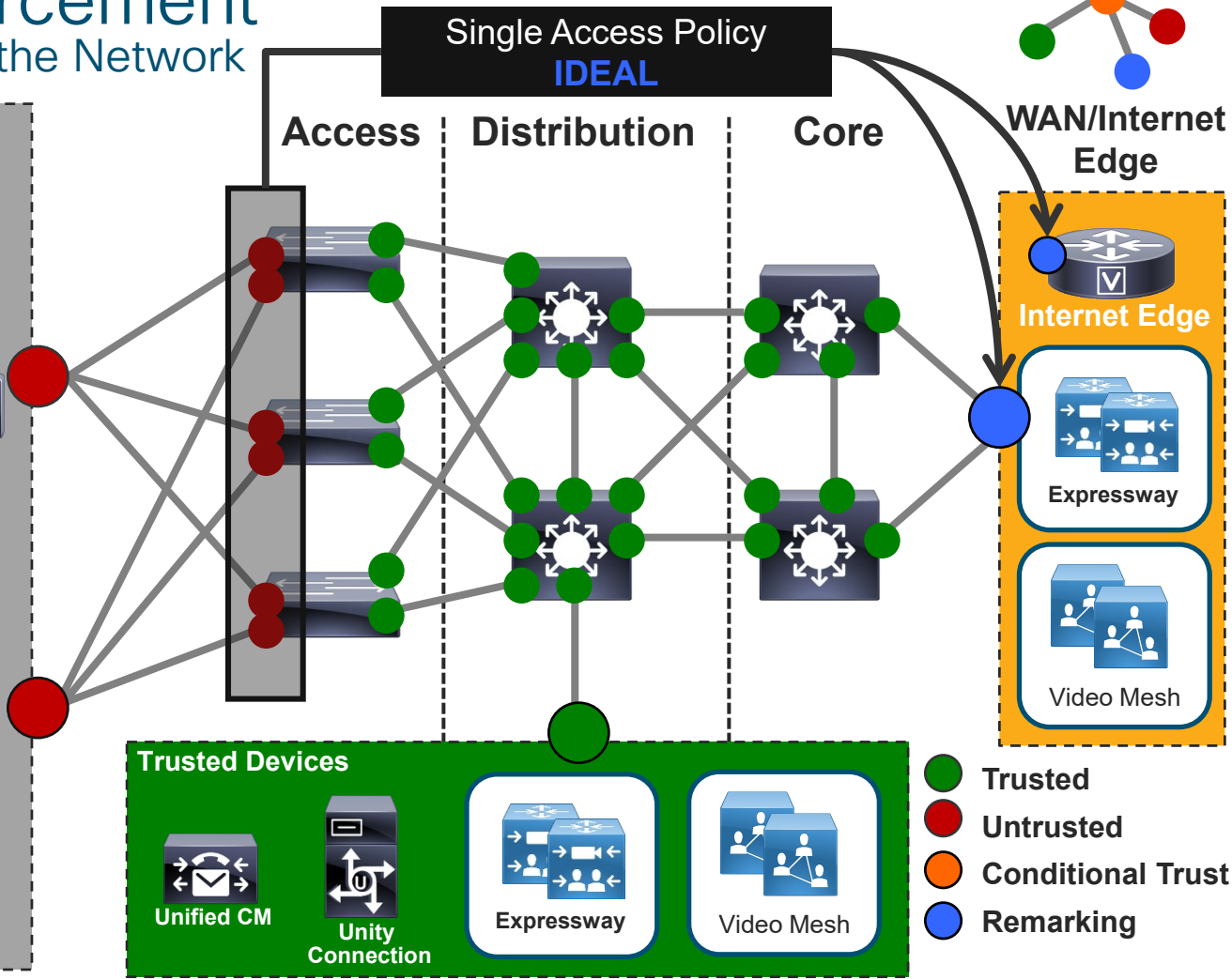
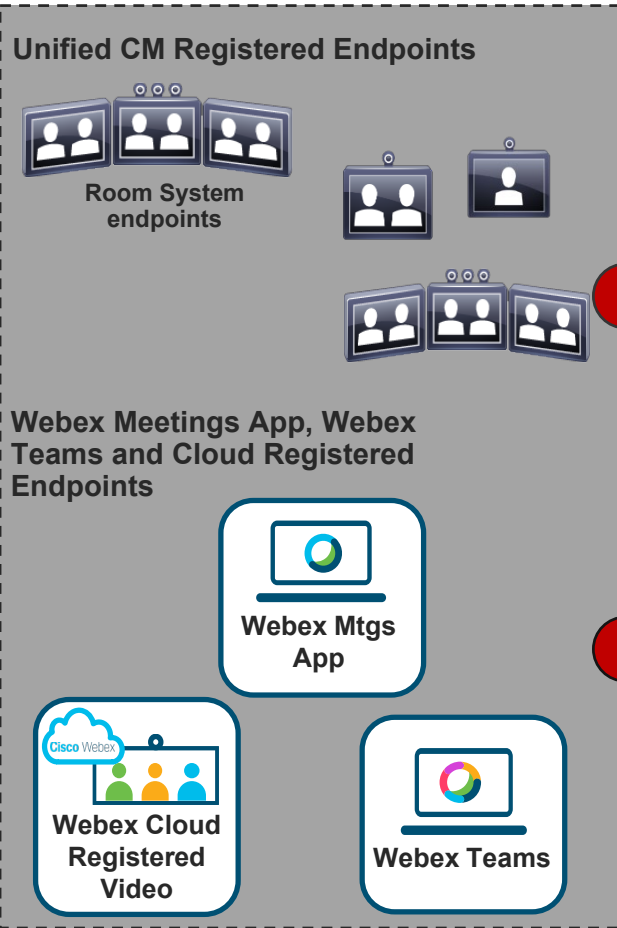
IOS SIP Gateway
SRST Gateway
Unified BE

- Trusted
- Untrusted
- Conditional Trust
- Remarking



Trust and Enforcement

Devices and Places in the Network



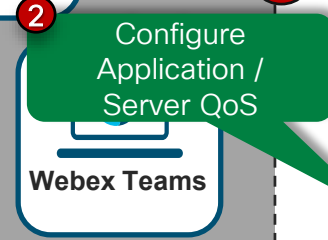
Trust and Enforcement

Devices and Places in the Network

Unified CM Registered Endpoint



Webex Meetings App, Webex Teams and Cloud Registered Endpoints



1 Configure Endpoint QoS and Port Ranges

3 Deploy an Access Layer Policy

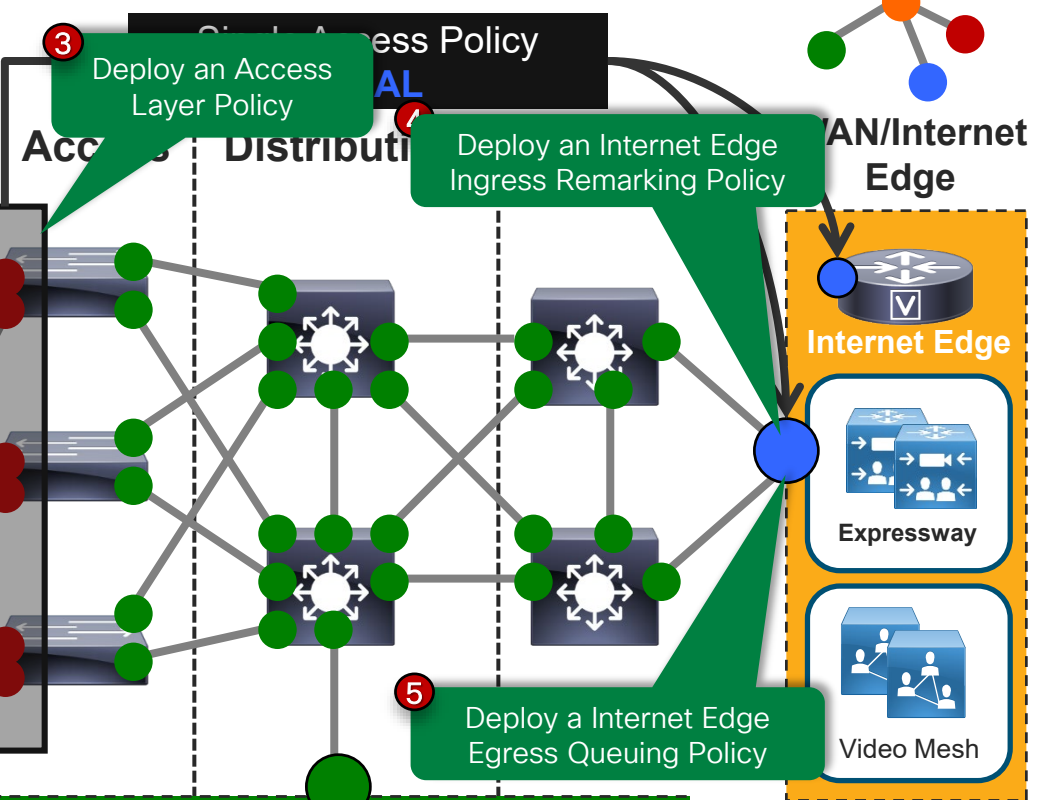
4 Deploy an Internet Edge Ingress Remarking Policy

5 Deploy a Internet Edge Egress Queuing Policy

Trusted Devices

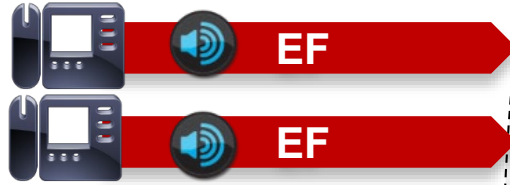


- Trusted
- Untrusted
- Conditional Trust
- Remarking



Dual video queue

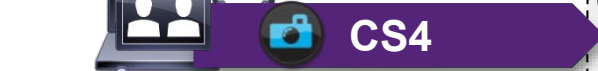
Audio of IP Phone



Audio of TelePresence



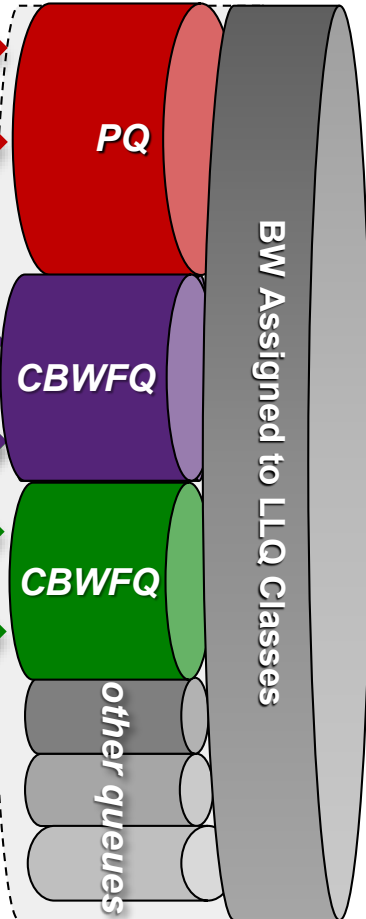
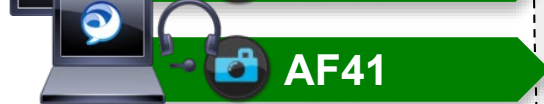
Video of TelePresence



Audio of Desktop Video



Video of Desktop Video



Single video queue

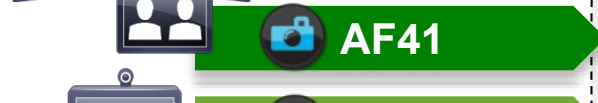
Audio of IP Phone



Audio of TelePresence



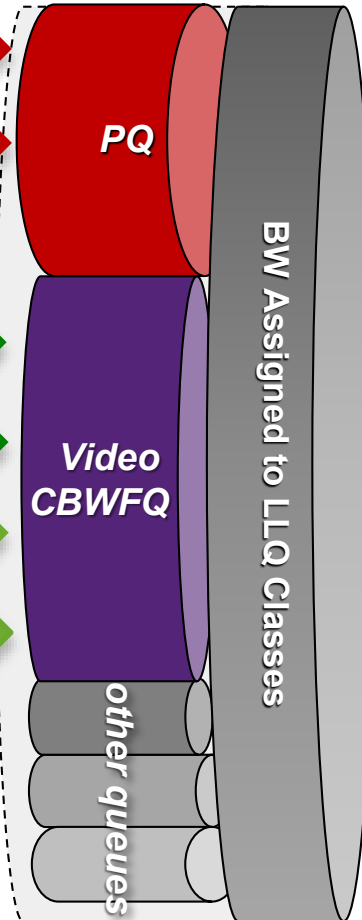
Video of TelePresence



Audio of Desktop Video

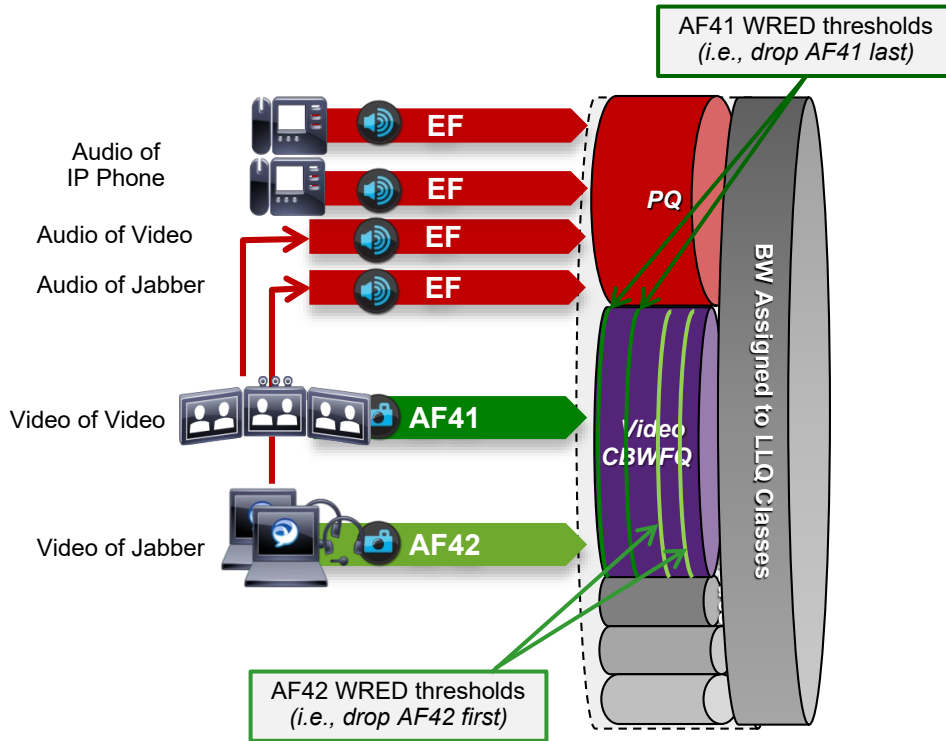


Video of Desktop Video



WAN Queuing Considerations

Summary



- Map audio streams of voice and video calls (EF) to a priority queue
- Map video streams of video calls (AF41 and AF42) to a class-based queue with WRED:
 - AF41: higher drop thresholds (e.g., 50-100% of queue depth)
 - AF42: lower drop thresholds (e.g., 15-35% of queue depth)
- During congestion, AF42 traffic is dropped first:
 - Packet loss triggers rate adaptation
 - Media resilience limits the impact

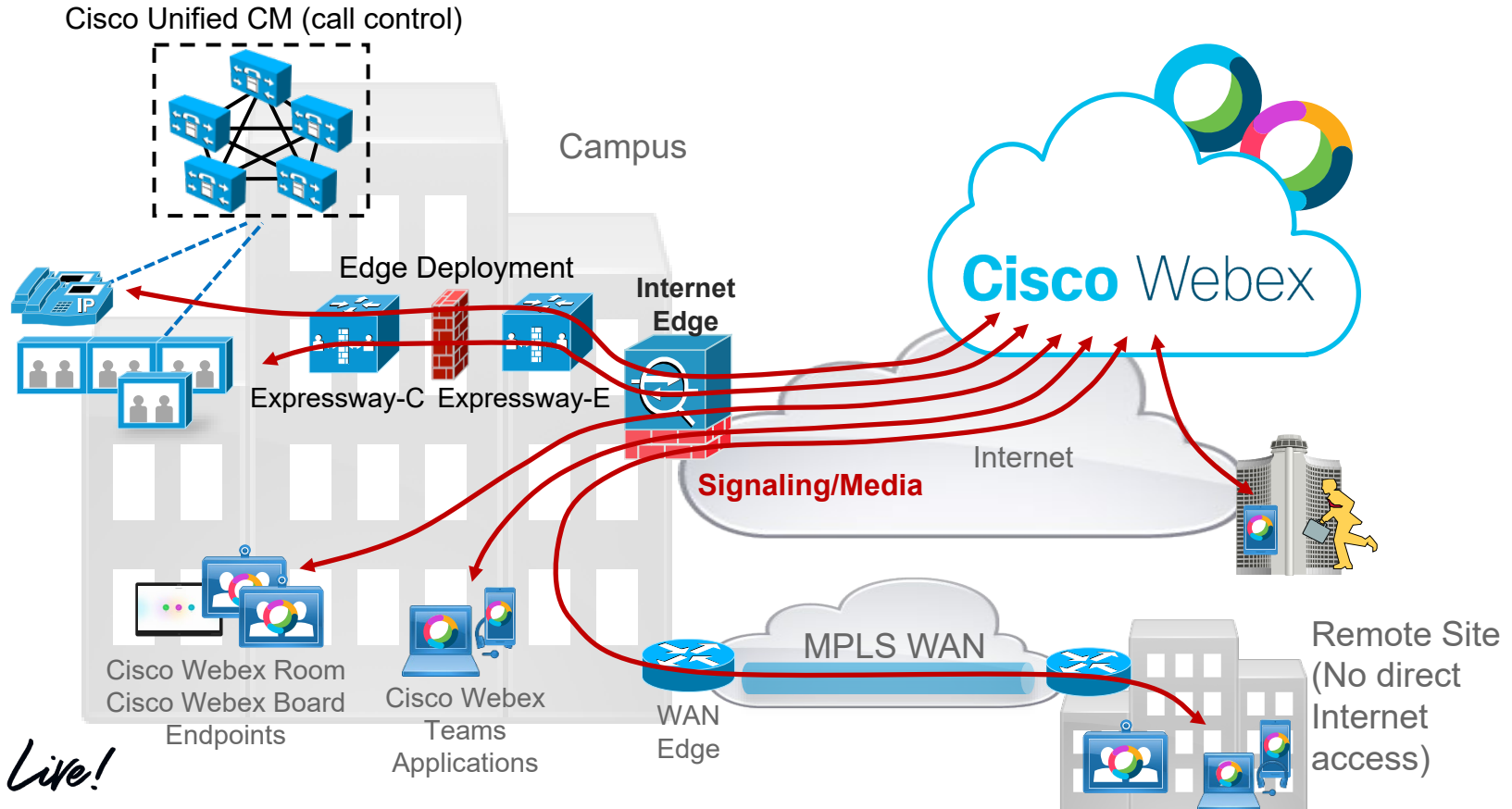
Summary

- Create a Simplified QoS Policy – Use throughout the network
- Egress Queuing Policy
 - Single video queue for AF class traffic model is recommended
 - Consider multiple classes of Video AF41, AF42, AF43 (Prioritized Video vs Opportunistic Video)

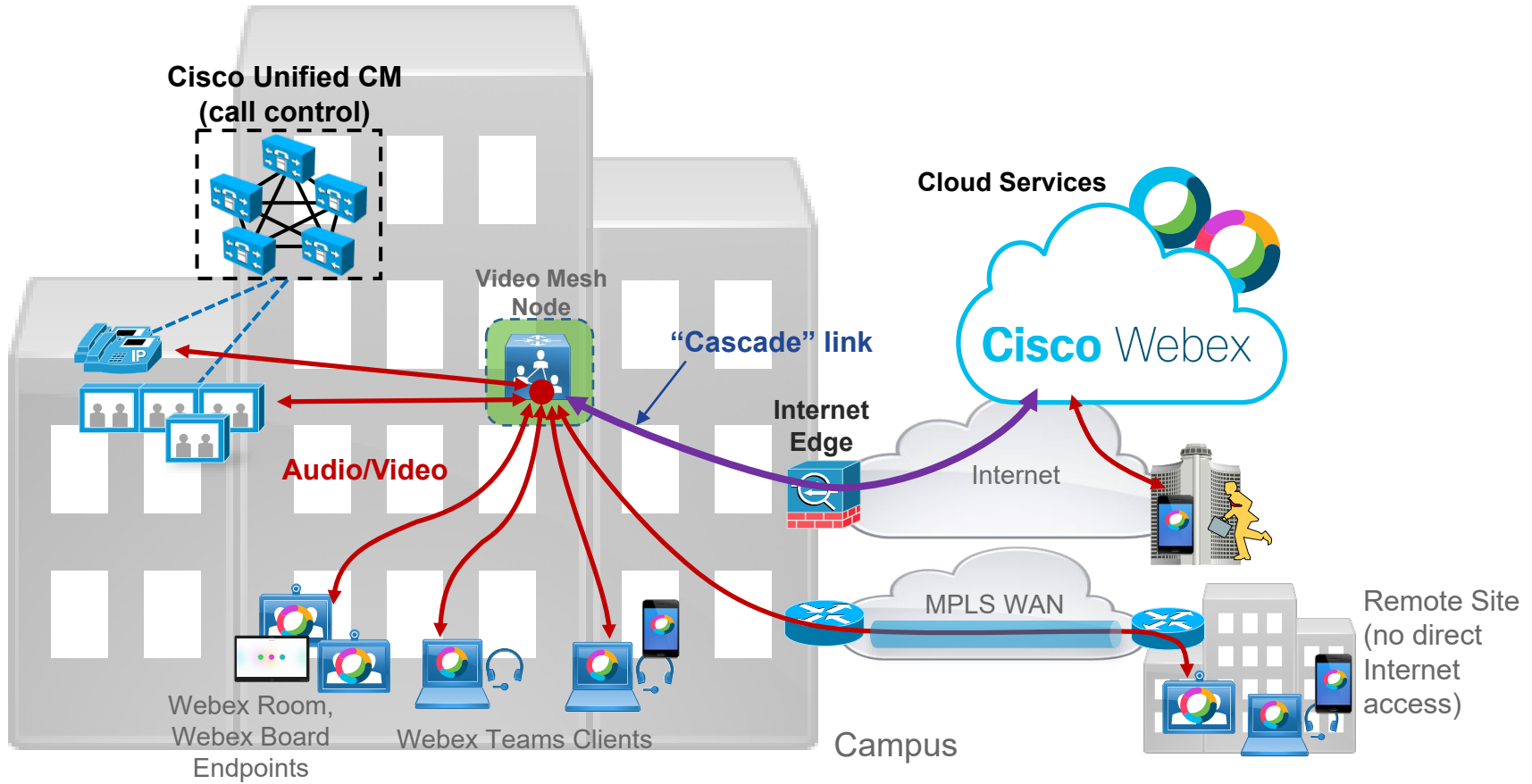


S Marking for
Webex Media

Webex Teams Media Flows Without Video Mesh Node



Webex Teams Media Flows With Video Mesh Node

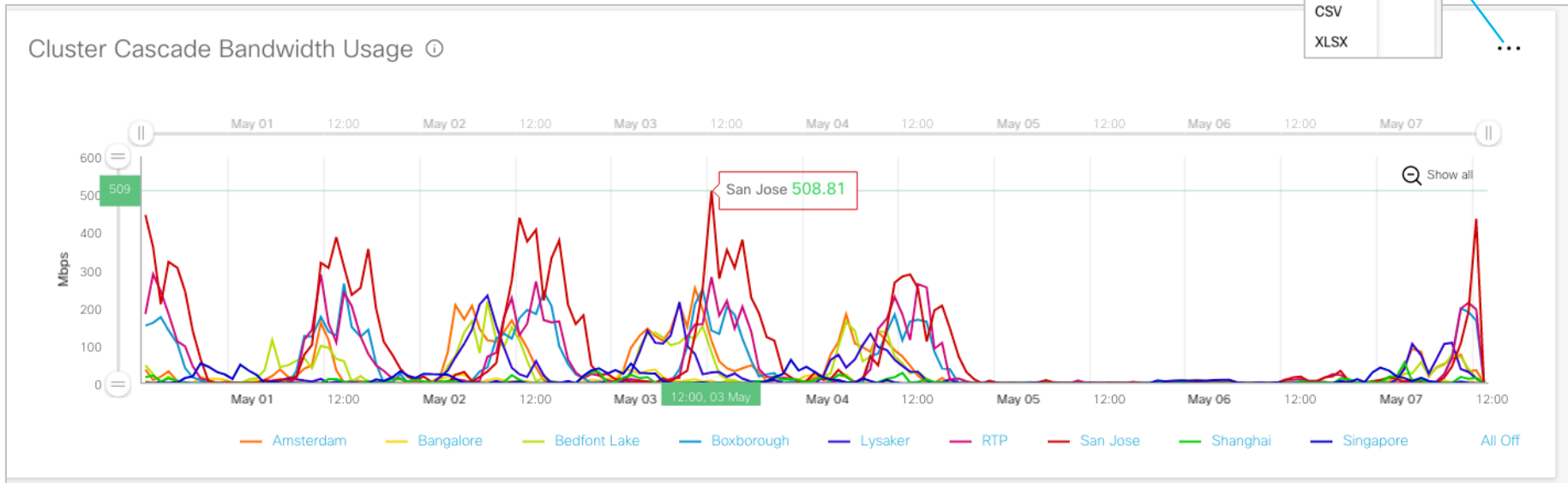
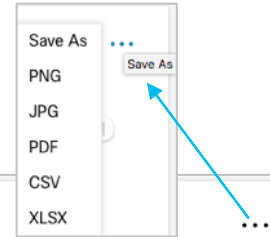


Cascade Bandwidth

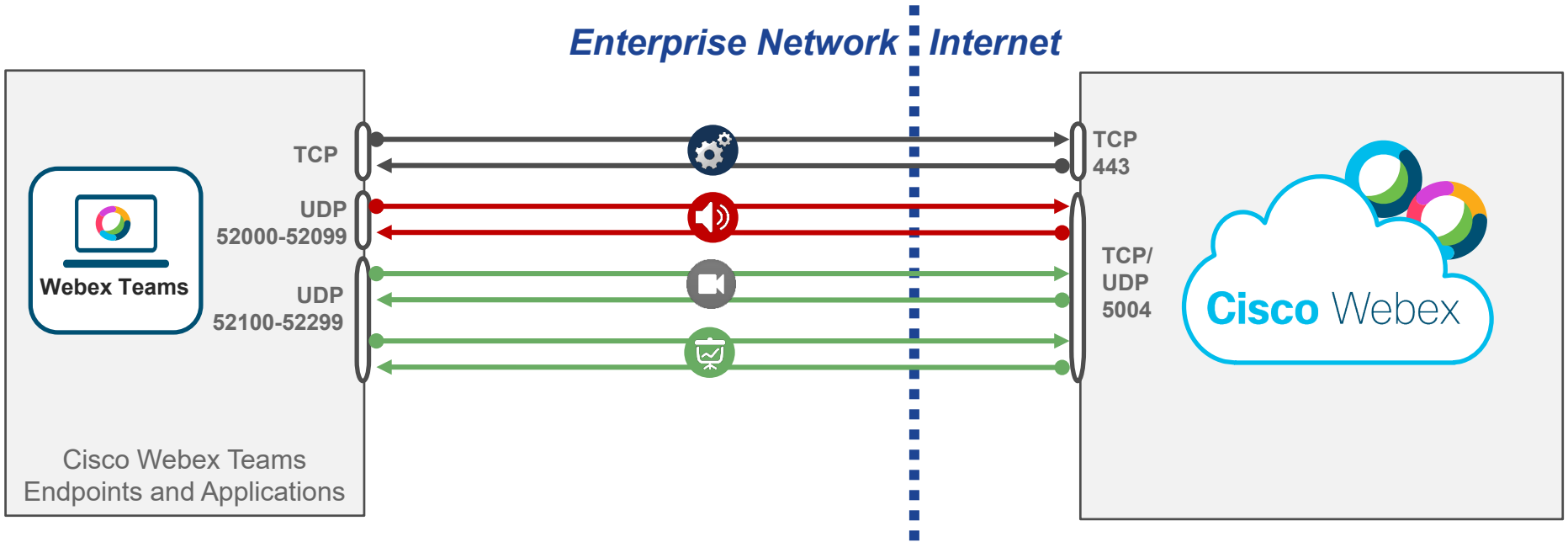
- Cascade bandwidth graphs are available in Control Hub.
 - The graphs are a per-cluster measurement.
- Cascade bandwidth per meeting is not configurable by the customer in Cisco Webex Control Hub.
- Maximum per-meeting negotiated cascade bandwidth is 20 Mbps for main video for all sources and the multiple main video streams they could send. This does not include the content channel or audio.
- In a 3 month timeframe with the top 20 customers based on the number of meetings with an average of 9100 meetings and 15,000 calls per month, the average total cascade bandwidth (Tx + Rx) for all the meetings was 11.6 Mbps.
- Webex Meetings new 5x5 grid layout is now supported on the Video Mesh.

Cascade Bandwidth Reports

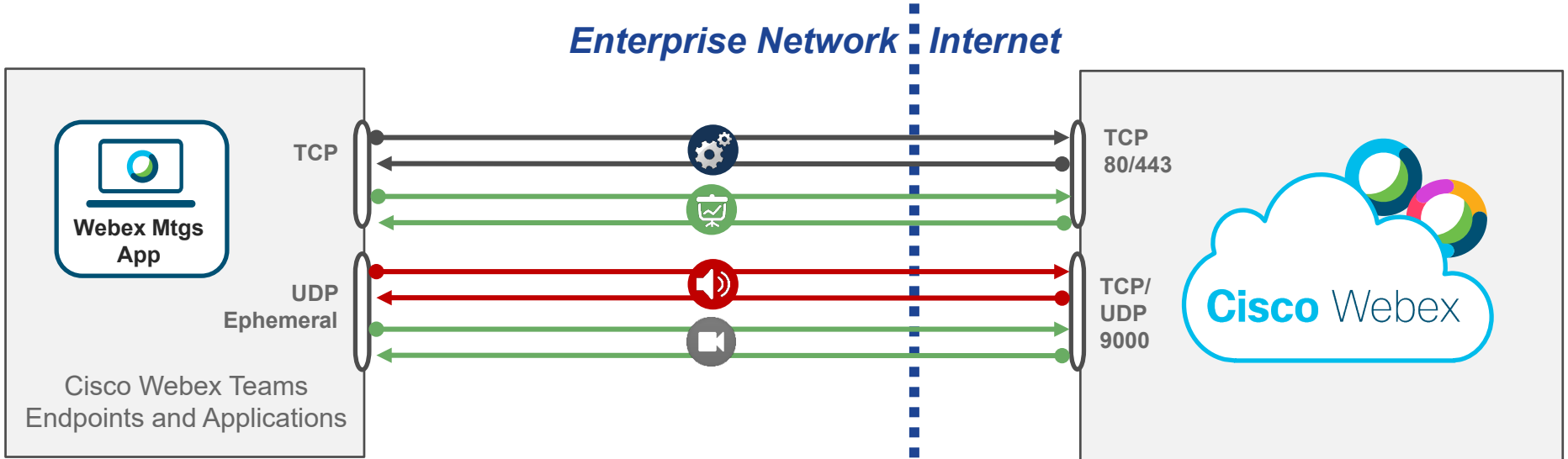
- Know your bandwidth usage for cascades
- Total or cluster cascade bandwidth to the cloud graphed



Port Usage Today – Webex Teams



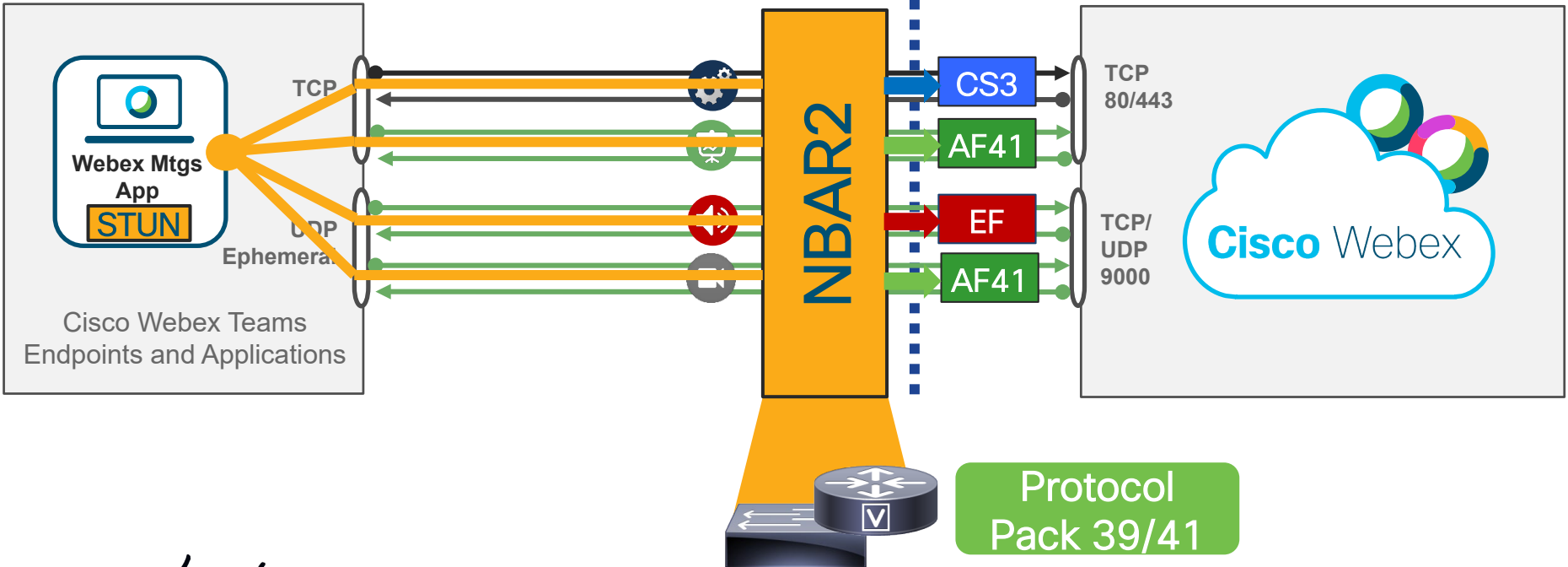
Port Usage Today – Webex Meetings App



Port Usage Today – Webex Meetings App

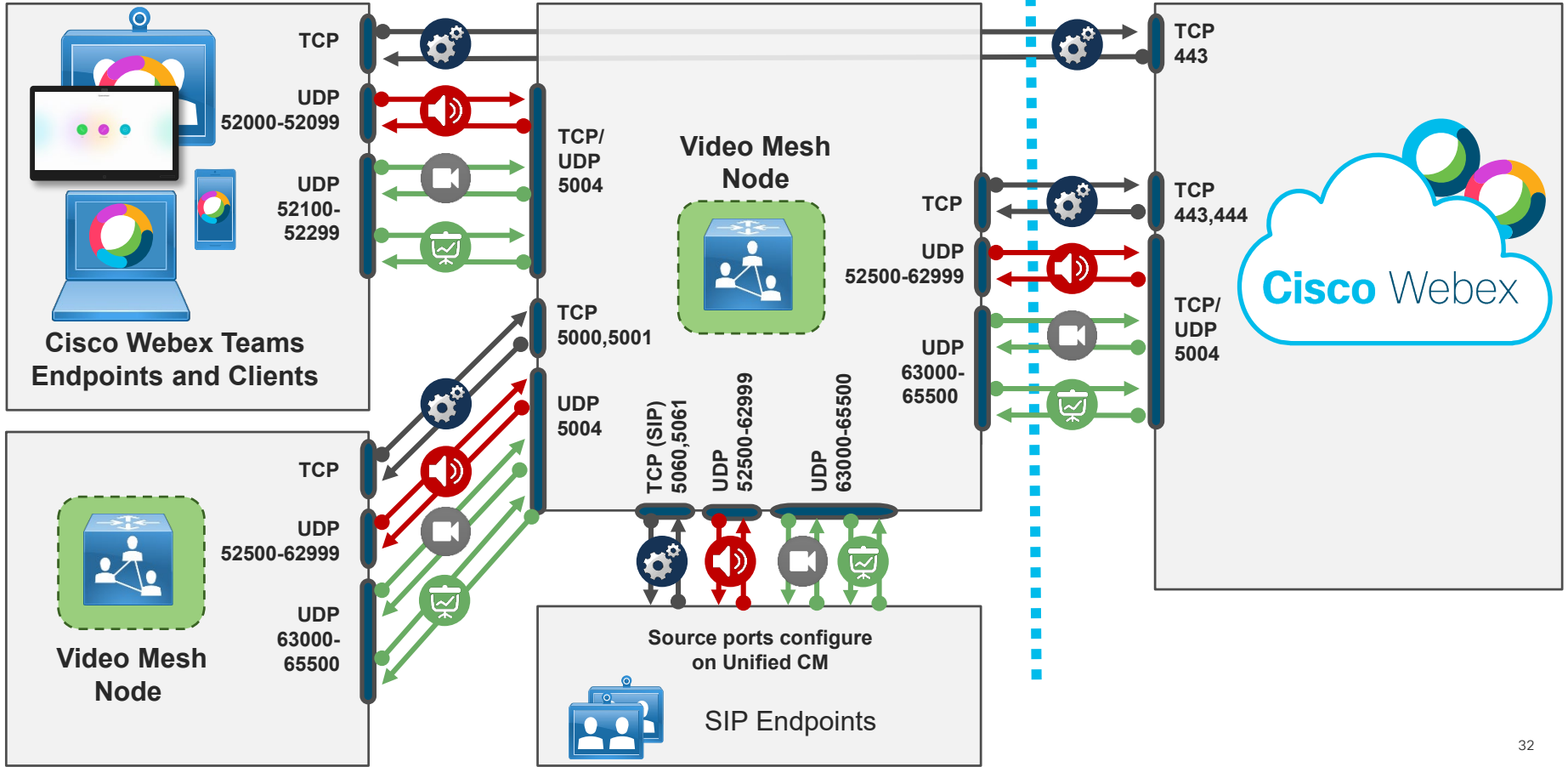
Latest Webex Version

Enterprise Network Internet



Port Usage Today – Webex Teams + Video Mesh

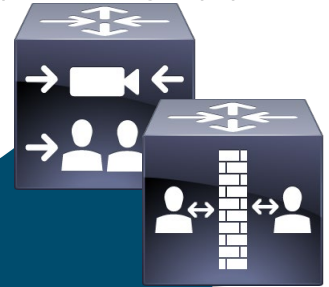
Enterprise Network | *Internet*



Expressway

- System → Quality of Service
 - DSCP Signaling value 24 (Default) → CS3
 - DSCP Audio value 46 (Default) → EF
 - DSCP Video value 34 (Default) → AF41
 - DSCP XMPP value 24 (Default) → CS3

Cisco Expressway Core (C) and Edge (E)



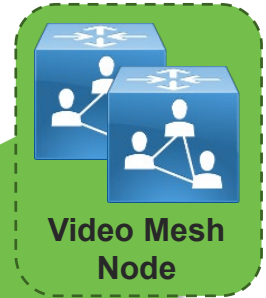
The screenshot shows the Cisco Expressway web interface. The top navigation bar includes 'Status', 'System', 'Configuration', 'Applications', 'Users', and 'Maintenance'. The 'System' tab is selected. Below the navigation bar, the 'Quality of Service' section is displayed. A breadcrumb trail indicates 'You are here: System > Quality of Service'. The 'Tagging' sub-section is expanded, showing a table of DSCP values:

Parameter	Value	Info
DSCP Signaling value	24	i
DSCP Audio value	46	i
DSCP Video value	34	i
DSCP XMPP value	24	i

Video Mesh Node – Ports

- Webex Control Hub Services > Video Mesh
- QoS (Enabled by Default)
- Enables Cascade Port Ranges and Native Marking
 - Audio 52500-62999 (EF)*
 - Video 63000-65500 (AF41)*

Video Mesh Cluster



Service Configuration

QoS

Quality of Service ⓘ

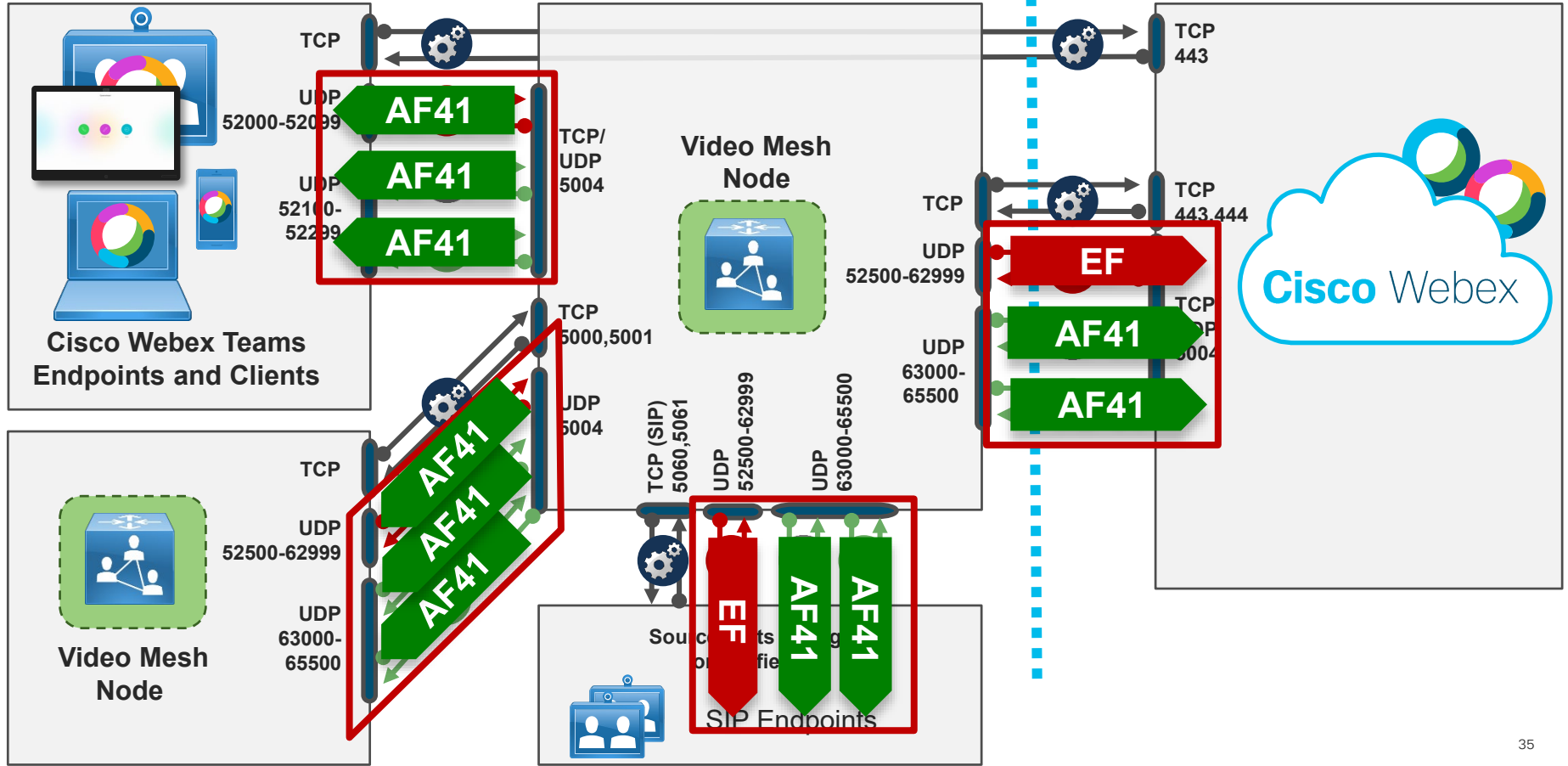
Enabling this setting modifies the UDP port range for Video Mesh cascade media and the Quality of Service (QoS) markings for both Video Mesh cascade and SIP client media. See the [Ports and Protocols documentation](#) for guidance.



* When disabled changes the source ports that are used for audio, video, and content sharing from the Video Mesh node to the range 34000 to 34999

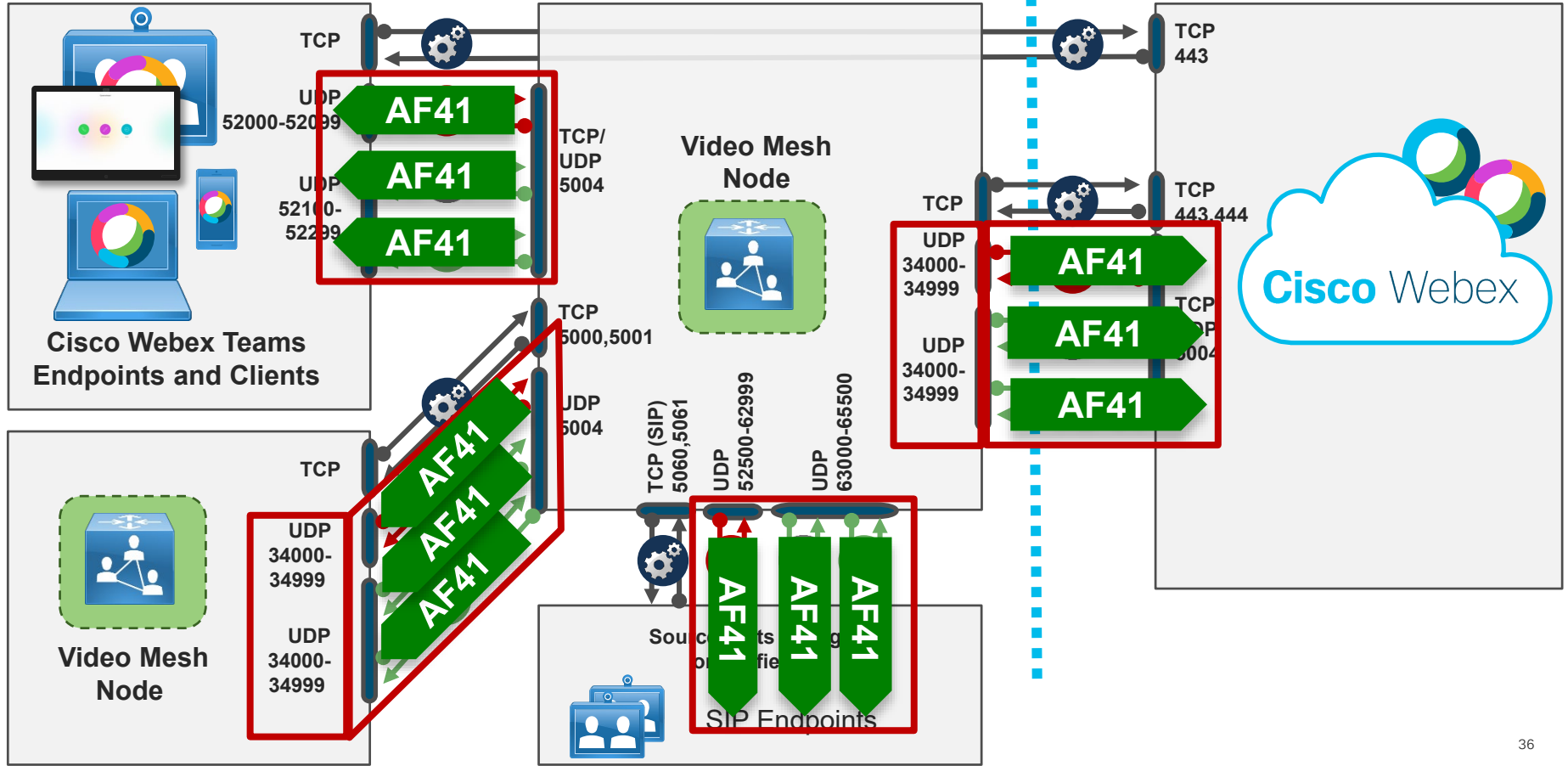
Video Mesh - Native Marking QoS Enabled

Enterprise Network Internet



Video Mesh - Native Marking QoS "Disabled"

Enterprise Network Internet



Media Signatures for Cisco Webex Teams and Cloud Registered Endpoints

Client to Cloud (Reverse for Cloud to Client)

REFERENCE

Source IP	Destination IP	Source UDP Ports	Destination UDP Ports	Recommended DSCP	Media Type ^{1,2}
Webex Teams application or endpoint	Webex cloud and Video Mesh Media Services	52000 to 52099	5004	EF	Audio
Webex Teams application or endpoint	Webex cloud and Video Mesh Media Services	52100 to 52299	5004	AF41	Video
Video Mesh Node	Webex Cloud Media Services	52500 to 62999	5004	EF	Audio
Video Mesh Node	Webex cloud Media Services	63000 to 65500	5004	AF41	Video
Video Mesh Node	Video Mesh Node	52500 to 62999	5004	EF	Audio
Video Mesh Node	Video Mesh Node	63000 to 65500	5004	AF41	Video

Media Signatures for Cisco Webex Meetings Application

Client to Cloud (Reverse for Cloud to Client)

Source IP	Destination IP	Source UDP Ports	Destination UDP Ports	Recommended DSCP	Media Type
Cisco Webex Meetings Application	Webex Cloud	Ephemeral	9000	AF41	Audio / Video

Webex Meetings App

- webex-audio** = Webex audio streaming
- webex-video** = Webex video streaming
- webex-app-sharing** = Webex app sharing traffic
- webex-meeting** = Webex Signaling Traffic - (non-media – not port based)

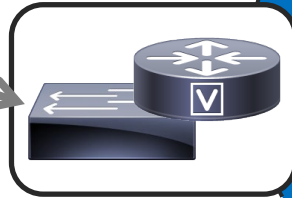
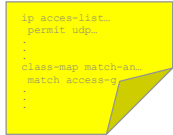
NBAR2



Webex Ingress QoS Policy



Update QoS configuration



Webex Meetings App

webex-audio = Webex audio streaming
webex-video = Webex video streaming
webex-app-sharing = Webex app sharing traffic
webex-meeting = Webex Signaling Traffic - (non-media, not port based)

NBAR2

```
ip access-list extended QOS_VOICE
 permit udp any range 17000 17999 any dscp ef
ip access-list extended QOS_PRIORITIZED_VIDEO
 permit udp any range 17000 17999 any dscp af41
```

```
ip access-list extended QOS_WEBEX_TEAMS_AUDIO
 permit udp any range 52000 52099 any any
 permit udp any eq 5004 any range 52000 52099
ip access-list extended QOS_WEBEX_TEAMS_VIDEO
 permit udp any range 52100 52299 any any
 permit udp any eq 5004 any range 52100 52299
```

```
class-map match-any VOICE
```

```
 match access-group name QOS_VOICE
```

```
 match access-group name QOS_WEBEX_TEAMS_AUDIO
```

```
class-map match-any PRIORITIZED_VIDEO
```

```
 match access-group name QOS_PRIORITIZED_VIDEO
```

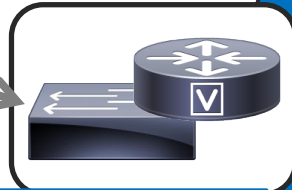
```
 match access-group name QOS_WEBEX_TEAMS_VIDEO
```

Webex Ingress QoS Policy



Update QoS
configuration

```
ip access-list  
permit udp  
...  
class-map match-any  
match access-g
```



Webex Teams

cisco-spark-audio = Teams audio streaming
cisco-spark-video = Teams video streaming
cisco-spark-media = Outdated: Will match if
Audio and Video are not matched
cisco-spark = Teams Signaling (login, chat,
keep-alive, etc...)

NBAR2

```
ip access-list extended QOS_VOICE  
    permit udp any range 17000 17999 any dscp ef  
ip access-list extended QOS_PRIORITIZED_VIDEO  
    permit udp any range 17000 17999 any dscp af41
```

```
ip access-list extended QOS_WEBEX_TEAMS_AUDIO  
    permit udp any range 52000 52099 any any  
    permit udp any eq 5004 any range 52000 52099  
ip access-list extended QOS_WEBEX_TEAMS_VIDEO  
    permit udp any range 52100 52299 any any  
    permit udp any eq 5004 any range 52100 52299
```

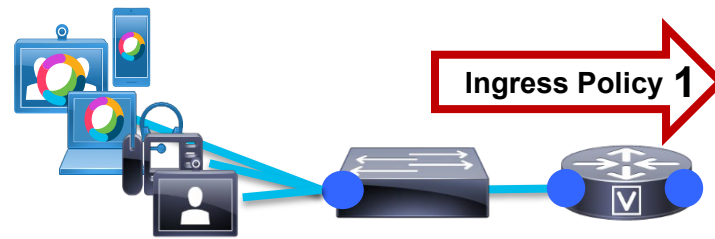
```
class-map match-any VOICE
```

```
match access-group name QOS_VOICE  
match access-group name QOS_WEBEX_TEAMS_AUDIO
```

```
class-map match-any PRIORITIZED_VIDEO
```

```
match access-group name QOS_PRIORITIZED_VIDEO  
match access-group name QOS_WEBEX_TEAMS_VIDEO
```

WAN Ingress QoS Marking Policy



Reference

Ingress Policy 1

! This section applies the policy-map to the Interface
Router(config-if)# service-policy input **INGRESS-MARKING**
! Attaches service policy to interface

2

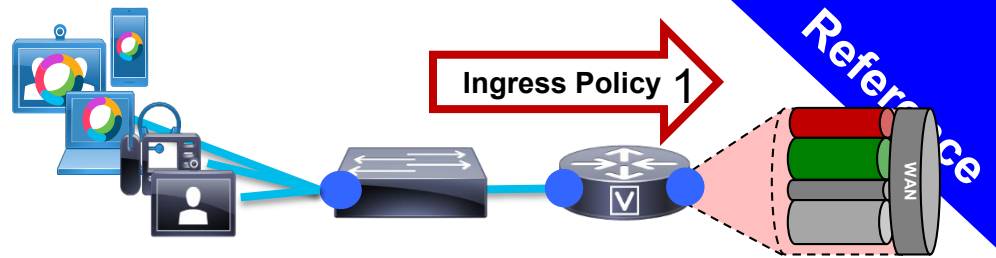
! This section configures the policy-map to set DSCP for Trusted and Untrusted Voice, Video and SIP Signaling on ingress

```
policy-map INGRESS-MARKING  
class VOICE  
  set dscp ef  
class PRIORITIZED-VIDEO  
  set dscp af41  
class OPPORTUNISTIC-VIDEO  
  set dscp af42  
class SIGNALING  
  set dscp cs3  
class class-default
```

! This section configures the classes

```
class-map match-any VOICE  
  match webex-audio  
  match cisco-spark-audio  
class-map match-any PRIORITIZED-VIDEO  
  match webex-video  
  match cisco-spark-video  
class-map match-any SIGNALING  
  match webex-meeting  
  match cisco-spark
```

3



! This section configures the classes

class-map match-any VOICE

match webex-audio

match cisco-spark-audio

class-map match-any PRIORITIZED-VIDEO

match webex-video

match cisco-spark-video

class-map match-any SIGNALING

match webex-meeting

match cisco-spark

4

3

! This section configures the policy-map to set DSCP for Trusted and Untrusted Voice, Video and SIP Signaling on ingress

policy-map INGRESS-MARKING

class VOICE

set dscp ef

class PRIORITIZED-VIDEO

set dscp af41

class OPPORTUNISTIC-VIDEO

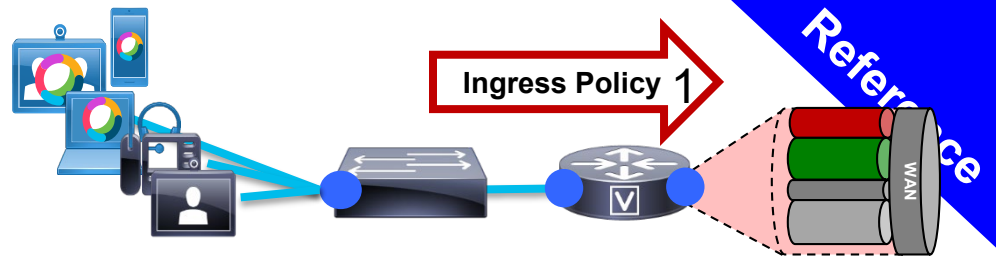
set dscp af42

class SIGNALING

set dscp cs3

class class-default

Egress Policy 6



! This section configures the classes

```
class-map match-any VOICE
```

```
  match webex-audio
```

```
  match cisco-spark-audio
```

```
class-map match-any PRIORITIZED-VIDEO
```

```
  match webex-video
```

```
  match cisco-spark-video
```

```
class-map match-any SIGNALING
```

```
  match webex-meeting
```

```
  match cisco-spark
```

4

! This section configures the policy-map to set DSCP for Trusted and Untrusted Voice, Video and SIP Signaling on ingress

```
policy-map INGRESS-MARKING
```

```
  class VOICE
```

```
    set dscp ef
```

```
  class PRIORITIZED-VIDEO
```

```
    set dscp af41
```

```
  class OPPORTUNISTIC-VIDEO
```

```
    set dscp af42
```

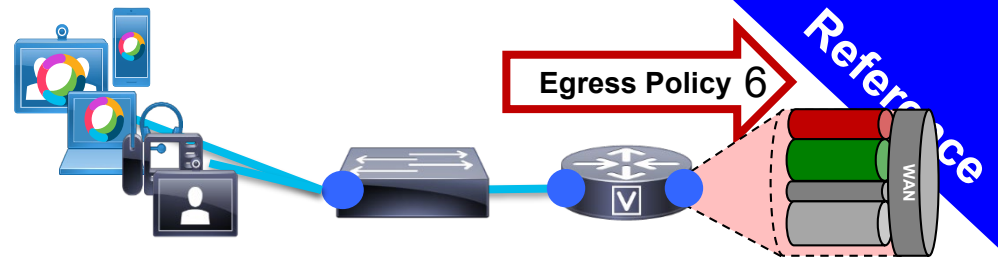
```
  class SIGNALING
```

```
    set dscp cs3
```

```
  class class-default
```

3

Egress Classification and Queuing



6.1

! This section applies the policy-map to the Interface
Router (config-if)# service-policy output EGRESS-QUEUING
! Attaches service policy to interface

! This section configures the bandwidth for all collab traffic

policy-map EGRESS-QUEUING

class VOICE

priority percent 10

! Provisions 10% LLQ to VOICE class

class VIDEO

bandwidth percent 30

! Provisions 30% CBWFQ to VIDEO class

class SIGNALING

bandwidth percent 2

! Provisions 2% CBWFQ to SIGNALING class

6.2

! This section applies the policy-map

class-map match-all VOICE

match dscp ef

class-map match-any VIDEO

match dscp af41

match dscp af42

class-map match-all SIGNALING

match dscp cs3

6.3

! This section configures the ACL's

```
ip access-list extended QOS_WEBEX_TEAMS_AUDIO
```

```
permit udp any range 52000 to 52099 any 5004  
permit udp eq 5004 any range 52000 to 52099
```

```
ip access-list extended QOS_WEBEX_TEAMS_VIDEO
```

```
permit udp any range 52100 52299 any 5004  
permit udp eq 5004 any range 52100 52299
```

```
ip access-list extended QOS_WEBEX_MTGS_MEDIA
```

```
permit udp any any any eq 9000  
permit udp any eq 9000 any any
```

! This section configures the classes

```
class-map match-any VOICE
```

```
match access-group QOS_WEBEX_TEAMS_AUDIO
```

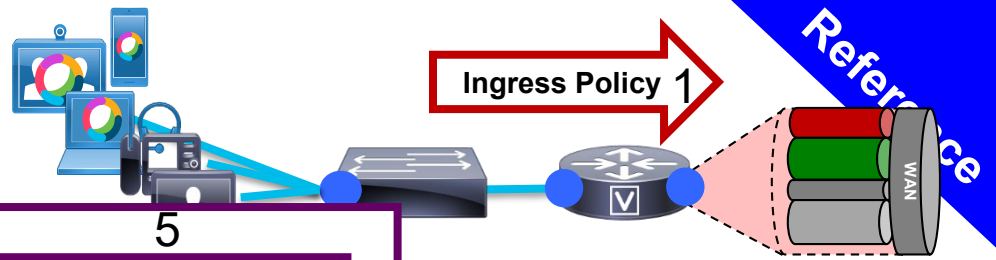
```
class-map match-any PRIORITIZED-VIDEO
```

```
match access-group QOS_WEBEX_TEAMS_VIDEO
```

```
match access-group QOS_WEBEX_MTGS_MEDIA
```

```
class-map match-any SIGNALING
```

```
match access-group QOS_SIGNALING
```



5

Ingress Policy 1

Egress Policy 6

4

! This section configures the policy-map to set DSCP for Trusted and Untrusted Voice, Video and SIP Signaling on ingress

```
policy-map INGRESS-MARKING
```

```
class VOICE
```

```
set dscp ef
```

```
class PRIORITIZED-VIDEO
```

```
set dscp af41
```

```
class OPPORTUNISTIC-VIDEO
```

```
set dscp af42
```

```
class SIGNALING
```

```
set dscp cs3
```

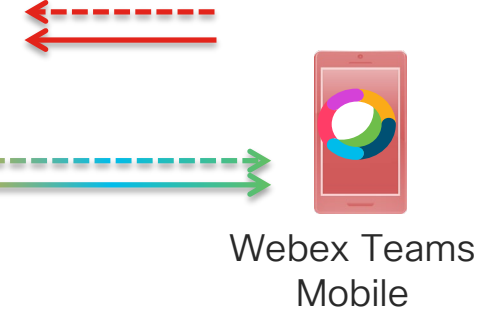
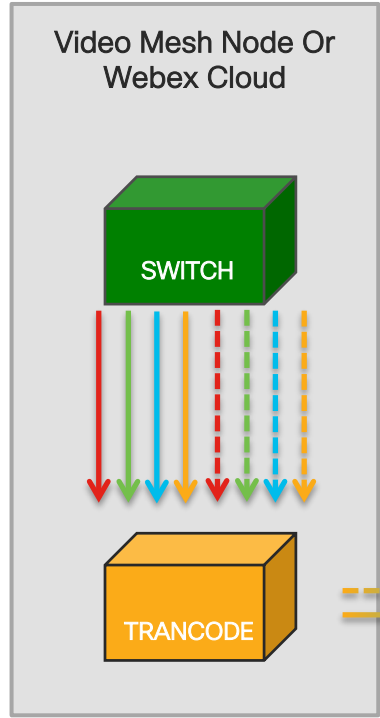
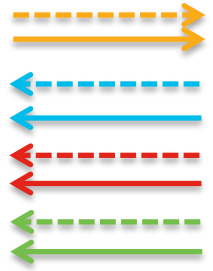
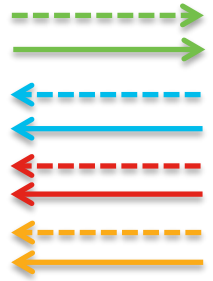
```
class class-default
```

3

Bandwidth Provisioning for Webex Media

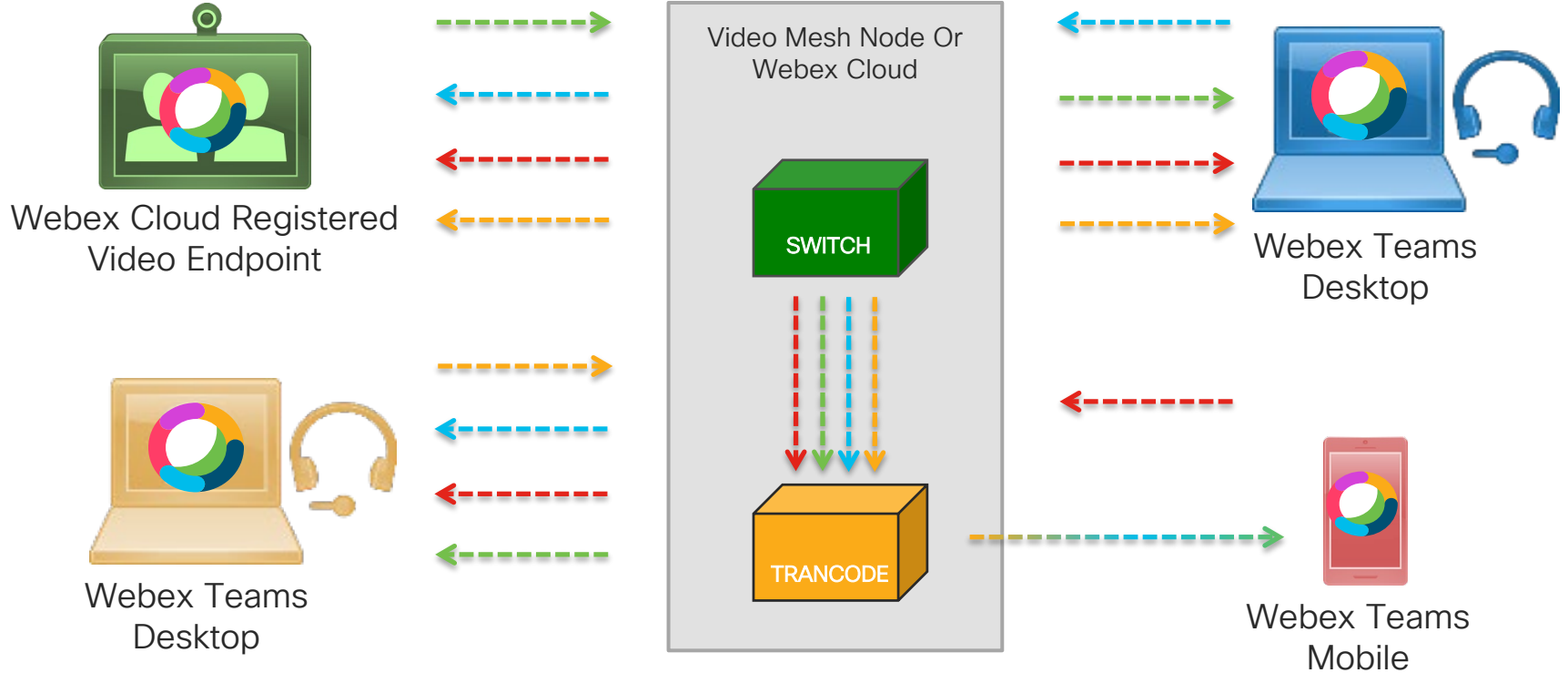


Simulcast Multistream Audio and Video





Simulcast Multistream Audio

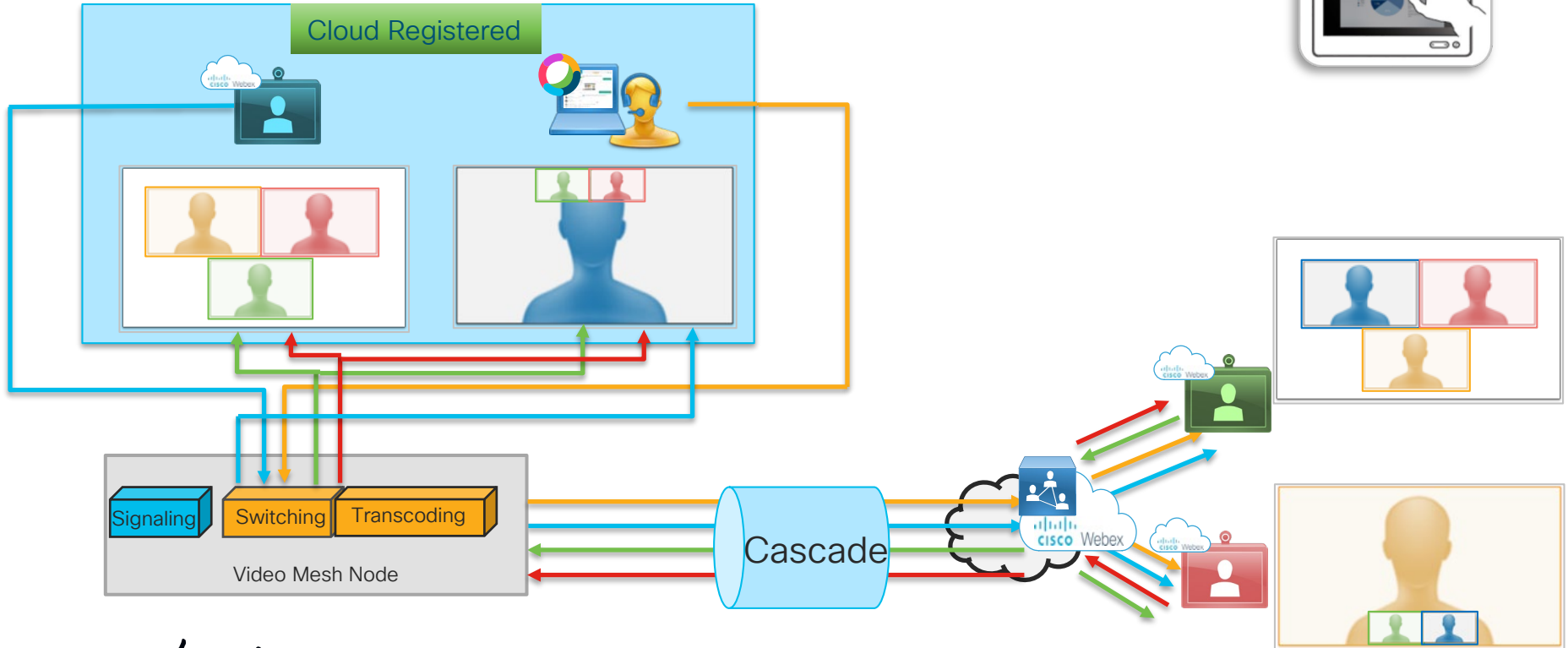


Main Video with Multiple Layouts Example



Is speaking

Active Presence and Equal View Layout



Webex Multistream Audio and Video Summary

- Audio uses the Opus codec which allows for rate adaptation
- Audio of the last 3 active speakers sent to Webex Teams and Webex Meetings App Desktop Clients as well as Cloud Registered Endpoints.
- Webex Teams and Meetings Mobile Apps are transcoded limiting audio and video streaming. **Regular audio video streaming, not multistream capable.**

Caveats and Expectations

- Bandwidth Provisioning Variability
 - Multistream Video: Multiple send and receive resolutions based on requested layouts!
 - Multistream Audio: Affects receive rate. Up to 3 audio streams!
 - Media Assure: FEC, Rate Adaptation, LTRF, GDR, Packet Pacing...
- The greater the input, the larger the buffer of spikes, the more bandwidth available for calls that exceed expectations.
 - Otherwise said: As the number of users/concurrent calls goes up, the more the bandwidth utilization will tend smooth out!
- You'll see various numbers in documentation and it doesn't mean they are wrong!
The values here are simplified as a starting point!

Approximate Bandwidth Values 720p

For Provisioning Purposes – Avg values

- UCM Registered SIP endpoints – Expressway sizing
 - Voice call (or audio stream of a video call): 80 kbps
 - Video streams of video endpoints: 2mb at 720p resolution
 - Use Video Mesh sizing for UCM registered endpoints

Approximate Video Bandwidth Values 720p

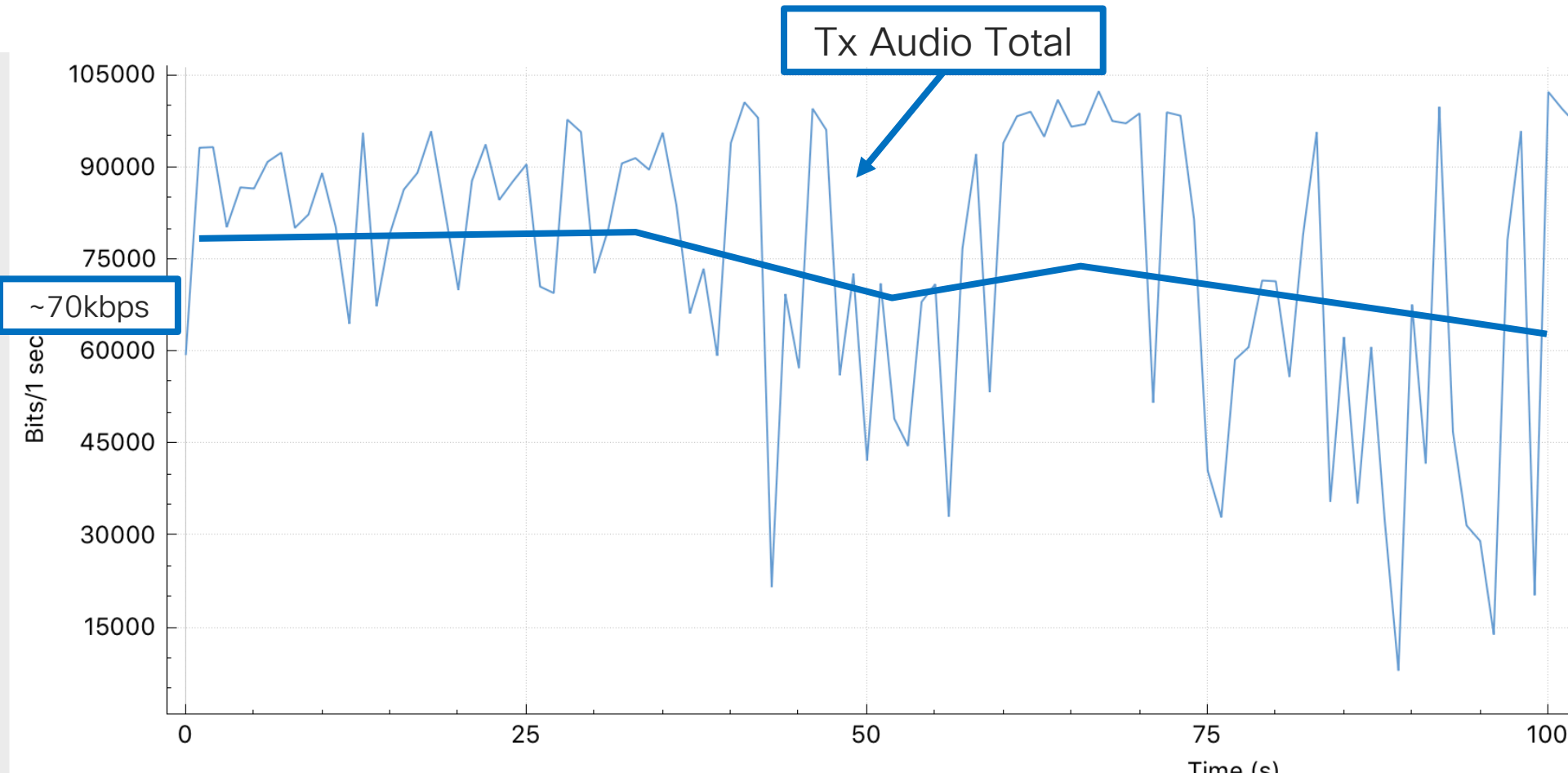
For Provisioning Purposes – Avg values

- Webex Mtgs App Desktop/Mobile: 1.8mb-2mb
 - Grid 5x5 = 5MB (Max)
 - High FPS Content Share: Addtl 1mb - 2.5mb (max=intensive video)
- Teams Clients and Apps Desktop/Mobile: 2mb
 - Teams Clients: 2 Mbps at 720p resolution, 1 Mbps at 540p resolution and 500 kbps at 360p resolution
- Cloud Registered Endpoints (Single/Dual): 2mb/4mb
- Video Mesh Per Meeting Cascade: 12mb

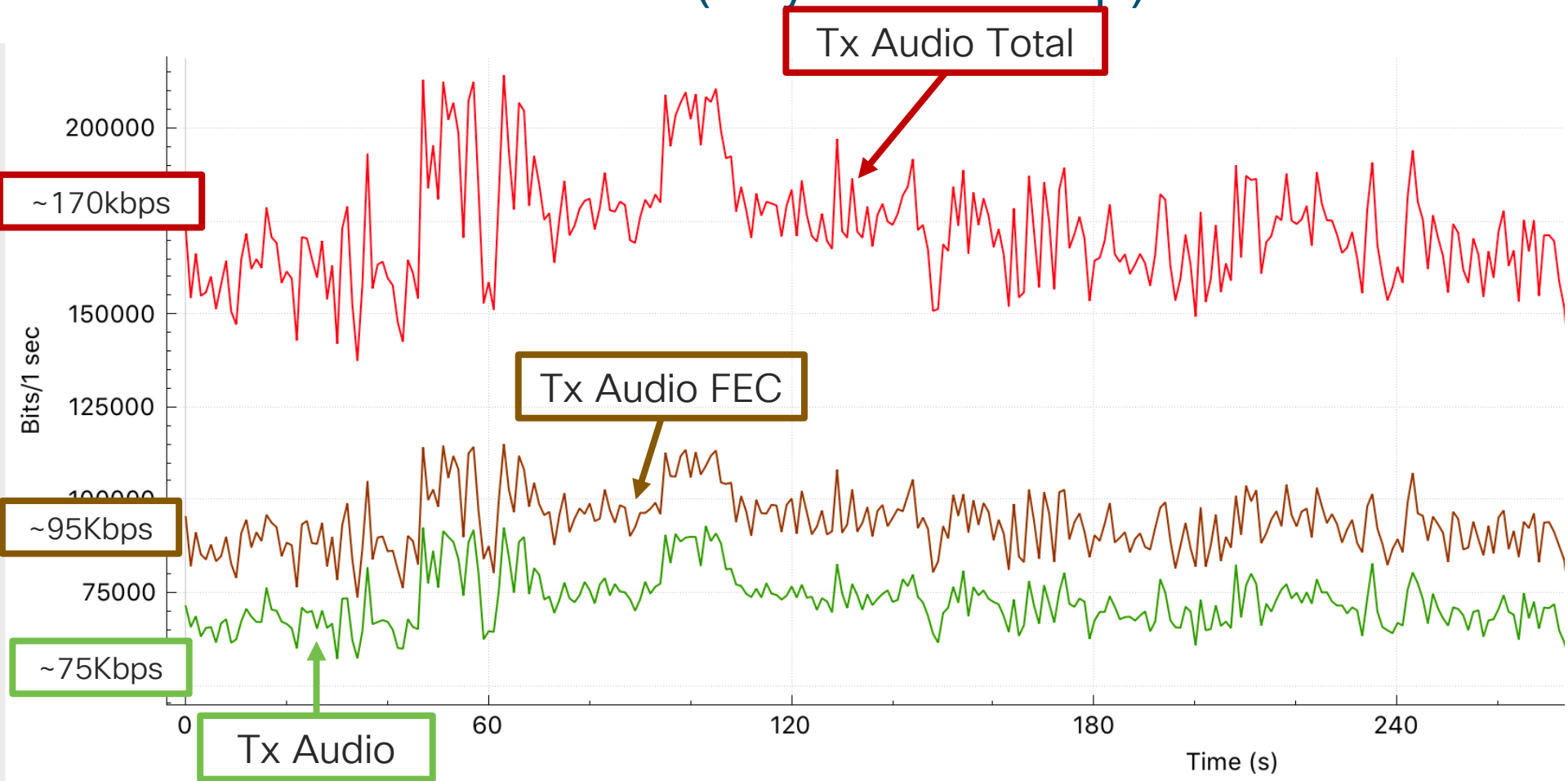
Using these values is a good starting point,
but only a starting point!

Your mileage may vary

Webex Meetings App Audio (Layer 3 and up)



Webex Teams Audio (Layer 3 and up)

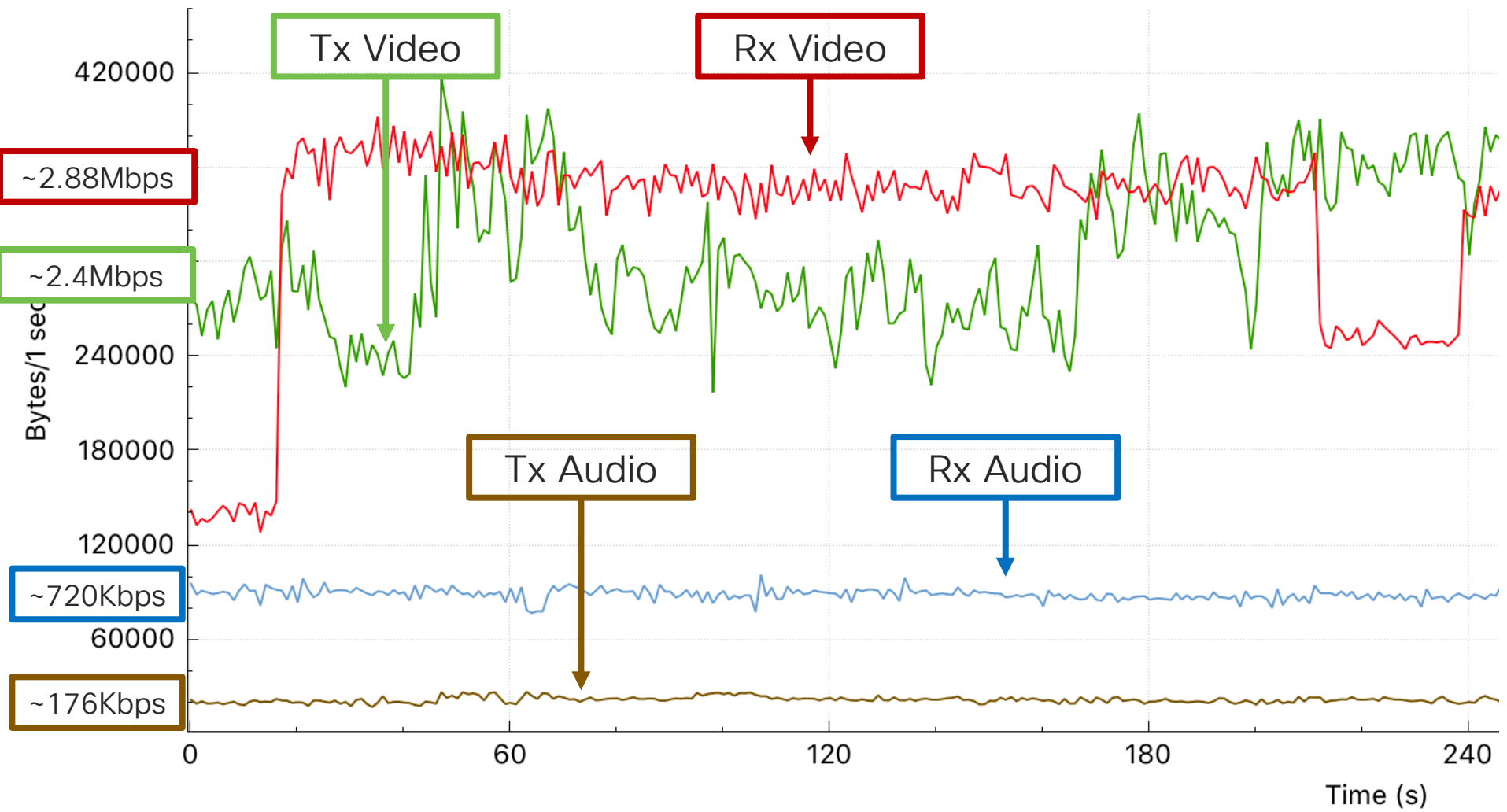


Approximate Audio bandwidth Utilization

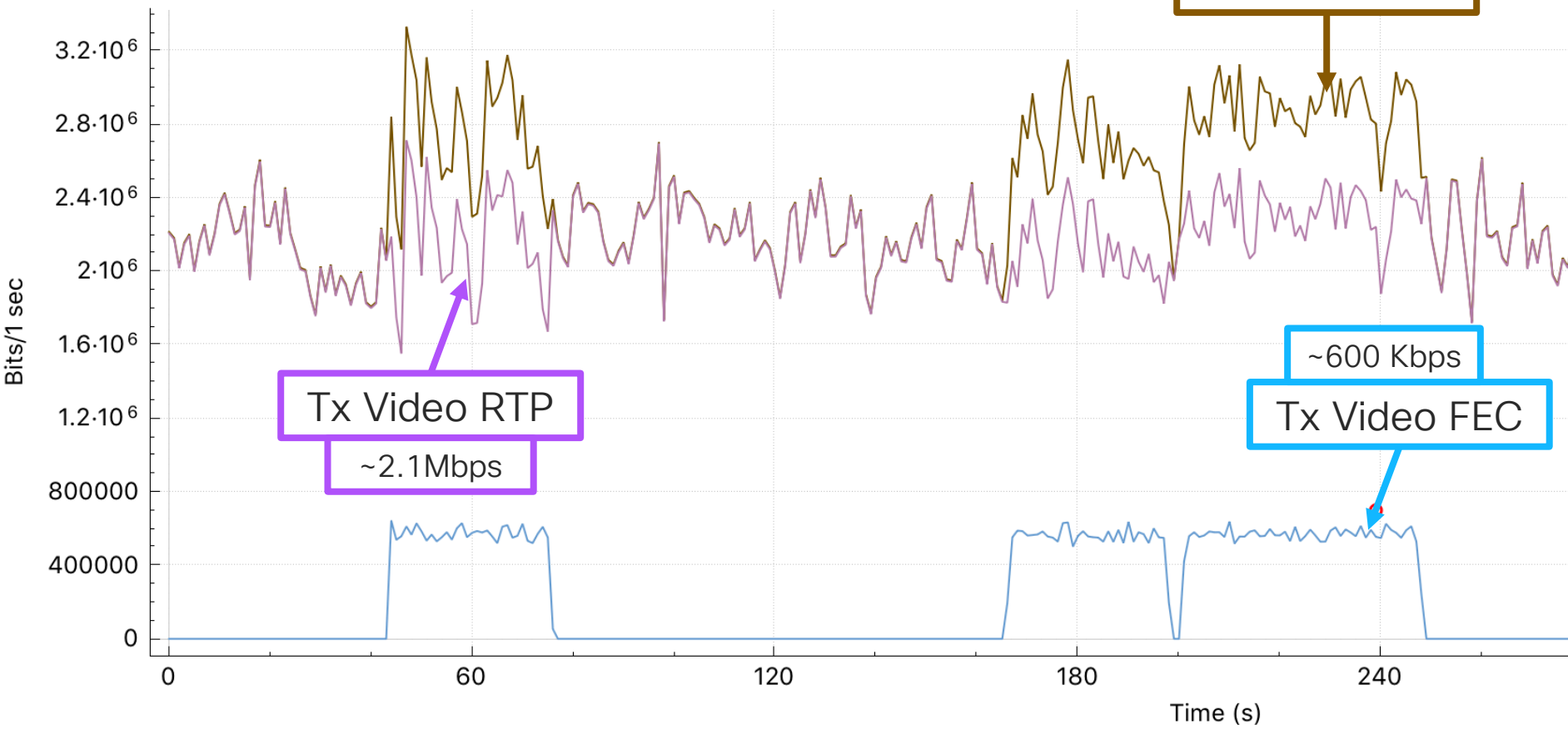
For Provisioning Purposes – Avg values

- Due to multistream audio more bandwidth is required for meetings with groups of 3 or more. We recommend provisioning approx 100-120k per user to account for the meeting bandwidth.
- Webex Teams Audio bandwidth uses about ~170k avg
 - 100% packet redundancy!
- Webex Meetings App Audio uses about ~70k avg
 - Packet redundancy increases as packet loss rises

Your mileage may vary



Wireshark IO Graphs

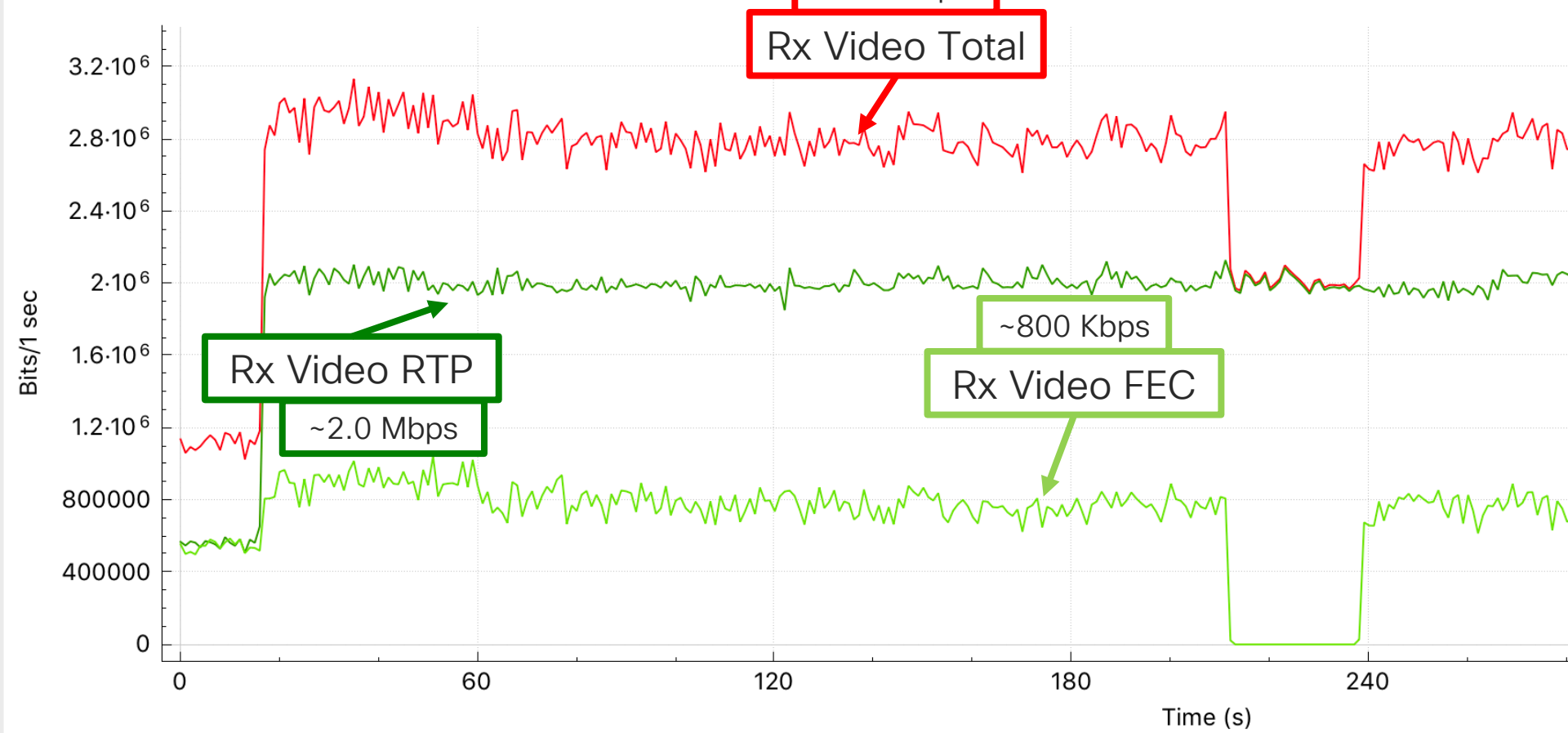


Tx Video RTP
~2.1Mbps

~2.7Mbps
Tx Video Total

~600 Kbps
Tx Video FEC

IO Graphs: Meeting capture



~2.8 Mbps

Rx Video Total

Rx Video RTP

~2.0 Mbps

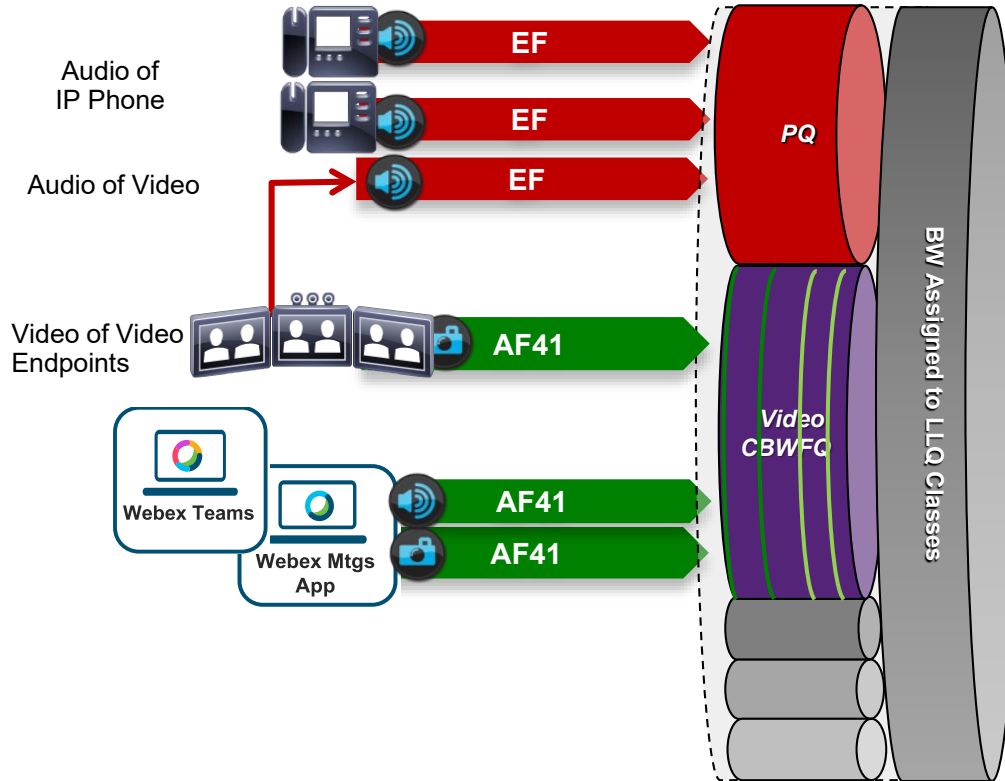
~800 Kbps

Rx Video FEC

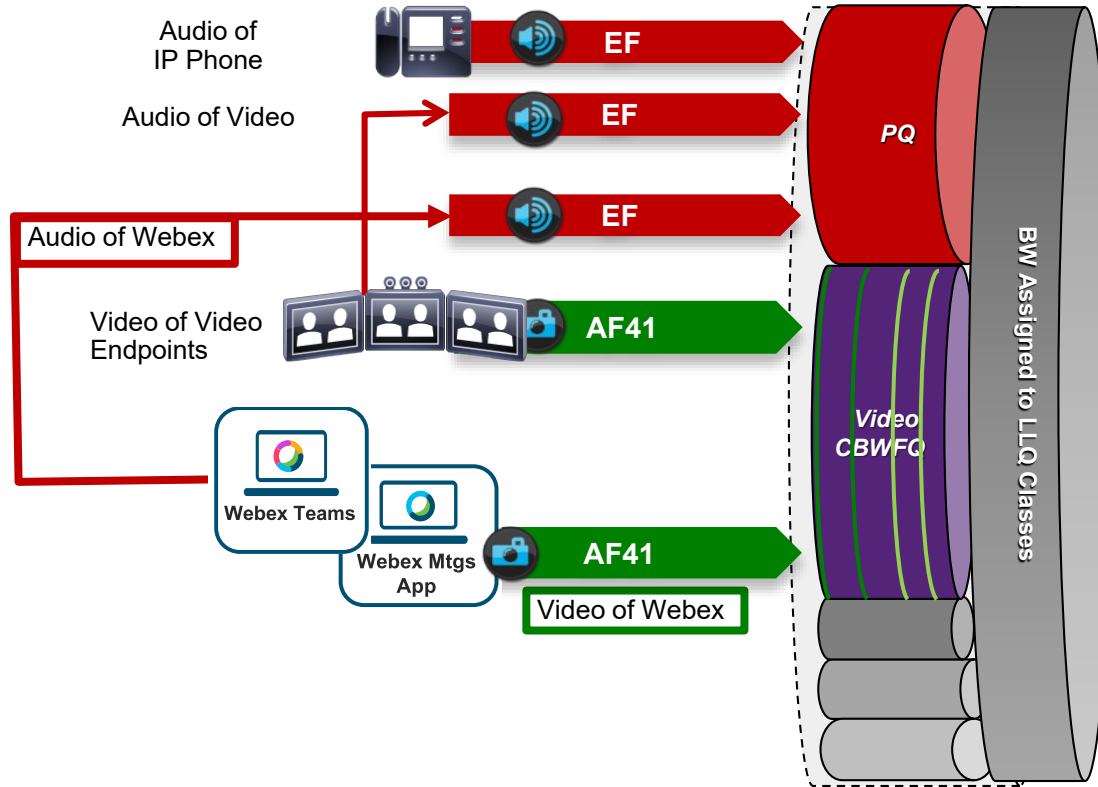
Time (s)

	↑ Transmit		↓ Receive	
Video	Main	Screen Share	Main	Screen Share
Resolution	1280 x 720	--/--	1280 x 720	--/--
Frame rate	29 fps	--/--	30 fps	--/--
Bit rate	1557 kbps	--/--	1509 kbps	--/--
Packet loss	0 %	0 %	0 %	0 %
Roundtrip/Latency	200 ms	0 ms		
Jitter	0 ms	0 ms	9 ms	0 ms
Transport	UDP	UDP	UDP	UDP
Audio				
Codec	Opus		Opus	
Bit rate	21 kbps		251 kbps	
Packet loss	0 %		0 %	
Roundtrip/Latency	195 ms			
Jitter	0 ms		9 ms	
Transport	UDP		UDP	

Mixed Environment



Mixed Environment



Key Takeaways

- Create a Simplified Ingress Remarking Policy – Use throughout the network
 - UDP Port ranges and/or NBAR2 to classify traffic
- Egress Queuing Policy
 - Single video queue for AF class traffic model is recommended
 - Consider multiple classes of Video AF41, AF42, AF43 (Dependent on ability to differentiate video through ports/NBAR)
- If you have both Webex Audio and constant bit-rate (CBR) Audio consider putting Webex Audio in the Video Queue (AF41)
 - Provision bandwidth for it
- **Size, Provision, Monitor and Re-evaluate!**

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