Bandwidth Requirements for Meetings with Cisco WebEx and Collaboration Meeting Rooms

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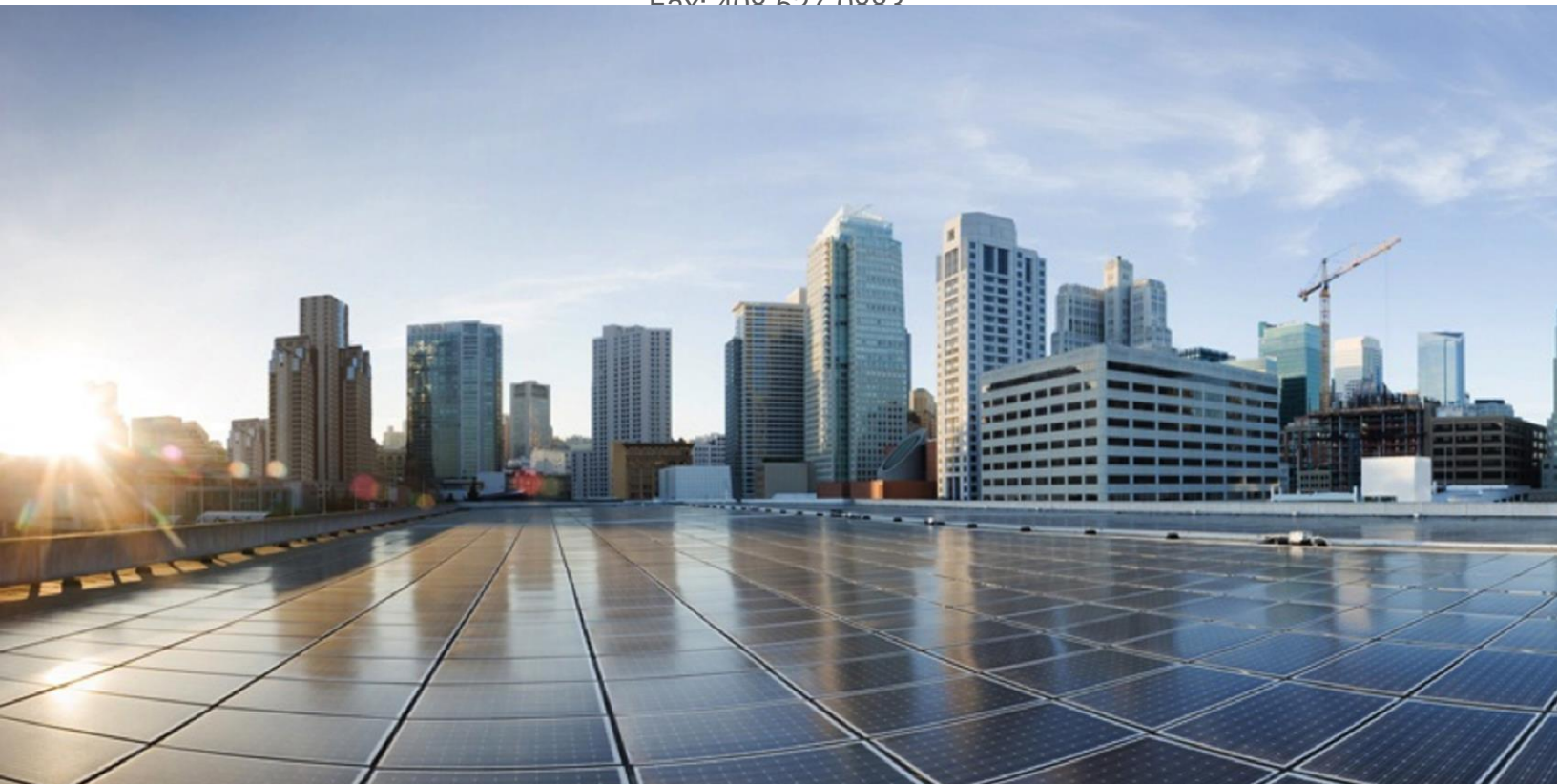## WebEx Meetings without Telepresence Participants

In this white paper, we will discuss how Cisco® Collaboration Meeting Rooms (CMR), when enabled on a Cisco WebEx® site, affects the meeting experience. First we'll cover bandwidth requirements for meetings with only WebEx® users, and then the requirements for both Cisco CMR Hybrid and Cisco CMR Cloud, to help you deliver optimal user experiences.

WebEx sites (such as Cisco.webex.com) provisioned for CMR can also be used to host meetings using only the WebEx desktop or mobile application - these are considered meetings without telepresence.

The meeting experience will be the same as before any type of CMR was added to the WebEx site provisioning. That means that as users share data and main video, all participants will send and receive the best version of the meeting that their client is capable of.

When Cisco WebEx and telepresence applications are brought together in a CMR Hybrid or Cloud meeting, the WebEx application must agree on a common video layer. We'll explore the effects of that action in later sections; first, we'll review bandwidth requirements for meetings without telepresence.

Bandwidth Requirements for WebEx Meetings without Telepresence Participants

When a user schedules a WebEx meeting using CMR Hybrid, if telepresence is not added at that time, the meeting is considered WebEx only (Figure 1). That means that only WebEx clients, mobile or desktop, may join. The same is true for CMR Cloud-based meetings in which telepresence is not added during scheduling.

Figure 1.   Meeting Topology for Meetings without Telepresence Participants

Cisco WebEx clients use H.264 SSL VPN Client (SVC) technology to communicate with both participants in the WebEx Cloud and participants on WebEx mobile and desktop clients. Where necessary, the system will send and receive one or more SVC layers to permit the best possible viewing experience for all users, regardless of individually available bandwidth. Highly connected participants may be asked to send lower SVC profiles if WebEx clients connected at lower speeds request it.

During the meeting, additional thumbnail layers are sent to and from participants as well, providing the ability to see the active speaker as well as the rest of the group. As network conditions and capabilities change, the WebEx client periodically runs a client test procedure to determine whether or not to move to a higher or lower SVC layer to improve the experience. All of these procedures are performed without any user intervention.

Typical Measured Participant Bandwidth in WebEx Meetings without Telepresence Participants

Table 1 shows average bandwidth consumption during a meeting using only WebEx applications. Because these values are for video traffic only, please add an average of 60 to 150 kbps for VoIP traffic (where present). If audio is out-of-band, such as PSTN or cellular, there is nothing to add. Scenarios where VoIP traffic is added include choosing "Call My Computer" from the audio prompt in a desktop client or "Use the Internet for Audio" in a mobile client.

Table 1.   Average Bandwidth Consumption for a Meeting Using Only WebEx Applications

Session	HD	HQ-Active Video			
Source	720 p	180p	360p	Six thumbs at 90p	One 180p + Six thumbs at 90p
Sender traffic (kbps)	1750-2380	330	911	-	-
Received traffic (kbps)	1260-1820	245	635	313	482

The actual bandwidth used by a WebEx client depends on a variety of factors, such as:

- Is the WebEx client presenting?
- Is the WebEx client receiving a presentation?
- Does the current active speaker have the camera turned on?
- Is the WebEx client viewing the presentation in "full-screen" mode?
- Is the presenter using two monitors?
- Are the attendees viewing the meeting in docked mode, with the video in the top right corner only?
- What kind of motion are user cameras picking up?
- How quickly is the presenter advancing slides or changing scenes?
- At what resolution is the presentation being sent?

The WebEx client is designed with bandwidth optimization in mind. It will not broadcast a 720p camera main video image, for instance, if that client is not currently the active speaker in the meeting. Even if it is the active speaker in a meeting, it will not send a 720p image unless someone in the meeting requests it. For example, a WebEx client in a meeting using only WebEx applications must be viewing the main video data in full-screen mode for someone to request the image.

The tables in this paper were taken from the Cisco WebEx Network Bandwidth white paper; please refer to this white paper for baseline client requirements (including mobile).

Bandwidth Requirements in CMR Hybrid and CMR Cloud

Now let's explore the requirements of a CMR Hybrid or CMR Cloud meeting. First we'll discuss how the WebEx Cloud operates specifically when bringing WebEx technology together with the telepresence participants (Figure 2).

Figure 2.   CMR Hybrid and CMR Cloud Connecting to Cisco WebEx Clients
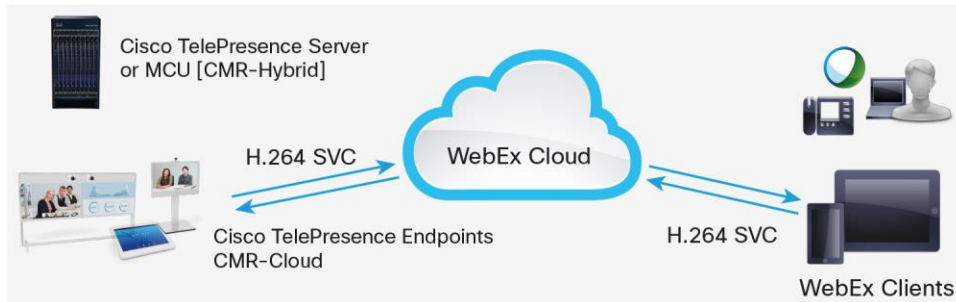
Since we can send only a single bidirectional stream over this gateway, we have the effect of choosing a "video floor" for certain participants (Table 2). This video floor is encountered primarily by Cisco WebEx mobile and desktop clients in CMR Hybrid that are not able to maintain a stable connection of ~1.3 mbps. (Mobile requirements are slightly lower; see mobile bandwidth requirements in Table 5.)

Based on the periodic client test, users below the video floor will see a yellow triangle in the main video region of the WebEx client and a low-bandwidth notification on mouse hover-over. This situation occurs only when a telepresence user is the active speaker in the main video window, from the perspective of the WebEx client. When a WebEx user is speaking to another WebEx user, that WebEx user will not experience this behavior; the normal meeting experience between WebEx applications only is the norm. It is still possible, of course, for main video to drop out with a yellow triangle in situations where communication is from one WebEx application to another, but this drop-out occurs at a much lower bitrate.

WebEx Client Bandwidth Requirements (Desktop PC or Mac)

The list of possible layers in Table 2 is not an exhaustive list. In fact, there are additional video layers between those mentioned. This list is merely a sampling of the experiences you can expect at various connected bandwidth levels.

There are, however, many factors that go into which level a particular WebEx client chooses to send and receive, in addition to available bandwidth. These factors include CPU speed and availability, available RAM, web camera type and driver, and even user activity within the application. User activity variables include:

- Is the person using the docked view?
- Is the person using a dual-monitor mode with the video full screen on one monitor?
- Is the person currently the presenter?

Table 2.   WebEx Client Bandwidth Requirements in CMR Meetings

Main Video: Common Layer between WebEx and Telepresence Applications	Data Sharing: As seen by WebEx Client	TX Bitrate for WebEx Client in CMR meeting (desktop)**	RX Bitrate For WebEx Client in CMR meeting (desktop)	Note: TX is generally higher than RX. Actual bandwidth used is typically much lower; however, clients must test as capable of these limits
HD/720p	1080p* (w/Conductor, Hybrid only)	4.0+ mbps	3.5 mbps	CMR Hybrid only, Cisco TelePresence Conductor required Source of presentation must be 1080p (16:9)
HD/720p	720p (5 or 1 fps)	3.5+ mbps	3.0 mbps	Source of presentation must be sharing at least 720p (16:9)
360p**	720p (5 or 1 fps)	2.5+ mbps	2.0 mbps	
180p	XGA	1.3+ mbps	1.3 mbps	Lowest level for WebEx client to receive main video from telepresence application
Video Floor: Below this level, no main video channel is sent between WebEx and telepresence applications. Communications between WebEx applications and those between telepresence applications operate normally.				
<none>/90p Receives low bandwidth warning	XGA	0.8+ mbps	0.8 mbps	Dropped from main video channel (will retest to re-enter); can still send and receive 90p with other WebEx clients but receives low bandwidth warning when a telepresence is the active speaker. Frames will begin to be sacrificed in the data channel, and freezing can begin to occur.

Assumes 60 to 80 kbps of VoIP audio is in use (Call My Computer Back option); if not, requirements are 60 to 80 kbps lower for every entry in this table for PSTN audio (WBS 28 sites).

Opus audio codec is in use on every WebEx site. WBS 29.8 and later and requires 70 to 150 kbps, so bandwidth requirements will be ~10 to 70 kbps higher in this table for VoIP users on WBS 29+ (PSTN users subtract 60 to 80 kbps).

*Note: WebEx mobile client requirements differ from this chart (see Table 2).

**For presenters from the WebEx client, TX is limited to 360p (also true for meetings using only WebEx applications). For telepresence users, presenters can send 720p to WebEx clients. This happening does not mean that the presenter negotiates a lower SVC layer while presenting; the client test and SVC layer determination are still based on the same factors such as available bandwidth, CPU, and RAM.

Cascade Link Bandwidth Requirements

Next, we'll discuss the differences in requirements for the cascade link, which sends the active speaker from the on-premises bridge to and from WebEx clients and the individual telepresence endpoints (Figure 3). First we will look at telepresence endpoint bandwidth availability (Table 3), which is typically extremely high. When endpoints connect over the Internet and through Cisco Expressway Mobile and Remote Access links, and register to an on-premises Cisco Unified Communications Manager system over the public Internet, these values will be important. They are not typically critical, however, in enterprise and campus environments.

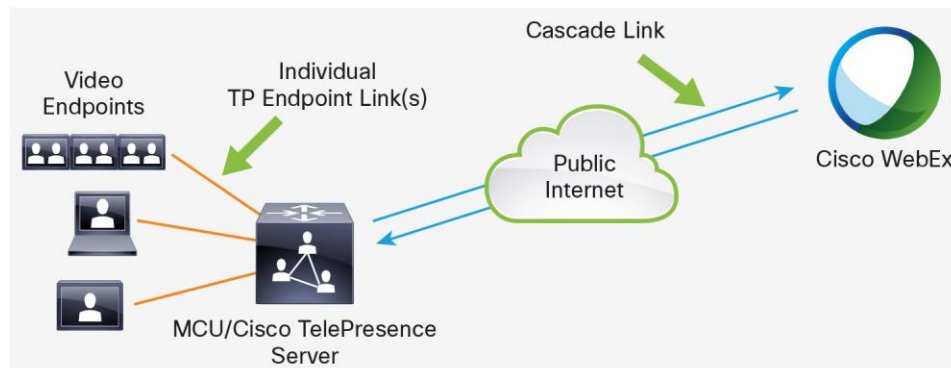**Figure 3.**   Differences in Requirements for the Cascade Link

Table 3. Telepresence Endpoint Requirements in CMR Hybrid

Call Rate	Main Video	Data Sharing	Notes
2.5+ mbps	1080p/30	1080p/5 fps[**]	Requires Cisco TelePresence Conductor for 1080p data sharing to WebEx clients
>1.2+ mbps	720/30	720p/5 fps[**]	[*]
700K - 1.2 mbps	576p	720p/1-5 fps[**]	[*]
500K - 700K kbps	448p	720p/1[**]	[*]
384K - 500K kbps	360p	XGA/1 fps[**]	[*]
<384K kbps	288p	XGA/1 fps[**]	[*]

[*] Conference layout and specific telepresence endpoints will vary somewhat from these tables, and the motion vs. sharpness setting is particularly important here.

[**] Assumption is that data sharing is always active in the meeting.

In typical meeting operation, the cascade link from the customer site to the WebEx client is expected to be stable and engineered (Table 4). It is assumed to have appropriate bandwidth and QoS to not be affected by other traffic flows from the customer location through the service provider hosting the link.

Table 4. Cisco TelePresence Cascade Link Requirements in CMR Hybrid

Call Rate	Main Video	Data Sharing	Notes
2.0 - 4.0 mbps	720p/30	1080p/5 fps (or 720p/5 fps)	Requires Cisco TelePresence Conductor for 1080p data sharing; main video is capped at 720p

[*] These levels are experienced through downspeeding only during a network impairment event; we require a 2.0-mbps (minimum) cascade-link call to WebEx clients.

[**] Assumption is that data sharing is always active in the meeting.

[***] Various multipoint control units (MCUs)/telepresence servers/5300 Series MCUs will experience some variations with respect to conference layout and with particular sensitivity to the motion vs. sharpness setting for the conference.

Mobile Device Requirements in CMR Hybrid and Cloud

Mobile device users in CMR hybrid and cloud (Figure 4) share the same requirements table. As with WebEx desktop clients, when another WebEx user is the active speaker, that speaker will be unaware of any video floor effect. However, Table 5 shows the bandwidth required when a telepresence user is the active speaker, in order for the mobile user to remain in the main video (or data) conference.

The table breaks down the cumulative bandwidth requirements for WebEx clients on mobile devices. The rows are additive, so where presentation sharing is present, add that value to the requirements of the main video and the audio channel. (If using VoIP, for instance, the "Use the Internet for Calling" option was selected when the mobile client joined the audio side of a WebEx conference.)

For example, to remain in the main video side of the conference when a telepresence user is the active speaker, add +600 kbps to ~178-328 kbps (call it 250 kbps) and then add for VoIP if applicable; for example, 850 kbps is required for a mobile device for the 180p layer.

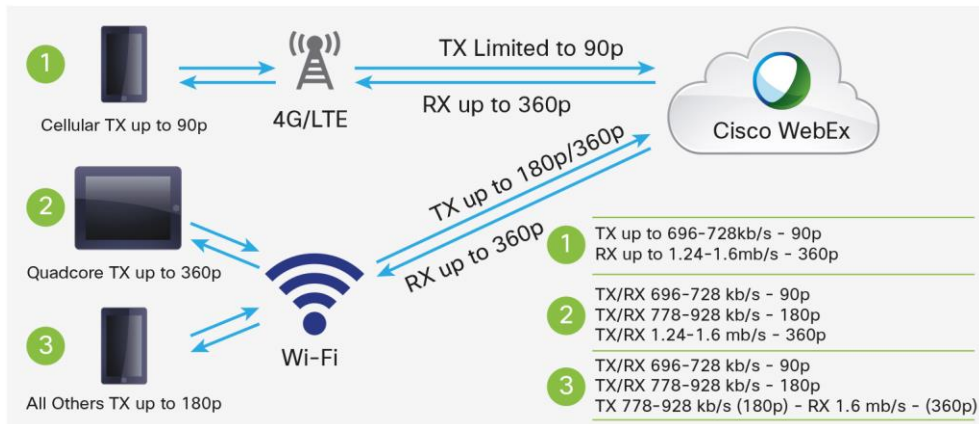**Figure 4.**   Mobile Data Requirements Topology Overview

Table 5.   Mobile Bandwidth Requirements

SVC Layer	Main Video Rate	Data Sharing	Total BW Required
90p layer	96-128 kbps	600 kbps	696-728 kbps**
180p layer	178-328 kbps	600 kbps	778-928 kbps**/***
360p layer*	640-1 mbps	600 kbps	1.24-1.6 mbps**/***

* Please see Table 6; not all mobile devices have this layer.

** Add 50 kbps if also using VoIP audio (noncellular), aka "Use Internet for Audio" option.

*** Traffic can be asymmetric (for example, TX and RX on different layers).
Please remember that because of Apple Store requirements, cellular-connected (even 4G LTE high-speed networks) mobile devices are limited to the 90p/TX layer (they can receive higher levels where facilities exist, however). Connect using Wi-Fi to bypass this limitation.

Mobile Device Capabilities as WebEx Clients

Not all mobile devices have equal video capabilities, of course, and Table 6 breaks down what you can expect from your device in a meeting. Please also remember that when connected to a cellular network rather than Wi-Fi, mobile devices are limited to sending 90p, per existing agreements with the Apple and Play stores.

In other words, mobile users who are sending video while connected to a mobile network can be seen only by other WebEx clients (both mobile and desktop). The telepresence side will see a silhouette of mobile users in this scenario, because the send capability is below the 180p floor requirement. Switching to Wi-Fi, however, will solve this problem.

Table 6.   Mobile Device Capabilities as WebEx Clients

Mobile Device Type (Wi-Fi only)		Send (up to) Wi-Fi Connected	Send (up to) Cellular Connected	Receive (up to)
Android*	**Quad Core**	360p	90p	360p
	Dual Core	180p	90p	360p
	Single Core	Cannot send	Cannot send	360p
iPad 2+		180p	90p	360p
iPhone		180p	90p	360p
BlackBerry		180p	90p	360p
Windows Phone 8		180p	90p	360p

* Android sharing disables the main camera, so it will be seen only as a silhouette by both WebEx and telepresence users (and bandwidth requirements are lowered for the Android presenter in the TX direction).
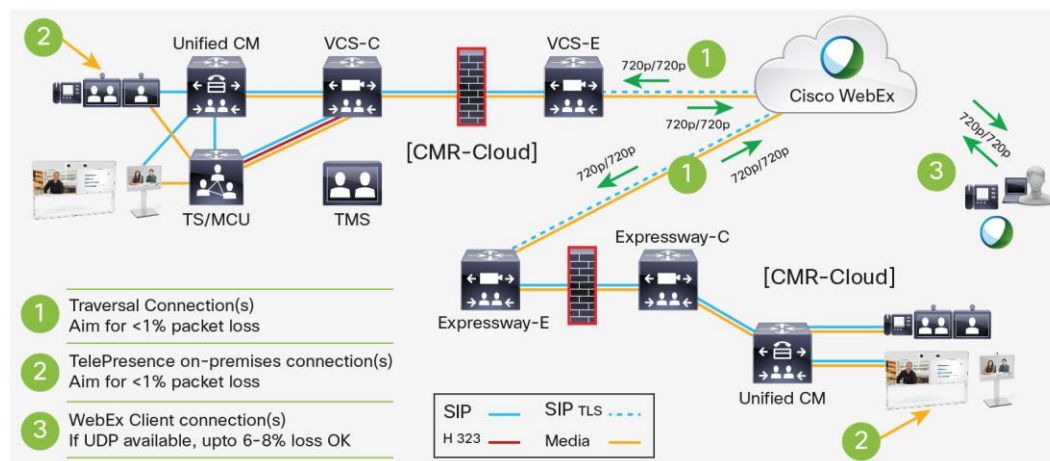
Network Impairment Tolerance

In the top half of Figure 5, you'll see a sample CMR Hybrid deployment, complete with an on-premises multipoint control unit (MCU) or telepresence server (TPS). The bottom half retains the same call-control elements, but is absent for on-premises MCU or TPS. The primary difference in these two environments is that telepresence endpoints join the on-premises MCU or TPS in CMR Hybrid deployments, and send a single cascade link to WebEx clients. In CMR Cloud, on the other hand, every telepresence endpoint individually calls into WebEx client.

Point 1 in the figure represents either the cascade link from CMR Hybrid, which is the MCU or TPS dialing into the WebEx client, or each of the individual calls from telepresence endpoints into CMR Cloud. Point 2 represents the on-premises endpoints calling into the MCU or TPS and any potential network impairment they may encounter on this link. Note that if the participant is using Mobile and Remote Access through Cisco Expressway, this link also would include that path over the public Internet.

For CMR Cloud, please consider this equivalent to any point-to-point testing you can perform on your local enterprise network. This testing may include WAN or campus links that you must traverse in order to egress the Expressway/VCS device to leave your network and dial into WebEx meetings. Position 3 in Figure 5 represents Cisco WebEx desktop or mobile clients that have joined the meeting. When facilitating your own meetings, you'll want to note whether the desktop client is User Datagram Protocol (UDP)-capable or in fallback to Transmission Control Protocol (TCP) mode, because it cannot open a UDP connection.

**Figure 5.** CMR Hybrid and Cloud Combined Network Requirements

WebEx clients have a limited capability to tolerate network impairments, such as loss, jitter, and high round-trip times, when TCP-connected versus UDP (Table 7). It is extremely important to ensure that the WebEx client is successfully connected to a WebEx meeting through UDP. Any WebEx desktop client, whether PC or Mac, simply needs to check under Meeting > Audio & Video Statistics to see which ports the client is using (Figure 6).

Table 7.   Network Requirements for CMR Hybrid and Cloud

	Leg in CMR Call	Packet Loss	Latency (RTT/ms)	Jitter (cumulative)
1	WAN leg MCU to WebEx (Hybrid) or telepresence to WebEx (Cloud)	Good = <0.05% OK = <1%	Good =<150 ms OK = <250 ms	Cumulative end-to-end jitter must be less than ~40-50ms
2	Telepresence endpoints to MCU (Hybrid) or telepresence endpoints in point-to-point calls on premises (Cloud)	Good =<1% OK =<1-10%*	Good =<200 ms OK =<300 ms	""
3	WebEx Clients to WebEx (UDP)	Good =<2% OK =<6-8%	Good =<300 ms OK =<400 ms	""
	WebEx Clients to WebEx (TCP)	Good = <1% OK =<1-2%	Good =<200 ms OK =<300 ms	""

*Where ClearPath is available, less packet loss is always better.

Figure 6.   Audio and Video Statistics Information in the WebEx Client
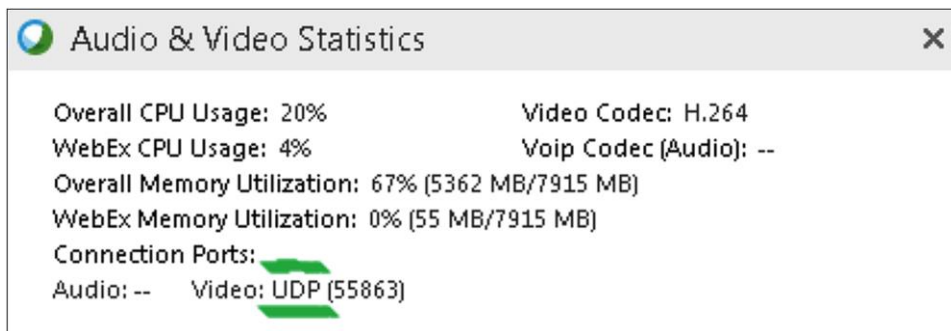
So please keep in mind that the tolerance the WebEx client has for impairments in a meeting has two distinct levels - one for TCP connections and one for UDP, where UDP ports 9000/9001 are available and open from the WebEx client to the WebEx site.

Best Practices for Cisco WebEx and Cisco CMR Meetings

- Ensure WebEx clients are connecting through UDP (vs TCP fallback).
- Turn off the camera on mobile devices when you're not active speaker - to remove yourself from the floor calculation.
- Turn off the camera on WebEx clients that are experiencing low-bandwidth warnings.
- Perform a network assessment test particularly for Wi-Fi users to ensure adequate connectivity.
- Ensure WebEx site settings are set to 15 fps for video, and that HD and 360p video are enabled.

Summary

CMR meetings have special bandwidth requirements and a different performance envelope than meetings using only Cisco WebEx applications.

Because of the requirements needed to build a common layer between WebEx and telepresence users, we will find a common floor, which is dynamic in any CMR meeting. This floor effect will be noticed only by telepresence users when the WebEx user is the active speaker, and vice-versa. When a telepresence user is the active speaker, seen by other telepresence users, there is no floor effect. The same is true for users communicating through only WebEx applications.

There may be concern about minimally connected WebEx users above the video floor. For example, if anyone on the WebEx side is client-tested and connected at 1.3 mbps, the common floor for the experience between the WebEx client and telepresence endpoints is set to that layer.

WebEx users who temporarily find themselves below the video floor will see the low-bandwidth yellow triangle warning and receive notice that the client will periodically retest to join the conference above the video floor. But unless their connection is truly poor (<500 kbps), they will still see, hear, and receive content and data from any active speaker using a WebEx application during this interval.

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