

Introduction

The performance of a WebEx session depends on many factors – some that vendors can control, and others that lie outside of our reach, within the customer's corporate network or home computing infrastructure. In this paper, we provide measurements for network bandwidth generated during the WebEx session.

WebEx services create data streams that vary depending on the type of application being shared, complexity of the graphics, use of Voice over IP (VoIP), use of video, and many other factors. WebEx services create network traffic only when customers actively share slides, desktop or video. Simply viewing a slide doesn't generate any activity in the meeting and creates very little network traffic. There are intermittent spikes in the network traffic during intense activity, with a return to low bandwidth use when there is no activity. This behavior is similar to standard file traffic on the network.

Bandwidth measurements for this paper were taken primarily on Cisco WebEx Meeting Center. In addition, WebEx Training Center was used to measure VoIP. The WebEx services architecture is common across all meeting services (Meeting Center, Training Center, Event Center, Support Center) and utilizes the same network traffic.

Optimized Bandwidth Usage

Cisco WebEx services optimize bandwidth usage to minimize the amount of data transmitted over the network. This helps reduce network congestion, maximize performance and improve user experience. The most significant optimizations are listed below:

Vector Graphics

Text and graphics are sent in a vector format (drawings of lines, rectangle, text, etc.) and not as bitmaps. This produces high quality images and also drastically reduces the size of the data.

Compression

All large data transfers and file uploads are compressed. This not only reduces network traffic, but also adds a level of encryption to the data stream.

Incremental Update

During application sharing, the contents of the window are dynamically updated. WebEx services incrementally update only those portions of the screen that have changed. The updates are transmitted as vector graphics commands and not as bitmaps.

Video Compression

Several video compressions and optimizations have been incorporated into WebEx Meeting Center. The size of bandwidth produced by video transmission is directly related to the rate of change of the video and its size.

Optimal Protocol

WebEx services can work through all firewalls using HTTP protocol. However, WebEx first checks to see if communication can be established using the lower level TCP protocol. This approach is more efficient and reduces network traffic by approximately 10% when compared to HTTP. For Secure Socket Layer (SSL) sites, WebEx uses HTTPS.

Measurements and Methodology

We created scenarios to test bandwidth under the following conditions:

- Idle
- Presentation share
- Desktop and application share
- VoIP

These test scenarios were created to emulate typical usage circumstances and identify how much network traffic was resulting from these activities. We also identified the high and low ranges of expected traffic to help you better understand how WebEx services may affect your network.

Measurements were conducted on the WebEx LAN. To ensure the accuracy and validity of the tests we first measured idle network traffic to ensure that information packets were not influenced by other network activities. We also ran each test multiple times to get an average result for each scenario. The version used for this test was Meeting Center T27LSP19.

BlackBerry BB Bold 9700 was used, with traffic monitored by the Mobile Data Alerter. For iPhone and iPad, we used true devices connected to a Mac and a traffic monitoring tool to monitor data usage. For PC, tests were run on Window XP and Windows 2000. All measurements were captured locally with the Iris Network analyzer tool. We monitored the inbound and outbound http traffic from the PCs to the WebEx Meeting Server. Measurements were captured from both the presenter's machine and the attendee's machine. There was no significant difference in the bandwidth, so all tests below assume both presenter and attendee traffic.

All measurements in this test are in kilobits per second (kbps), not kilobytes (KB). File sizes are measured in "K" or "KB" – short for kilobytes. A byte is 8 bits, and a kilobyte is (approximately) 8000 bits. Transmission rates are also measured in kilobits per second.

Measurement Scenarios

- Idle – baseline network traffic inside a meeting
- Presentation share – presenter shares a PowerPoint presentation with graphics and animations
- Desktop share and application share – presenter shares a desktop, running a PowerPoint presentation with 30-second transitions
- Internet phone (VoIP) – presenter and attendees have a conversation using PC microphones

Network Traffic Summary

iPhone4 (16G), BlackBerry Bold 9700 with 3G Network

	Traffic (Test Scenario)	Average (kbps)	Maximum (kbps)
iPhone	Idle meeting	0.17	0.28
BlackBerry		0.26	0.33
iPhone	Desktop share (slide presentation with 30-second transitions)	23	41
BlackBerry		2.87	3.08
iPhone	Presentation share (slide presentation with 5-second transitions)	14.5	17
BlackBerry		5.73	6.4

Network Traffic Summary

iPhone 3G, Blackberry Bold 9700, iPad (16G) with WiFi Network

	Traffic (Test Scenario)	Average (kbps)	Maximum (kbps)
PC	Idle meeting	0.8	3.7
iPhone		0.17	0.4
iPad		8.9	9
BlackBerry		0.42	0.45
PC	Desktop share (slide presentation with 30-second transitions)	43	598
iPhone		67	232
iPad		95	241
BlackBerry		24.8	29.92
PC	Presentation share (slide presentation with 5-second transitions)	6.5	7.5
iPhone		23	41
iPad		30	62
BlackBerry		54.56	55.28

VoIP (using a LAN connection)

	Average (kbps)	Maximum (kbps)
Upload direction (client to MMP server):	26	34
Download direction (MMP server to client):	56	80

Network Traffic Data Comparison Chart

iPhone 3G, iPad (16G), BlackBerry Bold 9700 with WiFi Network

Idle		
	Average (kbps)	Maximum (kbps)
PC	0.8	3.7
iPhone 3G	0.17	0.4
iPad 16G	8.9	9
BlackBerry	0.42	0.45
Presentation Share (Slide presentation with 5-second transitions)		
	Average (kbps)	Maximum (kbps)
PC	6.5	7.5
iPhone 3G	23	41
iPad 16G	30	62
BlackBerry	54.56	55.28

iPhone4 (16G), BlackBerry Bold 9700 with 3G Network

Idle		
	Average (kbps)	Maximum (kbps)
iPhone	0.17	0.28
BlackBerry	0.26	0.33

High Quality Video Bandwidth: Available in WebEx Meeting Center, Training Center and Support Center

In this chapter, we will share the test results for the bandwidth requirements for High Quality (HQ) Video capabilities available with Meeting Center (WBS27FR17), and Training Center and Support Center (WBS27FR26). The encoder and decoder both run on the client side. HQ video supports up to 360p video (640x360) at 30 frames per second. On the sending client side, the encoder compresses the captured raw data to standard bitstream and passes the bitstream to the application layer for packetization and transmission. It controls its output bit rate according to the application requirement and bandwidth availability. It produces good video quality and maintains graceful quality degradation for various network conditions. On the receiving client side, the decoder gets the bitstream from the application layer, decodes the bitstream into raw video data, and passes the raw video data to the application for rendering.

The following picture resolutions are supported: 360p (640x360), 180p (320x180) and 90p (160x90).

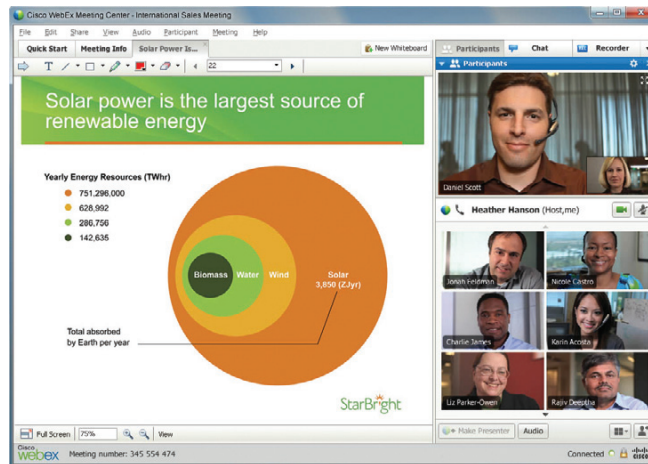
Name	Format	Display Size		Encoded Size	
		Width	Height	Width	Height
Large View	360p	640	360	640	384
Medium View	180p	320	180	320	192
Small View	90p	160	90	160	96

Depending on various conditions (user eligibility, subscription modes of the receivers, capability of camera and PC, network condition), one or two or three of the available resolutions can be encoded at the same time.

WebEx Video Modes

WebEx video provides two types of operation modes: single point video and multi-point video. Note: WebEx Support Center includes only a two-point video – to support the most common type of interaction between a support representative and the customer.

Single point video (SPV) provides one window where a single meeting participant can be viewed. The presenter determines which participant is viewed in the meeting. It's ideal for one-to-one or one-to-many meetings, where a single person is the primary focus.



Single point video is ideal for meetings where the focus is one person.

Multi-point video (MPV) in WebEx Meeting Center and Training Center provides up to six windows where up to six participants can be viewed simultaneously in addition to a single large video panel for the active speaker. Each user has the flexibility to scroll through the alphabetical list of participants. It is preferred for highly-collaborative group meetings where multiple people are actively participating. Due to the number of video streams and the flexibility available to the attendees, MPV requires more bandwidth than SPV. Any meeting participant can switch between SPV and MPV during the meeting. This can be done either through the Meeting Options menu or by right clicking the Video Panel title and selecting the video mode.



Multi-point video is preferred for collaborative meetings or training sessions where multiple attendees are actively participating

Average Bandwidth Consumption

Below is the average bandwidth consumption for the different video configuration:

Session	HQ-Active Video			
Source	180p		360p	
	UDP	TCP	UDP	TCP
Sender Traffic (kbps)	320	330	911	991
Received Traffic (kbps)	261	245	609	635

Session	SQ-Thumbnail Video			
Source	6 thumbs @ 90p		One 180p + 6 thumbs @ 90p	
	UDP	TCP	UDP	TCP
Received Traffic (kbps)	301	313	482	477

Please note that the above data is average. The nature of video traffic is that it is bursts depending on what the camera sees. Below are some examples of the bandwidth measured during our test with moving subject versus static subject.

Session	HQ-Active Video															
Camera	Logitech 9000						Logitech LS 7500						VCamera			
Source	Talkinghead.wmv				No moving		Talkinghead.wmv				No moving		wine_tasting2.avi			
	180p		360p		180p		180p		360p		180p		180p		360p	
	UDP	TCP	UDP	TCP	UDP	TCP	UDP	TCP	UDP	TCP	UDP	TCP	UDP	TCP	UDP	TCP
Sender Traffic (kbps)	271	264	881	975	72	89	290	308	888	923	59	58	320	330	911	991
Received Traffic (kbps)	220	235	603	631	47	57	228	244	604	628	54	46	261	245	609	635

Maximum Bandwidth Consumption

Note that the bandwidth requirement for sending the video is higher than the requirement for receiving the video. This is due to the technology used in the client software where we send more information within the multilayer frames, compared to receiving the video data traffic, specific to local capabilities.

		Max bit rate (Send)	Max bit rate (Receive)
High Quality	360p (640x360)	1.5 Mbps	1 Mbps
Standard Quality	180p (320x180)	0.5 Mbps	0.5 Mbps
6 Thumbs	90p	N/A	0.5 Mbps
1 Thumb	90p	50 kbps	N/A

The video quality can be set by the site admin for the entire site and/or at the host account level, user level (attending) settings have no control over the video quality, this is done automatically during the meeting based on various factors. Host can choose to schedule the meeting with maximum video resolution up to 360p or 180p. Thumbnail video is always at the 90p, no settings are available to change it.

HQ (360p) resolution @ 24-30fps, SQ (180p) @ 12fps, Thumbnail video @ 6-10fps (see frame rate range section for more details)

Examples of the bandwidth consumption for video use only (no data, no VoIP)

Please note that the client is capable of displaying one main window with active speaker, which means that at any time when the person is speaking, his/her video would appear in the main enlarged window. In addition to the main active speaker window, client can view up to 6 additional scroll-able thumbnail views in the participant list and up to five additional scroll-able thumbnail windows in the theatre (full screen) mode.

a. 3 participants all capable of sending and receiving video @ 360p scenario:

- 3 high-quality (360p) + 2 (90p) thumbnails on received view
- send: 900 from webcam = 900 (1Mbps) average per participant
- receive: 600 + (2x40) = 680 (0.7Mbps) average per participant

Explanation: On the send, we take the average (or maximum) for the resolution predicted based on hardware and network quality, which averages 1Mbps. There is no need to account for thumbnails, because we are only sending video from a single web cam per client. On the receiving site, we are calculating about 0.6Mbps for the main video with active switching, plus two thumbnails from the two other participants to show continuous presence. If we disable the thumbnails and switch to the regular active speaker window only, we would save approximately 80-100 kbps from the thumbnail view.

- b. 8 regular quality @ 180p participants in the meeting scenario.
- 8 regular quality (180p) + 6 (6x 90p) thumb nails received view
- send: 320 from webcam = 320 kbps (0.3Mbps) average per participant
- receive: 250 + (6x40) = 490kbps (0.5Mbps) average per participant

Explanation: On the send side, we take the average (or maximum) for the resolution predicted or configured with HQ disabled, which equals about 350kbps (average) or 0.5Mbps (maximum). On the receiving site we account for an average of 250kbps for the main active speaker window plus optional 6 thumbnails (6 x 40) average equal to 0.5Mbps average on the receiving side per participant with thumbnail view enabled.

Note: Above examples are per each client calculation; this needs to be multiplied by the number of clients on the network per conference and essentially the number of conferences any given time.

Frame Rate Range

WebEx supports various frame rate ranges. On the sender side, it depends on the camera capture capability and available computing and bandwidth resources. On the receiver side, it further depends on the bandwidth and computing resources.

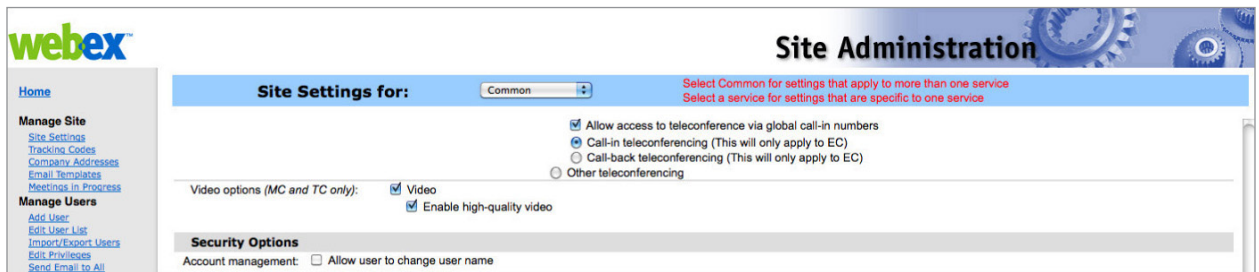
- Up to 30fps Large Video format is supported in one-on-one meetings.
- Up to 24fps Large Video format is supported for other cases.
- For Medium Video format, when it is encoded together with Large video, up to 12fps is supported.
- When Large Video format can't be captured, but receivers are subscribing to Large Video view, up to 24fps Medium Video format is supported.
- The lowest frame rate (that is, the temporal base layer frame rate), for Medium Video format and Large Video format is 5fps.
- Small Video format needs to sync up with the Medium Video format at the half-rate. The typical frame rate is 6fps, and its change can be in 5fps – 10fps.

The above design is based on the following considerations:

- Typically, 24fps provides fluent video for conferencing applications.
- Up to 30fps is required for specific use case.
- Smaller video format can have smaller frame rate, and visual testing on various resolution/frame rates have been run.

Site-level control

At the site level, the administrator cannot control the default and the maximum bandwidth levels for multipoint video compare to previous non HQ video site. The levels and frame rates are controlled automatically by software. Admin can't choose the default. Admin can choose to disable the HQ mode and limit the video to 180p resolution. See below picture for the checkmark to "enable HQ video".



User-Level Control and View

Name	Definition	Note
List View	Only one MV of the (curr/prev) active speaker on the panel	Option 1: the current speaker sees the previous speaker; Option 2: the current speaker sees self; all others see the current active speaker.
Thumbnail View	One MV of the (curr/prev) active speaker plus up to 6 SV	When the current speaker has no video, all see previous speaker
Theater Mode	One LV of the (curr/prev) active speaker plus upto 5 SV	In sync mode, the presenter assigns whom to see for all receivers, including the person him/herself.
Application Sharing	One video of the (curr/prev) active speaker, which can be SV/MV/LV	The user can drag the video window, depending on which the SV/MV/LV will be switched

Performance Requirements

The client PC's processing power can be an additional constraint to the overall video processing capability. Client software detects the PC's resources in terms of CPU, GPU and memory. The minimum requirement for realizing the full feature of HQ video with high quality support is PC with dual core 2.0GHz CPU, 1GB memory. With Single core CPU 2.4GHz and memory above 1GB you should be able to send/receive up to 180p video.

Minimum bandwidth consumption – The new HQ video client requires minimum of 384kbps internet bandwidth for audio/video/web collaboration to operate, if the minimum bandwidth on send/receive is not attained, the video feature will become disabled by the client automatically.

Supported Cameras

The following cameras were tested with the HQ video release. Additional cameras will be tested in future:

- Cisco VT Camera II
- Cisco VT Camera III
- Tandberg PrecessionHD
- Logitech Quick Cam Pro 9000
- Microsoft LifeCam HD

It should be possible to use other standard PC and Mac web cameras and USB/Fire-wire video capture cards with HQ video as well. However, our QA team has not officially tested them.

Parameters Affecting the Video Quality

Static Parameters:

- Site/host/meeting settings. For example, a video setting set by the administrator and/or host for the specific meeting may not allow HQ video at 360p resolution
- PC capabilities. For example, a non-dual core with insufficient memory can't process the 360p video quality and user will experience lower quality video.
- Camera capabilities. For example, certain cameras are capable of compensating for the low-light environment, some have auto focus, and others work in HD and require more CPU power.
- In-room lighting or backlight background.

Dynamic Parameters

- Measured bit rate – not enough bandwidth available for the client PC will automatically reduce the video quality or frame rate from 360p to 180p resolution
- Video mode and display size – 180p resolution will not achieve same video quality experience in the full-screen video mode as the 360p resolution

The displayed video size is what you see in the full-screen mode. Depending on the resolutions of your monitor, the displayed video can be scaled up and enlarged to fit the monitor screen. This video size is independent of the resolution of your incoming video source.

Note: If the highest quality of video that you can send is 180p based on your PC hardware and bandwidth available, 180p will be the largest video resolution that the remote site will be able to receive from you. We are referring to the video resolution after the decoding process. If the source of the incoming video is 180p, it is impossible for the decoder to output any resolutions higher than 180p.

WebEx Video Traffic Simulation using Cisco Medianet

Customers with Medianet IPSLA-VO enabled Cisco Catalyst switches or ISR G2 can precisely understand the impact of WebEx video on their networks prior to deployment through the Medianet Video Traffic Simulation feature. This can be done either through using the pre-loaded packet captures in the Medianet switch or by uploading customer-generated WebEx high-quality video packet captures. Once uploaded, this traffic stream can be replicated many times over to simulate WebEx high-quality video deployment across multiple sites. Traffic stream statistics are sent to a network management system (NMS) for analysis. Data collected by the switch or router includes end to end performance statistics of the traffic in the network, which helps determine whether a particular site can adequately support high quality video.

To learn more about IPSLA VO and other Cisco Medianet Media Monitoring features, please go to Cisco.com/go/mediamonitoring.

Cisco WebEx OneTouch Bandwidth Requirements

Cisco TelePresence integration with the Cisco WebEx Meeting Center web conferencing service enables transparent voice and data share between Cisco TelePresence environments and remote Cisco WebEx users. This integration extends the reach of a Cisco TelePresence meeting to remote participants.

The bandwidth requirement for Cisco TelePresence WebEx OneTouch is different from the standalone traditional WebEx video or the new HQ video featured WebEx site. 1Mbps send/receive is a minimum requirement per single meeting. Multiply this by number of expected meetings.

- Presentation video is still approximately 500Kbps max
- The maximum download needed for CIF video is variable, with the encoder rate limited to a maximum of 400Kbps per video channel
- A WebEx client can send one channel of its own camera video to the meeting server which needs up to 400Kbps (max). This requirement is only for sending the video and only one-way bandwidth of 400Kbps is needed

- A WebEx client can view multiple WebEx clients' camera videos. Each channel needs up to 400Kbps (max)
- The total bandwidth requirement for download-only speed is 400Kbps multiplied by the number of clients. Physically, the bandwidth is shared by all channels/connections, so the more channels are in use, the less bandwidth will be available per channel. For example, if you have a 400Kbps download speed and view video on four channels, each channel will have 100Kbps of available bandwidth. Internet Service Providers (ISPs) sometimes throttle the connection based on traffic direction. As a result, upload and download speeds may be different

The WebEx client average:

- CIF video - 300Kbps down only - main TP window
- Presentation - 450Kbps up and down (depends on whether the client is presenting or receiving a presentation)
- WebEx video 400Kbps up and down. 400Kbps multiplied by the number of streams the user is viewing
- WebEx VOIP - up/down 20-70Kbps

Summary

WebEx services minimize the amount of data transmitted over the network by only transmitting data when data is requested. During most of a meeting, the content is static and no data is transmitted, keeping network traffic to a minimum. When there is activity in a meeting - such as loading a presentation, changing a slide, or sharing an application - it only lasts for short periods of time, and only parts of the screen change. This includes Presentation share, desktop share, and live video.

This type of behavior produces inconsistent streams of network traffic, causing the traffic to remain below-average for most of the time, with occasional spikes to a maximum value. In a typical meeting, bandwidth requirements are usually low and have minimal impact on the network.

