WebEx

Network Bandwidth White Paper

Introduction

Network bandwidth is always a consideration when using applications and tools that provide productivity efficiencies across geographies via intranets as well as the Internet. WebEx Communications has built its core foundation on providing services that use public and private networks. The performance of a WebEx session has dependencies we can control within the WebEx interactive network and some we can not control that depend on the user bandwidth capacity whether within a corporate network or home computing infrastructure. The purpose of this paper is to provide data on the network bandwidth generated as a result of sharing data, video and voice-over IP telephony in WebEx meeting services.

Bandwidth measurements were primarily done with WebEx Meeting Center with the exception of Training Center, which was used to measure voice over IP (VOIP). The WebEx services architecture is common across all services (Meeting Center, Training Center, Event Center, Support Center) and will utilize the same network traffic.

WebEx services produce data streams that vary depending on a number of factors including – the type of application being shared, the complexity of the graphics, the use of voice over IP, the use of video, etc.

WebEx services create network traffic only when there is activity like slides changing, desktop sharing, video, etc. Otherwise, if there is no activity in the meeting (viewing a slide) then very little network traffic is generated.

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.

Optimized Bandwidth Usage

WebEx services perform several optimizations to ensure that it minimizes the amount of data transmitted over the network. This reduces network congestion, maximizes performance and improves user experience. Some of the most significant optimizations are listed below.

Vector Graphics
Text and graphics are sent in a vector format (i.e. drawing primitives 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 transfer and file uploads are compressed. This not only reduces network traffic it also adds a level of 'encryption' to the data stream.

Incremental Update
During application sharing the contents of the window are dynamic. WebEx services incrementally update only those portions of the screen that have changed. Furthermore the updates are transmitted as vector graphics commands and not as bit maps.

Video Compression
Several video compression and optimizations have been incorporated into meeting center. The size of bandwidth produced by video transmission is directly related to the rate of change of the video and size of video.

Optimal Protocol
WebEx services are able to work through all firewalls using the HTTP protocol. However, it first checks to see if communication can be established using the lower level TCP protocol. This is more efficient and reduces network traffic. Using the TCP protocol reduces network traffic by about 10% when compared to HTTP. For secure socket layer sites, WebEx uses HTTPS.

Measurements and Methodology

WebEx created measurement scenarios to test the following scenarios:

Idle
Presentation Share
Desktop and Application Share
Video - Web Camera
Video - Camcorder
Video – DVD movie
Internet Phone

The test scenarios were intended to capture typical usage scenarios and to identify how much network traffic was associated from these scenarios. We also identified the low and high ranges of the traffic you can expect to help you better understand how our service may affect your network.

Measurements were conducted on the WebEx LAN. To ensure the accuracy and validity of the tests we measured the idle traffic of the network to ensure that the packet information gathered was not influenced by other network activities. We also ran each test multiple times to get an average across each test. The measurements were captured when running tests on the current versions (Meeting Center 5.0) of the WebEx MediaTone Network.

The tests were run using PC's running Window XP and Windows 2000. The measurements were captured locally with the Iris Network analyzer tool. We monitored the inbound and outbound http traffic from the PC's to the WebEx Meeting Server. Measurements were captured from both the presenters machine and attendees machine, there was no significant difference in the bandwidth used by either, so all tests below assume both presenter or attendee traffic.

All measurements in this test are in kilo*bits* per second (kbps), not kilo*bytes* (KB). File sizes are measured in "K" or "KB" – short for kilo*bytes*. Since a byte is 8 bits, a kilo*byte* is (approximately) 8000 bits. Transmission rates are also measured in "K" but the "K" here is short for "Kbps" – kilo*bits* per second – not kilo*bytes* but kilo*bits*. Note that there are exactly 1000bits in a kilo*bit*. In this paper we will refer to "Kbps" as kilobits per second.

Measurement Scenarios

Idle – Baseline network traffic while inside a meeting.
Presentation Share – Presenter shares a PowerPoint presentation with graphics and animations.
Desktop Share and Application Share – Desktop share a PowerPoint presentation with 30-second transitions.
Video – Web Camera – Show live video of a person talking.
Video – Camcorder – Show live video of a person talking.
Video – DVD – Play a DVD movie.
Internet Phone (VOIP) – using PC microphones have a conversation using the Internet Phone function.

Network Traffic Summary

Test Scenario	Avg. (kbps)	Max. (kbps)
Idle Meeting	0.70	3.4
Presentation Share (PPT) (5 sec transitions)	6.5	7.5
Desktop Share (PPT, 30 sec transitions)	43.4	618
Video – Web Cam (352 x 288 at 15 fps)	172	298
Video – Camcorder (352 x 288 at 15 fps)	227	351
Video – DVD (352 x 288 at 15 fps)	143	590
Internet Phone (half duplex)	13	16
Internet Phone (full duplex, one person muted)	18	22
Internet Phone (full duplex, both talking)	35	42

Network Traffic Analysis

Idle

Description– A WebEx meeting open with no activity.

Scenario - Measure the meeting traffic with presenter and attendee in the meeting with no activity.
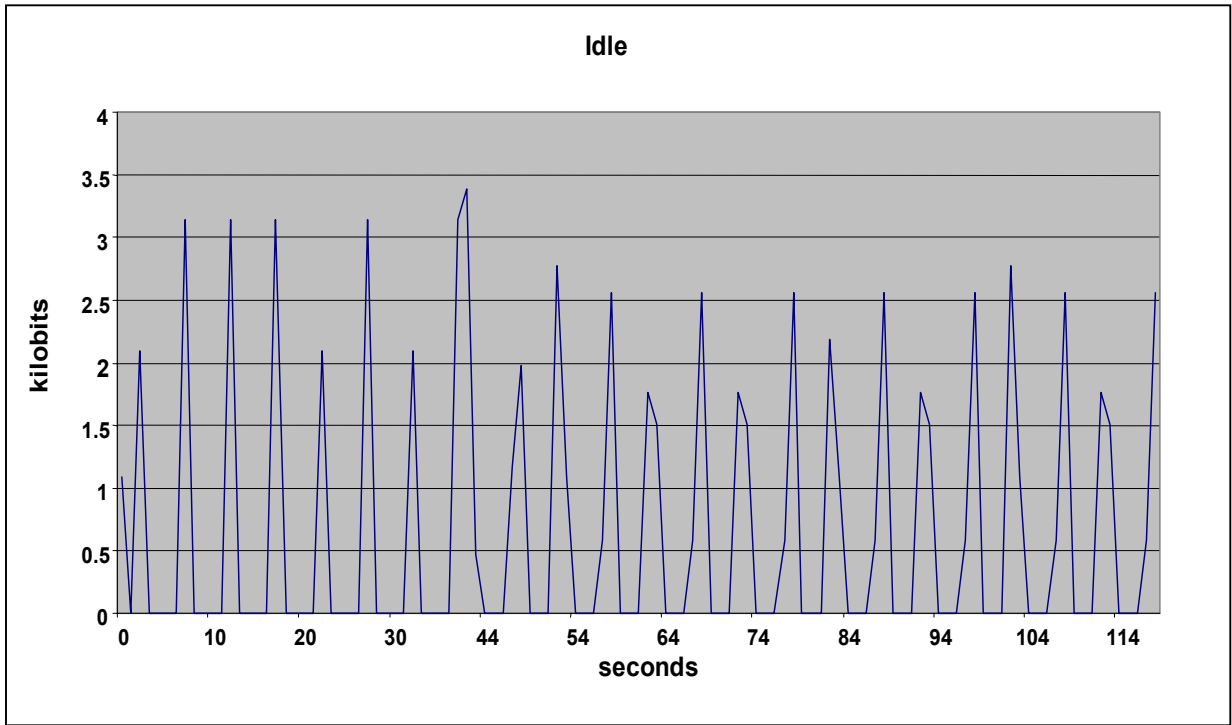
| Idle - Avg. (kbps)	Max. (kbps)
0.70	3.4

Analysis - Traffic during idle test was as an average of 0.70 kbps. This traffic represents a small heartbeat WebEx uses to keep the meeting alive. Notice half the time there is no network activity at all.

Presentation Share

Description– Share a PowerPoint presentation with animations.

Scenario – We used a 1.9 MB PowerPoint presentation (15 slides) with graphics and animations. Each animation build and slide was switched at 5-second intervals; the entire presentation took roughly 5 minutes. The graph below illustrates the initial sending of the PowerPoint presentation to the WebEx server.

Presentation Share
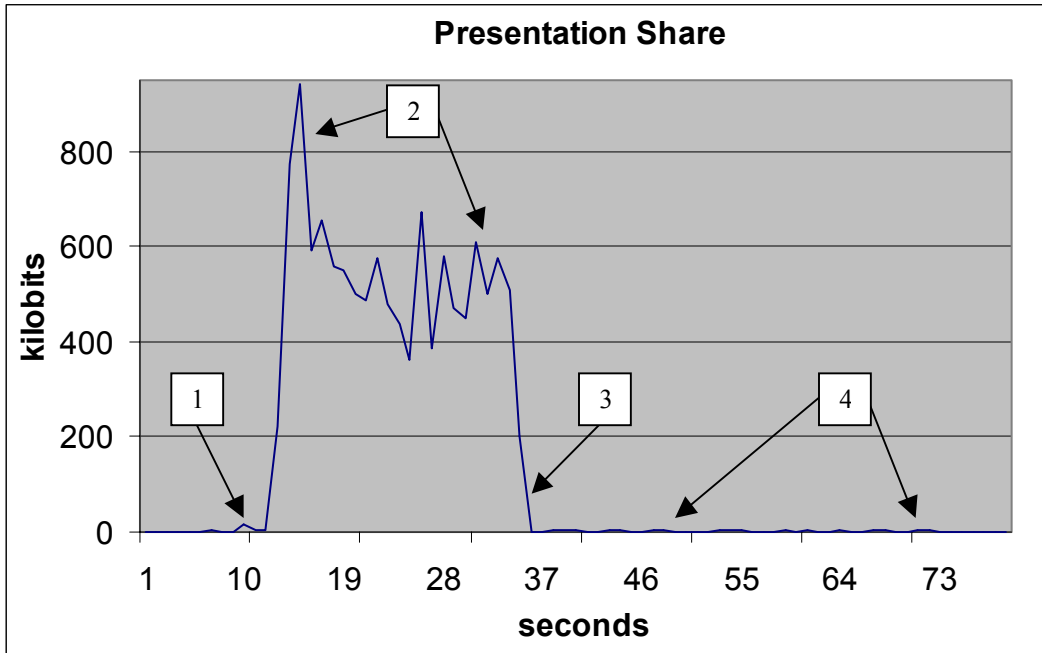
Analysis (during load) –
1. The initial importing of the 1.9 MB PowerPoint presentation into the meeting resulted in a spike in network traffic. At about 10 seconds is when the import begins.
2. The area between 10 and 37 seconds represents the loading of the 1.9 MB to the WebEx server in memory.
3. The PowerPoint presentation is loaded in memory and traffic drops.
4. Changing slides uses minimal bandwidth and is close to idle traffic.

Analysis (after the initial load, not shown) - Moving the slides at a very high pace (every 5 seconds) resulted in a 6.5 kbps. Bandwidth usage while changing slides is a function of time, and the faster slides were changed the more bandwidth was used per second. Our test case was a near worst-case scenario, changing the slides every 5 seconds. A typical case scenario where slides are changed every 30 to 60 seconds bandwidth usage is closer to a meeting idle state and is in the 1-2 kbps range.

Presentation Share (after import)	
Avg. (kbps) (5 second transitions)	Max. (kbps)
6.5	7.5

Recommended bandwidth – 56k modem or higher.

Desktop Share

Description– Presenter desktop shared the PowerPoint presentation used in the Presentation Share test.

Scenario – To create a repeatable test, we used the same PowerPoint presentation we used in the Presentation Share test. The slides were automatically changed every 30 seconds.
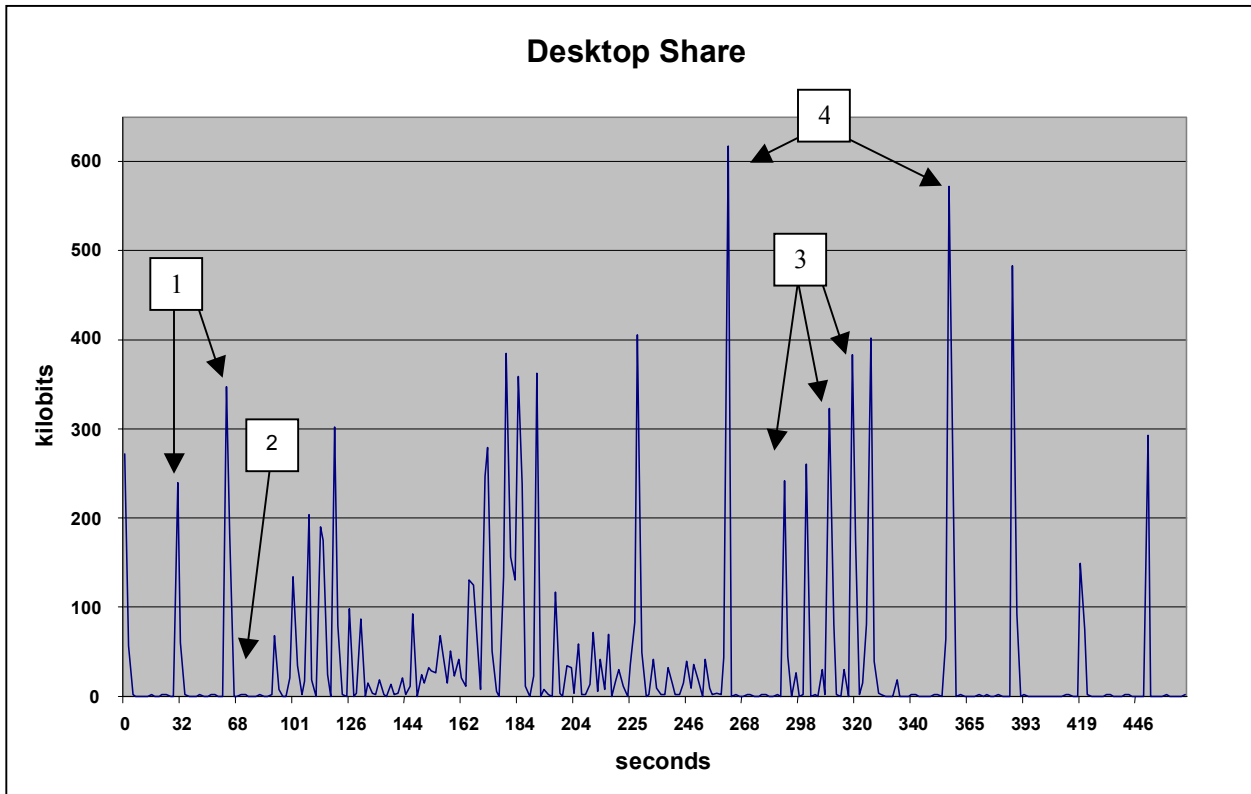
Desktop Share - Avg. (kbps)	Max. (kbps)
43.4	618

Analysis – Network traffic in desktop share is dependent on how much of the screen is changing and the frequency of the changes being made. Using a PowerPoint presentation with slides changing every 30 seconds, we are effectively changing the whole or partial screen every 30 seconds.

1. PowerPoint slides are changed every 30 seconds, these spikes represent each slide changing.
2. In between the slides changing, the traffic returns to an idle state.
3. Some slides have animations, where only parts of the screen are changing these represent smaller spikes. Also smaller spikes may represent slides with only partial screen changes.
4. When the entire contents of the screen change, with minimal overlap in content, larger spikes may occur.

In a typical scenario when you are demonstrating an application (Word, Excel, etc.) and only parts of the screen are changing, the upward spikes should be much less than in the graph above, and overall bandwidth consumption should be less on average. As you can see in desktop share mode, network traffic happens in bursts and is usually not sustained for more than a second or two. When using WebEx for PowerPoint

slides, presentation share mode is preferable since it requires much less bandwidth. Application share mode was also tested and network traffic behaves the same as desktop share mode.

Recommended bandwidth – DSL, cable modem or higher.

Video – Web Cam

Description – Show live video of a person talking.

Scenario – To test the range of network traffic, we tested the camera facing a plain white board with no motion, and then we tested a typical scenario with a person talking (graph below), showing mostly their head with moderate motion. We tested at the largest video setting at 15 fps.

Video - Web Camera
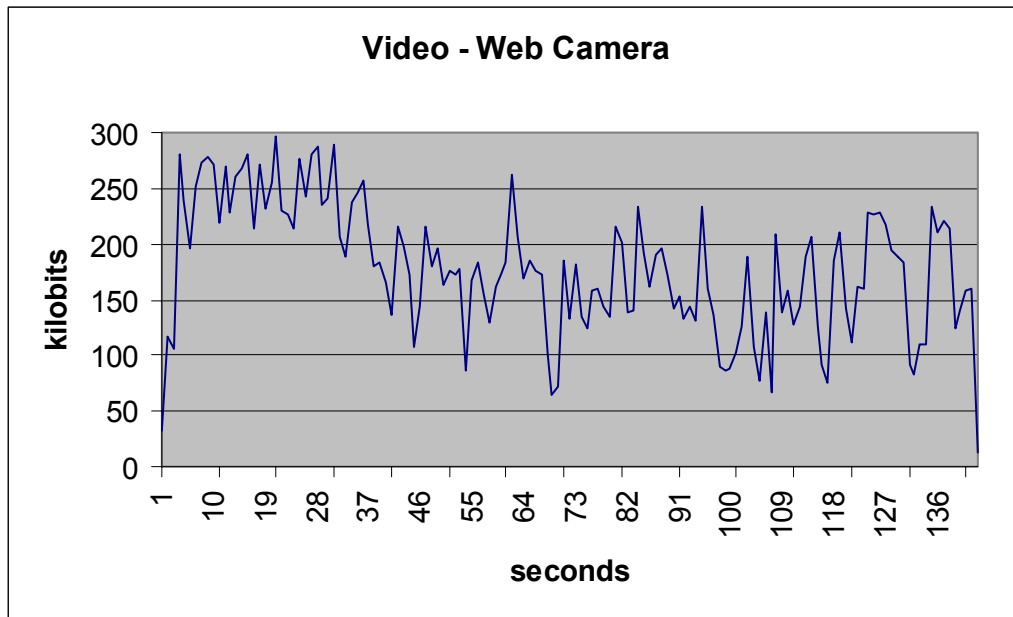
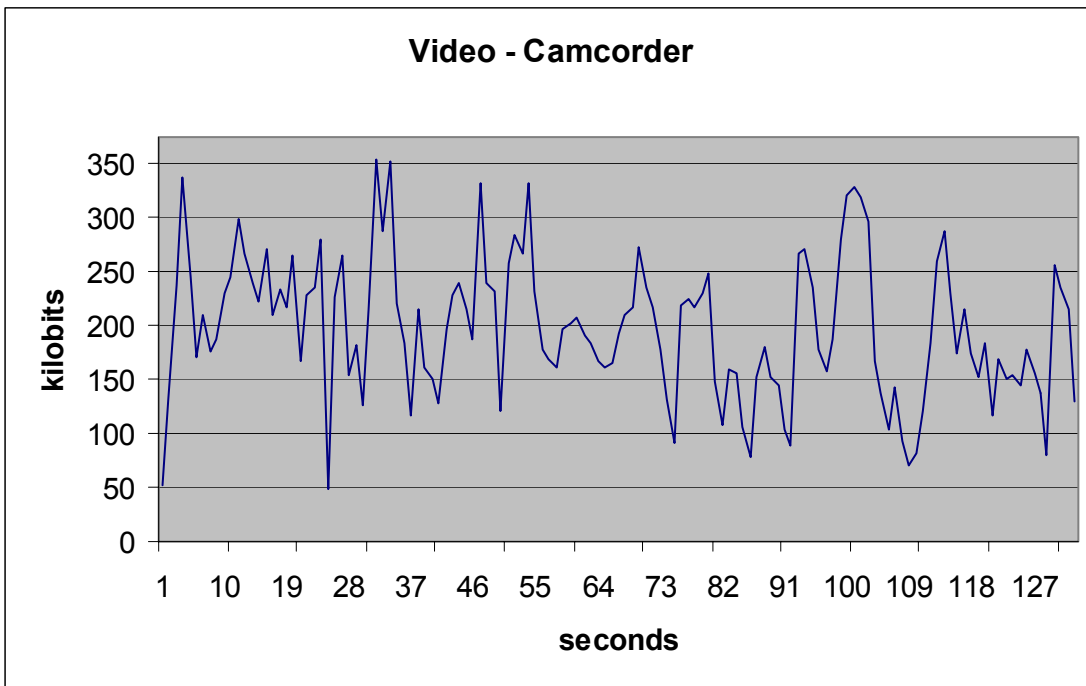| Avg. (kbps)	Max. (kbps)
172	298

Analysis – The network traffic usage of video is dependent on the screen changes of the video and therefore is largely a function of the amount motion and lighting changes in the video. Therefore there can be wide variations in the amount of bandwidth used, depending on the environment and what is being displayed. The graph above represents a typical scenario of a live person talking with moderate motion produced an average of 172 kbps over a 2 minute period. The upward spikes show more motion and screen change and the lower spikes represent less motion. If the appropriate bandwidth is not available, the result will be choppiness in the video and lost frames. When using video at the largest setting (352 x 288) and 15fps it is recommended to be on a high-speed connection. To reduce network traffic you may reduce the video size or the frames per second.

Recommended bandwidth – DSL, cable modem or higher when in the large video setting at 15 FPS.

Video – digital camcorder

Description – Show live video of a person talking with a digital camcorder.

Scenario – Using a digital camcorder connected to a PC via a Dazzle DVC 80, we measured the bandwidth consumption of a live person talking for about 2 minutes.

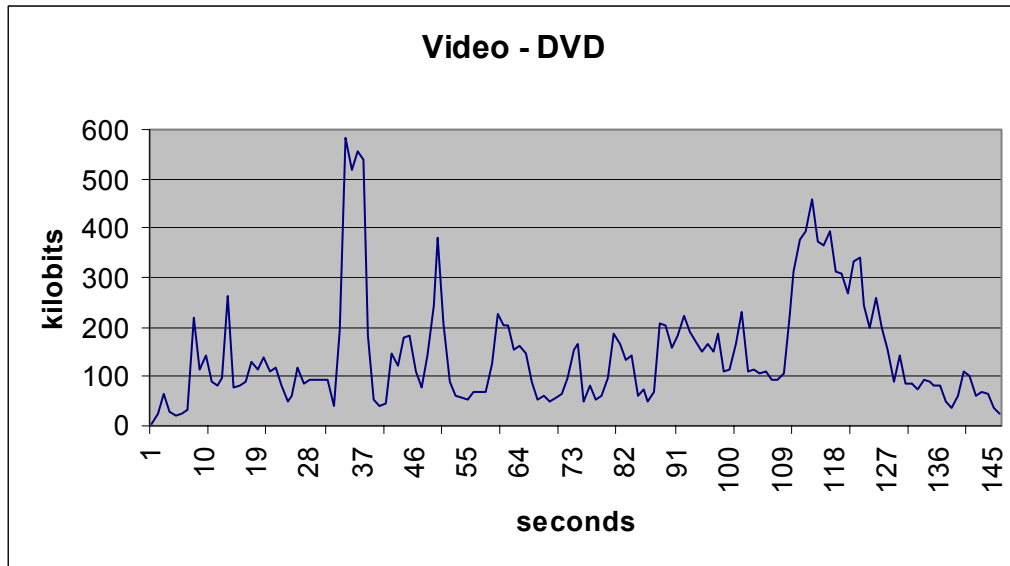| Avg. (kbps)	Max. (kbps)
225	351

Analysis – Based on our Web Cam test we knew that video is largely a function of motion and lighting changes. A digital camcorder has a much higher quality resolution than a Web Cam, and displays much finer detail so the network traffic increased as expected. So with higher quality you will require more bandwidth, nothing less than DSL or a cable connection is recommended. The results are for a typical scenario of a person talking, showing mostly their head.

Recommended bandwidth – DSL, cable modem or higher when in the large video setting at 15 FPS.

Video – DVD movie

Description – Show a DVD movie with a external DVD player.

Scenario – Using a DVD player connected to a PC via a Dazzle DVC 80, we measured the bandwidth consumption when playing a DVD movie clip for 2 minutes. The graph below is a 2-minute clip from Star Wars – Episode I.

Avg. (kbps) (Star Wars, wide screen)	Max. (kbps)
143	590

Analysis – We played clips from two different movies, Star Wars and Ice Age. Star Wars we played in the wide screen format. Ice Age we played in the full screen (TV mode format). Similar to video in the Web Cam and camcorder screen changes via motion or lightness have a heavy influence on the bandwidth being used. The DVD quality is even higher than camcorder so as expected the bandwidth consumed is slightly higher. Star Wars was played in wide screen format and thus displayed less information and created less network traffic. Ice Age played at full screen used much more network traffic. Depending upon the content off the movie, traffic can vary widely. Since the quality the traffic will be usually higher than that of Web Cam or camcorder, a high-speed connection is highly recommended if you are to show or view a DVD movie.
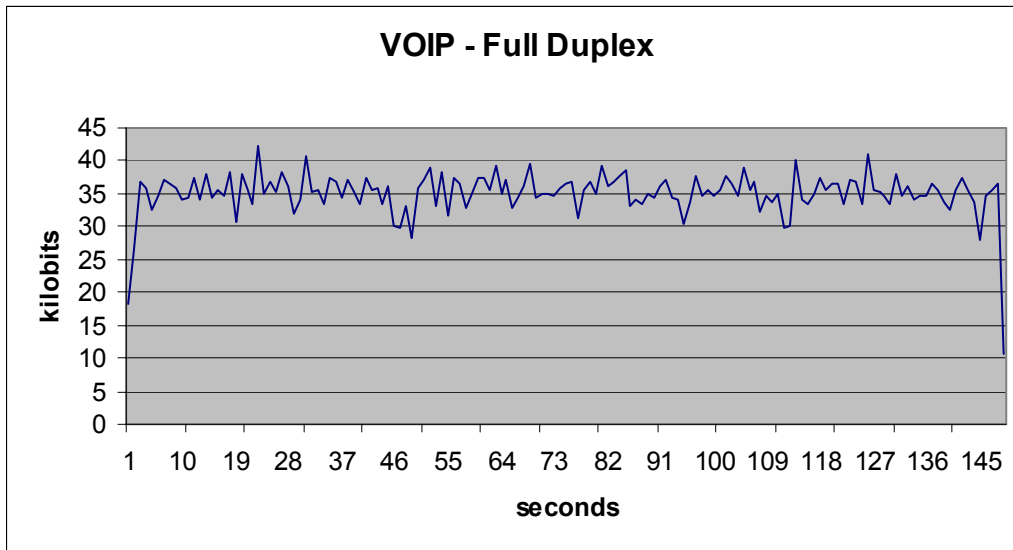
Avg. (kbps) (Ice Age, full screen)	Max. (kbps)
355	650

Recommended bandwidth – DSL, cable modem or higher when using the large video setting at 15 FPS.

Internet Phone – Voice Over IP (VOIP)

Description – Use the Internet Phone function in Training Center.

Scenario – Using the Internet Phone function with PC headset microphones, test full duplex VOIP and half duplex VOIP.

VOIP - Full Duplex

[Line chart showing kilobits (y-axis, 0 to 45) versus seconds (x-axis, 1 to 145). The plotted line rises sharply from about 18 at second 1, fluctuates between roughly 28 and 42 throughout, averaging around 35, then drops sharply at the end to about 10.]

Full Duplex (2 people speaking) – Avg.	Max. (kbps)
35	42

Analysis – VOIP bandwidth is not a function of what is being said or who is saying it, instead it is only a function of whether there is any noise being transmitted to the other party. In our test cases we tested half duplex, full duplex, and full duplex with only one person speaking. In all cases we tested the worst-case scenario with continuous talking. The test with two people speaking over one another represents a worse case scenario (graph). In a typical scenario one person will talk while another listens, and therefore the network traffic will be less than what we tested. Even in the half duplex mode there will be pauses by the speaker, which will result in less network traffic. The maximum values are only slightly higher than the average as the range is fairly consistent when there is continuous talking and no pauses.

Full duplex – (1 person speaking, 1 person muted) - Avg.	Max. (kbps)
18	22

Half Duplex – (1 person speaking) - Avg.	Max. (kbps)
13	16

Recommended bandwidth - DSL, cable modem or higher when considering VOIP will often be combined with Presentation share or Desktop share.

Summary

The data that we presented above illustrates that the WebEx service performs in a way to minimize the amount of data transmitted over the network. Not unlike browsing the web or checking e-mail WebEx only transmits data when data is requested. During most of a meeting the content will be static and therefore no data will be transmitted and network traffic will be at a minimum. When there is activity in a meeting, it is usually for short periods of time, like loading a presentation, changing a slide or sharing an application; where only parts of the screen change; this includes Presentation share, desktop share and live video. Thus these modes usually produce inconsistent streams of network traffic and therefore, many times the traffic will be much less than the average and sometime the traffic will spike up to the maximum values we presented. Video playback through a DVD and VOIP will usually produce a more consistent stream of network traffic and thus the averages are more typical of the impact you would expect on your network. As our tests illustrate above WebEx services introduce a low level of network traffic even in our high activity tests. In a normal meeting, where the level of activity will be significantly lower, the bandwidth requirement will be very manageable and will have minimal impact on the network.