LifeSize™

High Definition – The Way Video Communications Was Meant to Be

Critical Success Factors for Technology Decision Makers

If seeing is believing, then the videoconferencing experience of the past has always been something less than believable. Despite boastful claims that the video was "just as good as being there" and would allow us to "extend the conference room table 10,000 miles," the truth was always something short of expectations.

The quality of videoconferencing was limited. Viewed in low resolution, participants always have appeared blurred and murky. While organizations have gone to great lengths to modify rooms and lighting to create the best possible quality, they have done so with limited success and at great expense.

Now, the opportunity to make video communications deeply compelling and true-to-life is about to be seized. This promises to be a consequential leap in technological innovation, but it also represents an important advance in terms of productivity in an era of global collaboration and communication.

Why High Definition (HD) is Important

Why are advances in video communications technology important? Such innovations matter because the productive value of interactive video is inextricably bound to the technology itself. After all, no one would watch television if it was difficult to turn on and had a low quality picture. Similarly, the reluctance to actively use video communications is linked to poor image resolution, unimpressive sound quality, and user complexity. As interactive video becomes a vivid, high definition experience, it will also become an actively used and highly productive form of communication.

Advances in video communications technology represent immediate savings to the bottom line as travel time and costs are reduced. But video communications and other rich media collaboration solutions also "provide better ways to communicate and work," according to a report by Wainhouse Research. "New tools provide ways for knowledge workers not just to exchange information, but to interact productively."

New technology promises resolution that offers three times (3X) the resolution of standard television (NTSC) resolution and ten times (10X) the resolution of the conventional videoconferencing systems (FCIF) available over the past 15-20 years. With the introduction of high definition video, powerful new camera designs, spatial audio, and new user interface approaches, video communications is poised for dramatic advances *from a technical perspective*.

To maximize business and technical benefits of video communications, technology decision makers must recognize key criteria and consider how different vendors stack up against these criteria. While this paper makes the case for next generation products from LifeSize Communications, readers are encouraged to compare and consider the different options in the industry to ensure they are making their best decision.

Critical Success Factors when Assessing High Definition Video Communications and Traditional FCIF Systems

Several key criteria for assessing video communications technology are explored in this paper. While the standard criteria discussed here certainly relate to "quality" from a technical standpoint, they also are linked to the "productivity" of video calls as a means of conducting effective communication.

Herein, we recognize the technical strength from the perspective of producing a *realistic* experience (one that is vivid and true-to-life) and an intuitive experience (one that emphasizes simplicity and ease of use). Among the key assessment criteria discussed here are: *visual realism*; *acoustic realism*; and *usage simplicity*.

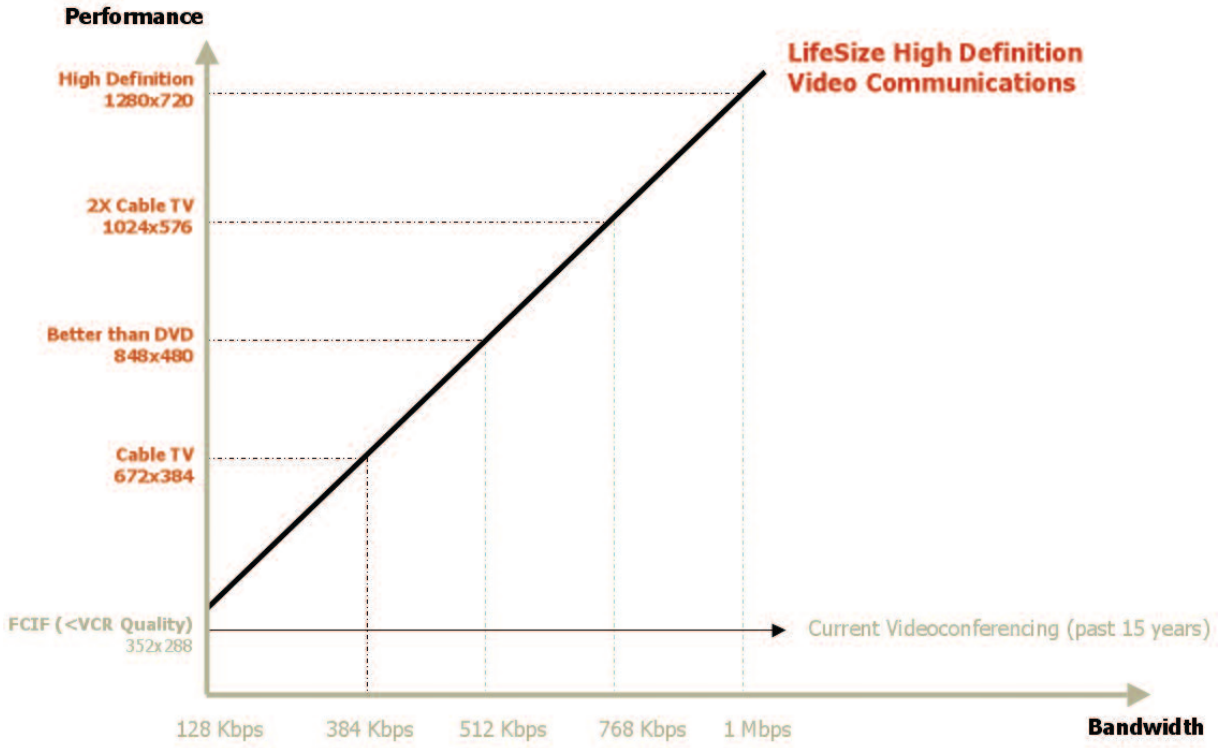
VISUAL REALISM. Video communications technology has reached levels that simply weren't possible a few years ago. Today, it's possible to provide a high definition visual experience in a cost effective way. Reaching that objective, however, requires us to consider how compelling, high definition video communications are both generated (video resolution) and perceived (visual acuity).

Video Resolution. In order to provide video resolution that generates a compelling, true-to-life experience, it is necessary for high definition video solutions to incorporate and encompass several recent advancements in the video communications field:

- Architecture. As suggested in Moore's Law, there are advances in processing power that continue to double every 18 months. Today's videoconferencing systems are limited to providing FCIF (352 x 288) resolution video at 15-30FPS due to computing limitations or MIPS available in the architecture of these systems. Video communications is a processor intensive application. New advances in processor technology enable new compression/decompression (CODEC) architectures that provide high definition video communications at a resolution of 1,280 x 720, 30 FPS which is 10X FCIF quality.

- Bandwidth. In order to achieve higher resolution video communications, some early adopters have gone to great lengths to provide uncompressed high definition video using MPEG devices and cobbled together components. The limitation of these efforts is that they require significant amounts of bandwidth – upwards of 2-5Gbps, according to USC's Integrated Media Systems Center (http://imsc.usc.edu/research/). There are very exciting applications available for this level of video communications but the bandwidth required and unsupported and unreliable configurations would severely limit usage by mainstream users. While many of today's video communications networks operate at bandwidths of 384Kbps to 768Kbps,

this has been primarily due to diminishing returns of quality associated with applying additional bandwidth. In fact, most organizations have chosen to use this bandwidth for data applications due to the lack of benefit linked to using more bandwidth with a FCIF system. With LifeSize, users will experience improved quality at all bandwidths but will achieve full high definition resolution (10X FCIF) by utilizing 1Mbps+ of bandwidth. In recent years, cost effective bandwidth and network convergence have become widely accessible in the enterprise and other organizations such as universities and government institutions.



- **Standards.** When exploring investments in video communications, it is also important to consider the linkage between a particular solution and industry standards. Adherence to industry standards protects an investment by ensuring compatibility with existing systems. Meanwhile, breakthrough standards – such as the newly released H.264 standard – make it possible to take high definition video communications to new levels. H.264 is a culmination of 10 years of work in the industry to create the very best video compression algorithm, extended to include high definition resolutions. This standard is 2-3X better than compression algorithms that the industry has previously used. Importantly, it is also backward compatible. As a standard, it is crucial to provide interoperability for systems to expand the growth and communication of multi-vendor systems. In it's new video communication systems, LifeSize has embraced this standard and has fully leveraged its capabilities.

- **Cameras.** High definition cameras have primarily been available for the broadcast market or for digital camcorders. In the case of broadcast equipment, the cameras are not cost effective for mainstream video communications. On the other hand, digital camcorders do not provide the quality needed for interactive videoconferencing systems. One factor making high definition interactive video possible is the availability of reasonably priced image sensors that are driven by the digital camera market. LifeSize has internally developed a cost effective high definition camera using commercially available image sensors and has developed software to make the camera appropriate for the challenges of video communications. Such developments make it possible to cost effectively address exposure and backlight compensation challenges (see sidebar) to generate a vivid and compelling picture.

Visual Acuity. The human eye has a certain well known and measurable level of visual acuity. If you look at an object, you can resolve the detail only to certain limits – like the numbers on an eye chart. In the viewing of a video image, what is important is producing as much resolution as the eye can resolve. This is the standard to measure against: visual acuity. Added resolution is unnecessary because the eye cannot see it. If the video resolution is below the eye's, the image will appear to be filled with pixels. In other words, there's a certain optimal resolution in relation to visual acuity.

LifeSize achieves that optimal resolution and provides a "large window" view of the participants on the far end of the conference call. With a 50 inch, plasma screen (1280 x 720 pixels), the optimal viewing distance based on the human visual system is about 10 feet. The screen image looks as good as if someone is standing in the room. The

CAPTURING THE HIGH DEFINITION IMAGE: *Advances in Exposure and Backlight Compensation*

Most videoconferencing systems today rely on cameras that have a manual setting for "backlight compensation" – which is an adjustment in relation to light and dark lighting. Unfortunately, the setting – in standard practice – is rarely changed to match the light levels in a room.

As a result, participants see images of people on their screen that tend to be too light or too dark. If there is a background of bright daylight outside, the participants in the call may appear dark. If the videoconference occurs at night, the bright white lights in a room may often wash them out. There are many possible causes for the person to be improperly exposed. The poor exposure, however, is distracting to the participants.

While most videoconferencing systems depend on the participant to adjust the camera setting to reflect lighting conditions, few of us bother. We merely learn to live with the exposure problems. LifeSize, however, has built "automatic backlight compensation" into its high resolution cameras. The feature automatically shifts the exposure to ensure the lighting matches the circumstances and the participants are well lit.

LifeSize addressed this challenge by focusing on the human participants in the exposure. Compelling video communication, after all, is mostly about capturing the people who are participating. LifeSize's system has an automatic patent pending, skin detection system. It weights human skin – no matter the color or tone – higher than anything else in the frame. This has proved a powerful means of ensuring backlight compensation is automatically and effectively managed.

eye can't tell the difference from a resolution standpoint. People appear to be true-to-life, which is an important factor in making the experience as credible and compelling as possible.

But consider the "optimal" viewing distance for a FCIF (352 x 280 pixels) image. It is 32 feet away. That's the distance at which the visual acuity of the eye matches the resolution of the image. Rather than provide a full screen view, videoconferencing must shrink the image to avoid projecting a blurry image with a standard room.

By projecting a high definition image onto a large window, LifeSize enables the videoconference participant to clearly see the participants on the far end without moving a camera around. Not only is the "window" matched to the eye's resolution limit, the person you are seeing is true-to-life. If you have enough of a view, then you just move your eye to look at whoever you want to see. The larger the participants on the screen, the more "real" the experience seems.

For videoconference calls within an executive office, LifeSize has designed an integrated system for a 17-inch screen with a 16:9 format. The optimal viewing distance at which the image matches the eye's visual acuity is 3.3 feet. Contrast that with conventional systems on the market, which use the FCIF standard and therefore, would require the participant to be 10 feet away from the monitor to obtain optimal resolution.

ACOUSTIC REALISM. While audio is often an overlooked aspect of the videoconference experience, it is critical to recognize how vital acoustic quality is to the overall perception of the experience itself. This factor is reflected in the high fidelity, stereophonic audio systems that accompany today's consumer television systems. Indeed, acoustic realism lends credibility and effectiveness to the experience. It makes it sound as if the other participants are indeed in the room. Among the criteria of acoustic realism explored here are: *input quality* and *output quality*.

Input Quality. This criterion revolves around the quality of sound captured by an audio conferencing system. Ultimately, the high definition audio conferencing experience we explore here is determined by one's ability to pick up voices and other relevant audio signals with great clarity, while eliminating irrelevant noise. Here are some of the key factors that influence input quality:

- Architecture and Performance. Almost all conference phones on the market today use multiple microphones in order to provide audio pickup over a broad area. Most of these older microphone designs use a number of directional microphones (anywhere from 3 on the low end up to as many as 9 depending on whether you add on extra microphone pods (mic pods) to the product). However, for several reasons, typically only one of those microphones is active at any one time. The result is that each signal transmitted to the far end comes from of a single microphone on the sending side. By contrast,

LifeSize has introduced an entirely different, "omni-directional" architecture that differs markedly from these old style conference phone designs. The LifeSize Phone™ (that comes fully integrated with LifeSize video communications systems, consists of a circular array of 16 microphones, arranged around the circumference of the phone. LifeSize's circular array architecture gives an additional overall boost to the LifeSize system's signal-to-noise ratio of almost 12dB. That corresponds to clearer audio and more productive conference calls. With a single phone, LifeSize can cover about 2X the linear distance (which means almost 4X the amount of square footage, depending on the room) of any other competing audio conference solution.

- **Frequency Response.** The range of the audio frequencies transmitted is extremely important in terms of conference quality. Frequencies on the low end of the audio range give you a sense that the person on the other end is actually in the room with you. It's an issue of *presence*. On the high end of the range, what you get is clarity. It is an issue of *intelligibility*. Some of the most expensive audio conferencing products available today are actually restricted in software from transmitting any frequencies below about 200 Hz. The reason for this restriction is that the microphones are highly susceptible to vibration noise – someone tapping a foot on the conference table leg or a truck driving by outside, for instance. On the high frequency side, many of the microphones in these same designs are unable to pick up what normally would be clearly audible frequencies (e.g., above 5kHz) unless the person speaking is seated directly in front. LifeSize, by contrast, relies on a new design that is insensitive to vibration and other low frequency noise. With a special mic suspension system that isolates vibration noise down to well below 100 Hz, LifeSize can demonstrate that its mics are about 20 decibels better than the best competing solutions on the market. On the high end of the frequency range, the omni-directional mic system enables the LifeSize Phone to consistently outperform competing designs by a factor of 10 and generate high definition audio signals – even as audio conference participants freely move about a room.

- **Directional Designs.** Directionality is important to ensure human voices are picked up differently than other background noise (such as the air conditioning system or a projector on the table). In a typical conference room, there are a number of undesired noise sources (such as the projector fan mentioned earlier) that can potentially interfere with the desired speech signal. In contrast to other competing systems, the LifeSize Phone's circular microphone array technology uses a sophisticated mathematical technique called "beam forming" to produce a number of "virtual" directional microphone signals. The omni-directional pattern of the LifeSize circular array is entirely software controlled. Thus, there are no "best" or "worst" directions, and the directional pattern can be varied to suit the real environment. LifeSize's beam forming technology enables audio conference participants to ensure high definition sound quality is generated.

Note that not all high definition video communications systems will operate in an environment with an integrated audio conference phone as the input device. It is also important to interface to installed audio systems in a highly integrated, custom room environment – for example in a classroom or auditorium.

Output Quality. While it's critical to be able to effectively capture audio input in order to generate a high definition signal, the quality of the conference call is truly experienced in the audio output – the sound generated by the speaker. Here are some of the key factors that influence output quality:

- Spatial Audio. In order to maximize the acoustic realism of the event, it is necessary to match voices with the visual picture on the screen. This is a powerful element in efforts to make the video conferencing experience compelling and productive. Unfortunately, most videoconference companies today rarely focus on this challenge. LifeSize, by contrast, offers a camera that has 8 microphones that are used to determine the angular position of the person speaking. That angular position is sent to the far end as side channel information. Then, on far end, it is repositioned. Voices are then "projected" through audio speakers in relation to the person's place on screen. In other words, "spatial audio data" enables the system to provide an exact match.

- Distortion. A simple definition of distortion is the addition of extra components to a signal that are not present in the original. The LifeSize system contains a specially designed (patent pending) loudspeaker system that exhibits distortion that is two orders of magnitude lower than those of many competing products. As a result, the acoustic echo canceller (AEC) used to reduce distortion need not eliminate components of the original signal in order to produce a clean signal that can then be passed on to the far end of an audio conference. The result is that the AEC operates more effectively, giving a much clearer, more natural sounding communications experience. Indeed, the LifeSize speaker design reduces distortion in some cases more than 10X over competing providers of audio conference systems.

- Compression Algorithms. Existing audio conferencing phones use standard algorithms such as G.711 and G.722 as well as other proprietary approaches for compression. Most of these algorithms are limited to 3.5 kHz or 8 kHz bandwidth. In the case of proprietary algorithms, the benefits of higher bandwidths are limited to systems connected to similar proprietary vendor systems. LifeSize uses a different approach for its super wide bandwidth audio system codec. The LifeSize Phone uses a variant of the industry standard MPEG AAC (Advanced Audio Compression) algorithm from Germany's Fraunhoffer Institute which can support the full 20+kHz audio bandwidth. The optimized LifeSize implementation of AAC for two-way communications provides higher bandwidth. In the case of using the LifeSize Phone when integrated with the LifeSize Room video communications systems, the transmitted audio can range from 100 Hz up to 16 kHz super wideband audio.

USAGE SIMPLICITY. Videoconference systems have been notoriously cumbersome to connect and use on a reliable basis. The difficulties associated with ensuring videoconferences merely operate properly have restrained the technology's growth potential to date. Additionally, today's communications consumers have become accustomed to simple yet powerful communications media such as email, phones (cell and analog), PDAs, instant messaging and more. They expect video to be added to their daily options but require a similar level of user simplicity.

With this in mind, it's apparent that next generation video communications solutions must address simplicity and ease of use along several dimensions:

User Interface and Integration. As videoconference systems have evolved, there have been a wide range of approaches to the user interface including infrared remotes and onscreen navigation systems. LifeSize has focused on reducing the need for user interaction with the systems (thus reducing complexity) by making systems more intelligent. The onscreen user interface that interacts using the remote control provides context specific buttons that relate using color and icons between the remote control and the onscreen, high definition user interface. Systems are smart enough to hand shake and require limited user intervention with the exception of knowing an IP number.

Due to user comfort with the phone or conference phone, it is also effective for users to make video calls from the integrated conference phone like dialing a standard audio call. LifeSize has approached this by fully integrating the LifeSize Phone and providing a "Video Call" button for one touch addition of video or audio participants just like dialing a regular phone call.

Automatic Call Establishment™. Recognizing the past challenges associated with arranging and establishing videoconference calls, it's critical that next generation systems make this process as simple and seamless as placing a phone call. By taking the technical complexities out of the call establishment process, one can better meet the objectives and needs of the user. LifeSize Systems are intelligent to detect network capabilities. With additional solutions such as LifeSize Control™ management software, users can now automatically detect network information, identify relevant numbers and place point-to-point and multi-point video calls, eliminating the need for forward call planning.

Multimedia Sharing. Rich, multi-media communications are now part of our in-person meetings. Typical examples include presentations using Microsoft PowerPoint®, spreadsheets, DVD video clips, whiteboard interactions, documents and other media. Now, they can easily become part of networked video communications as well. Typical videoconferencing systems require additional boxes to power collaboration or media sharing, creating added hassle and user complexity. LifeSize, by contrast, approaches multi-media application sharing by simply providing a VGA cable for quick connection and standards-based dual streaming (H.239) to enable a mix of high definition video and multi-media resources.

The Next Era of High Definition Video Communications

Video communications technology has not advanced significantly for many years. As a result, decision makers have not had truly consequential decisions to make with regard to this technology. Until now.

Global and decentralized organizations increasingly will depend on video communications and other rich media collaboration technology to meet their business and collaborative objectives. However, the productivity of interactive video is inseparable from the quality of the technology. In this case, "realism" and user simplicity enhances the experience, efficiency and benefits of the communication. High definition video communications technology innovations, therefore, represent an important opportunity to drive productivity and creativity in a global economy.

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