VIDEOCONFERENCING AND ITS RELEVANCE IN THE MODERN WORLD

by

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Abstract

The world is highly involved in the competition existing iin the use of Information Communications Technology and available resources to foster development and make life easier. With the introduction of relatively low-cost capacity broadband telecommunication services in the late 1990s' coupled with powerful computing processors and video compression techniques, videoconferencing usage has made significant inroads in business, medicine, education, government, law, the general public, media relations and sign language. This research reveals the technology, components, architecture, modes, echo cancellation, shortcomings and areas of impact of videoconferencing.

Keywords: Videoconference, telecommunication, education, Internet Protocol, technology business, collaboration, information and medicine.

Introduction

Videoconferencing is the conduct of a videoconference by a set of telecommunication technologies which allow two or more locations to communicate by simultaneous two-way video and audio transmissions. It can equally be known as visual collaboration. It is designed to serve a conference or multiple locations rather than individuals (Mulback et. al, 1995). Thus videoconferencing uses audio and video telecommunications to bring people at different sites together. This can be as simple as a conversation between people in private offices (point-to-point) or may involve several (multipoint) sites in large rooms and multiple locations. Besides the audio and visual transmission of meeting activities, allied videoconferencing technologies can be used to share documents and display information on whiteboards. Internet Protocol-based videoconferencing and more efficient video compression technologies were developed in order to permit desktop or personal computer-based videoconferencing. In 2000s, videotelephony was popularized through free internet

which promoted low cost videoconferencing to virtually every location with an Internet connection. Recent technological developments have extended the capabilities of video conferencing systems beyond the boardroom for use in hand-held mobile devices that combine the use of video, audio and on-screen drawing capabilities broadcasting in real-time over secure networks independent of location. Mobile collaboration systems allow multiple people in previously unreachable locations, such as workers on an off-shore oil rig the ability to view and discuss issues with colleagues thousands of miles away. Traditional videoconferencing system manufacturers have begun providing mobile applications as well, such as A Ver Information's VCLink app which allows for live and still image streaming, (http://www.communication.aver.com).

These days, videoconferencing has been widely used in all areas such as education, business, medicine, media and so on. Since the advent of the era of globalization of the economy, corporations are looking for a more efficient way to do more works by using less resource and the technology of videoconferencing provides their needs. The expenses, time and risks of business trips can be reduced. It has become a practical method of increasing competitive advantage of organizations since it can take the place of traditional meeting that requires all the people to be present in a physical manner. It can not only allow users to exchange information in a more efficient manner but also help the company save travel expenses. With a newer Internet technology, people can have videoconference at anywhere and anytime.

Technology for videoconferencing

The core technology used in a videoconferencing system is digital compression of audio and video streams in real-time. The hardware and software that performs compression is called a codec (coder/decoder). The resulting digital stream of 1s and 0s is subdivided into labelled packets, which are then transmitted through a digital network of some kind (usually ISDN or IP). The use of audio modems in the transmission line allow for the use of the Plain Old Telephone System (POTS), in some low-low speed applications, such as videotelephony, because they convert the digital pulses to /from analog waves in the audio spectrum range. Other components required for a videoconferencing system are:

- Video input such as video camera or webcam
- Video output : computer monitor, television or projector.
- Audio input such as microphones, CD/DVD player, cassette player or any other source of Pre Amp audio outlet.
- Data transfer: analog or digital telephone network, LAN or Internet.

- Computer, serving as a data processing unit that ties together the other components, does the compressing and decompressing. It also initiates and maintain the data linkage through the network.

Videoconferencing systems are basically of two types:

(a) Dedicated systems: These have all required components packaged into a single piece of equipment, usually a console with a high quality remote controlled video camera that can be controlled at a distance to pan left and right, tilt up and down and zoom. They are known as PTZ cameras. The console contains all electrical interfaces, the control computer and the software or hardware-based codec. Omnidirectional microphones are connected, as well as a TV monitor with loudspeakers and/ or a video projector. Several types of dedicated videoconferencing devices exist. Examples are large group, small group and individual videoconferencing. Large group videoconferencing are non-portable, large and more expensive devices used for large rooms and auditoriums while small group videoconferencing are non-portable or portable , smaller, less expensive devices used for small meeting rooms. Individual videoconferencing are usually portable devices meant for single users. They have fixed cameras, microphones and loudspeakers integrated into the console.

(b) Desktop system: These are add-ons (hardware boards) to normal PCs, transforming them into videoconferencing devices. A range of different cameras and microphones can be used with the board, which contains the necessary codec and transmission interfaces. Most of the desktop systems work with the H.323 standard. Videoconferences carried out through dispersed PCs are known as e-meetings.

Videoconferencing components and architecture

The conferencing system components can be divided into various layers : User Interface, Conference control, Control or Signal Plane and Media Plane. The User Interfaces could either be graphical or voice responsive. It could be used for scheduling, setup and making the call. Through it, the administrator can control the other three layers of the system. Conference control performs resource allocation, management and routing. Along with the user interface, it creates meetings or adds and removes participants from a conference. Control plane contains the stacks that signal different endpoints to create a call and/ or a conference. These signals control incoming and outgoing connections as well as session parameters. The media Plane contains the audio and video mixing and streaming. It manages Real-Time Transport Protocols, User Datagram Packets (UDP) and Real-Time Transport Control Protocols (RTCP). The RTP and UDP carry information such as the type of codec, frame rate

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and video size. RTCP acts as a quality control protocol for detecting errors during streaming, (http://www.en.wikipedia.org).

The Architecture of Videoconferencing Systems

Video Chatting-based Personal Videoconferencing

Many services like Gtalk, Skype and other alternatives allow a video chatting between two people connected over the internet/ intranet. This is the most common and least expensive form of 'seeing and talking' to each other, even though it has a low quality in most of the cases. There is also some delay in the transmitted images at the far end which makes the visual movements look slower and broken sometimes. The rrequired iinfrastructure includes PC, Webcam, Headset/Microphones (or) speakers/microphones, broadband/leased line internet connectivity and a messenger software like Gtalk, Skype etc. The advantage is that it is cheap. It is also aavailable anywhere, and uses the internet which is commonly available. The disadvantage is an aaverage picture quality (as most webcams come with a lower resolution) and delayed reception/display of images. It supports **a** video compression format called H.264**.** Also called MPEG 4 Part-10, H.264 is a compression technology used by video transmission/ storage systems to give a good compression ratio for transmitted/ stored videos. Since it is a standard, any device at one end can compress and send the video files and the same can be de-compressed by another device at the other end. The advantage of H.264 is the achievement of better video quality at a lower bandwidth (when compared to uncompressed video).

IP Video Phone-based personal videoconferencing

IP Video phones are not very popular, but offer a good and an effective choice for personal video calling between two persons, sometimes even three. Interestingly, the video phones use open standard VOIP (Voice over Internet Protocol) protocol called SIP (Session Initiation protocol). That makes it easier for them to integrate into business VOIP System as an IP extension and hence can receive voice only calls as well as video calls. Some video phone manufacturers also offer a unique phone number that can be used anywhere (over the internet) to call another phone of the same manufacturer/ model. That makes it easier than having to procure a static IP address at each end or having to register them with an IP PBX (Private Branch Exchange**,** a private telephone network used within an enterprise). Interestingly, one can also call from an IP Video Phone to any standard Professional Video

conferencing system if the latter supports video over SIP or IP-SIP protocol. Ssome of the video phones support H.264.
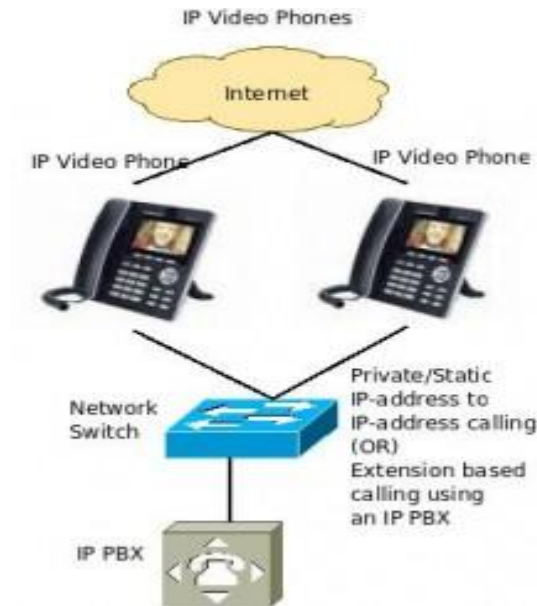
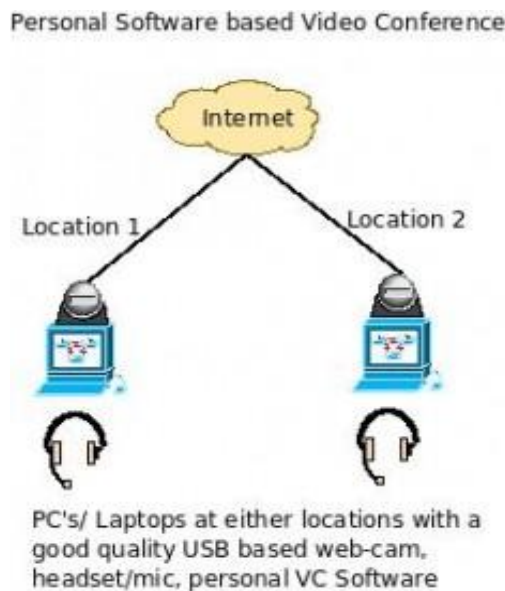**Fig 1: IP Video Phones – Connectivity architecture**

The rrequired iinfrastructure includes an IP Video Phones (at both ends) and internet connectivity (preferably an Internet leased line/ high speed broadband) as at least 128 Kbps upload and download is required for a single channel of video to be transmitted at 15 frames/ second. Some manufacturers of the IP video phones include Polycom, Grandstream etc. The advantages are that it can work independently or with an IP PBX, can be used with video conferencing systems that support SIP. It is relatively cost effective, can work with broadband as well and supports H.264. The disadvantage is that the interoperability between IP Video phones of different manufacturers is not widely tested. The smaller screen, limited audio (over speaker phone/ handset) and an average quality of images over broadband connections operating at lower speeds are also among the disadvantages.

Software /PC based ppersonal Video conferencing System

As an interesting alternative to video chatting, there are certain software's that are provided by professional videoconference system manufacturers that can be downloaded to any standard PC (at both ends) and can be used along with any standard web-cams and headset/microphones or speakers /microphones. The crucial

thing that the provided software does in addition to giving a user interface is that it can perform the compression/ decompression of the video using the PC hardware or processor which gives excellent quality of images even at lower bit rates. The required infrastructure includes a PC or Laptop, Internet (high speed broadband or internet leased line at least 128 Kbps dedicated – upstream and downstream), good quality standard web-cam and microphone/headset. Some examples of such systems include Polycom PVX, Tandberg Movi, Radvision Scopia etc.

The advantages are a lower cost, higher quality, use of standard PC, webcam ,headsets and support   for   High   Definition   Formats   (HD). The disadvantage is that the video quality depends upon the web-cam quality, all of which may not be very good. The lack of external microphone means wearing the headset continuously. The in-built microphones of PC or Laptop may not provide good audio quality. Depending on the manufacturer, some of them also offer hardware- based personal video conferencing systems that range from personal VC codec / camera to personal LCD monitor with integrated camera , microphones and speakers.

Personal Software based Video Conference

Internet

Location 1   Location 2

PC's/ Laptops at either locations with a
good quality USB based web-cam,
headset/mic, personal VC Software

Fig 2: PC based personal videoconferencing system

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Professional Videoconferencing system (Set-Top Box)

The architecture of a professional videoconferencing system (Set-Top Box) consists of a set-top Codec supplied by the Video Conference vendor which connect to monitors, projectors, plasma etc. for display, microphones (mostly supplied by the manufacturer of the video conferencing systems), ISDN/PRI(E1/T1) Lines OR Internet Leased Lines. Most of these set top boxes require at least 128 Kbps of Internet Leased Line (Or intranet bandwidth) to work fine. Some of them even support HD formats for superior video quality but require higher bandwidth. These systems are more for companies or organizations which have a requirement of one or few people from one place to see and talk to one person or few people at another place. One can also use document cameras or dvd players to display objects or videos to the other end. Most of them support dual video output streams for displaying video along with data (power point presentations etc) for better collaboration. Such systems support one person at either end or many people, depending on the model of the video conference system. Some of them even allow for viewing people from multiple locations simultaneously and can be expanded to accommodate many sites using a multi-conference system, (http://www.excitingip.com/290/what-is-high-definition-hd-video-conferencing). Hence, the requirements includes a videoconferencing system (usually codec), microphone(s), monitor (TV, projector, LCD display, plasma etc), speakers, bandwidth (Internet leased lines/ MPLS/ LAN). Some manufacturers who supply such systems include Polycom, Tandberg, Life size, Aethra, Sony etc. The advantages are the fact that it can accommodate single to multiple persons at each side, has cameras support pan/tilt/zoom/preset functions, has free IM (Internet Messaging), can display data (presentations) along with video and supports HD formats.The disadvantage is that it has hhigher cost and higher bandwidth requirements.

Fig. 3: Block diagram and Architecture of Professional Video Conference system

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Videoconferencing Modes

There are two basic operating modes used by a videoconferencing system: the Voice-Activated Switch and Continuous Presence. In the Voice-Activated Switch (VAS) mode, the Multipoint Control Unit (a means for making simultaneous videoconferencing among three or more remote points possible) switches which endpoint can be seen by the other endpoints by the levels of one's voice. This is such that the location with the loudest voice will be seen by the other participants. Continuous Presence mode displays multiple participants at the same time. A Multipoint Processor (MP) takes the streams from the different endpoints and puts them alltogether into a single video image such that the MCU sends the same type of images to all participants.

Echo cancellation in a Videoconferencing System

Acoustic Echo Cancellation (AEC) algorithm is used to detect when sounds utterances reenter the audio input of the videoconferencing codec, which came from the audio output of the same system, after some time delay. When this is not checked, it can lead to several problems such as the remote party hearing their own voice coming back at them, strong reverberation that renders the voice channel useless as it becomes hard to understand and howling created by feedback.

Shortcomings of a Videoconferencing System

i. Perlroth (2013), notes that poorly configured or inadequately supervised videoconferencing system can permit an easy 'virtual' entry by computer hackers and criminals into company premises and corporate boardrooms through their own videoconferencing systems, (http://www.nytimes.com).

ii. Eye contact: Van (2005) points out that this plays a large role in conversational turn-taking, perceived attention and intent. Vertegaa (2002) also adds that many videoconferencing systems provide an incorrect impression that the remote interlocutor is avoiding eye contact. Some telepresence systems have cameras located in the screens that reduce the amount of parallax observed by the users. Its being addressed by a research that generates a synthetic image with eye contact using stereo reconstruction, (http://www.portal.acm.org). Also, eye-to-eye videoconferencing using rear projection screens with the video camera behind can be used to eliminate the need for special cameras or image processing, (http://www.google.com).

iii. Appearance consciousness: Being on camera is another psychological problem with videoconferencing. There is the burden of presenting an acceptable on-screen appearance.

iv. Signal latency: Allan (2012) opines that an increased latency larger than about 150-300ms is noticeable and distracting. Hence, a small total round-

trip time is required for the communication channel in an interactive videoconferencing.

v. Complexity of systems: Most users are not technical and want a simple interface. In hardware systems, an unplugged cord or a flat battery in a remote control is seen as failure, contributing to perceived unreliability which drives users back to traditional meetings. Successful systems are backed by support teams who can pro-actively support and provide fast assistance when required.

vi. Perceived lack of interoperability: not all systems can readily interconnect, for example ISDN (Integrated Services Digital Network) and IP systems require a gateway. Popular software solutions cannot easily connect to hardware systems. Some systems use different standards, features and qualities which can require additional configuration when connecting to dissimilar systems.

vii. Bandwidth and quality of service: In some countries it is difficult or expensive to get a high quality connection that is fast enough for good-quality video conferencing. Technologies such as ADSL (Assymetric Digital Subscriber Line) have limited upload speeds and cannot upload and download simultaneously at full speed. As Internet speeds increase higher quality and high definition video conferencing will become more readily available.

viii. Expense of commercial systems: well-designed telepresence systems require specially designed rooms which can cost hundreds of thousands of dollars to fit out their rooms with codecs, integration equipment (such as Multipoint Control Units), high fidelity sound systems and furniture. Monthly charges may also be required for bridging services and high capacity broadband service.

Areas of Impact of Videoconferencing

- **Governnment and Law**:Tokson (2007), states that videoconferencing makes it possible to use testimony for an individual who is unable or prefers not to attend the physical legal settings or would be subjected to severe phychological stress in doing so. It can also be used for initial court appearances. Here, the systems link jails with court rooms, reducing the expenses and security risks of transporting prisoners to the courtroom, (http://www.lifesize.com).

- **General Public**: High speed Internet connectivity has become more widely available at a reasonable cost and the cost of video capture and display technology has decreased. Hence, personal videoconferencing systems based on a webcam, personal computer system, software compression and broadband

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Internet connectivity have become affordable to the general public. Also, the hardware used for this technology has continued to improve in quality and prices have dropped dramatically. Freeware generally in form of chat programs has made software based videoconferencing accessible to many.

- **Sign Language**: Firestone, et.al. (2007), notes that deaf, hard-of-hearing and mute individuals use affordable high quality videoconferencing as a means of communication with each other in sign language. Unlike Video Relay Service, which is intended to support communication between a caller using sign language and another party using spoken language. Videoconferencing can be used directly between two deaf signers. One of the first demonstrations of such usage occured when Telephone and Telegraph company (AT &T)'s videophone was introduced to the public at the 1964 New York World's Fair and two deaf users were able to communicate with each other between the fair and another city.

- **Education:** Videoconferencing provides students with the opportunity to learn by participating in two-way communication forums. Also, teachers and lecturers worldwide can be brought to remote educational facilities. Thus, the virtual field trips provides enriched learning opportunities to students, especially those in geographically isolated locations and the economically disadvantaged. These technologies can be used by schools to pool resources and provide courses, such as in foreign languages, which could not otherwise be offered, (http://www.communication.aver.com).

  - **Medicine and health:** It is a useful technology for real-time telemedicine and nursing applications such as diagnosis, consulting and transmission of medical images. Patients may contact nurses and physicians in emergency or routine situations. Also, physicians and other paramedical professionals can discuss cases across large distances. Rural areas can use this technology for diagnostic purposes, thus saving lives and making more efficient use of health care money, (http://www.lifesize.com). Special peripherals such as microphones fitted with digital cameras, videoendoscopes, medical ultrasound imaging devices and otoscopes can be used in conjunction with videoconferencing equipment to transmit data about a patient. Recent developments in mobile collaboration on hand-held mobile devices have also extended videoconferencing capabilities to locations previously unreachable, such as a remote community, long-term care facility or a patient's home, (http://www.justforcanadiandoctors.com).
- **Business:** Alison (2010), states that videoconferencing can help individuals in distant locations to participate in meetings on short notice, with time and money savings. Technology such as Voice over Internet Protocol (VoIP) can be used in

conjunction with desktop videoconferencing to enable low-cost face-to-face business meetings without leaving the desk, especially for businesses with widespread offices. It can also be used for telecommuting in which employees work from home. Videoconferencing is also currently being introduced on online networking websites in order to help businesses form profitable relationships quickly and efficiently without leaving their place of work. This has been used by banks to connect busy banking professionals with customers in various locations using video banking technology. Videoconferencing on hand-held mobile devices is being used in businesses such as manufacturing, energy, healthcare, insurance, government and public safety. Live visual interaction removes traditional restrictions of distance and time, often in locations previously unreachable, such as a manufacturing plant floor a continent away, (http://www.m.controleng.com).

- **Media relations**: Press videoconferencing permits international press conferences over the Internet. Journalists can participate on an international press conference from any location without leaving their offices or countries. They only need to seat by a computer connected to the Internet in order to ask their questions to the speaker.

Conclusion

The impact of videoconferencing in the modern world cannot be over-emphasized. The connectivity of people and resources through Internet technologies has aided collaboration and learning at several levels. Videoconference is very necessary for the implementation of a framework that will achieve multi-institutional and organizational knowledge sharing for the promotion of learning and fostering development. The application of relevant technologies coupled with more efficient video codecs, high-speed Integrated Services Digital Network (ISDN) data and Internet services will continue to make videoconferencing a highly useful technology.

Recommendations

Eventhough videoconferncing has frequently proven its value, some non-managerial employees prefer not to use it due to anxiety. Such anxieties can be avoided if they use the technology as part of the normal course of business. Also it has been found that attendees of business and medical videoconferences must work harder to interpret the information delivered during a conference than they would if they attended face-to-face. Hence, those coordinating videoconferences should make adjustments to their conference procedures and equipment.

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