

DISTANCE LEARNING APPLICATIONS ACROSS MULTIPLE PLATFORMS AND NETWORKS

Claus J. S. Knudsen

Division of Media Technology and Graphic Arts

Royal Institute of Technology (KTH)

Drottning Kristinas v.47 D, SE-100 44 Stockholm, Sweden

Tel: +46-8-790 6042; Fax: +46-8-791 8793.

E-mail: clausk@gt.kth.se

URL: <http://www.gt.kth.se>

Abstract

Interactive video/multimedia is one of the keys to effective communication between teacher and remote student individuals or groups. Today there are proprietary systems for video streaming on Internet, LAN and ISDN with a large number of solutions based on different platforms (PC or Mac) and codecs. Creating applications that work well in a mixed environment of platforms and networks is a complex task. This paper describes the experiences from a laboratory study in a mixed environment at the Royal Institute of Technology, Sweden (KTH). The main goal for the set - up was to explore combinations of software and hardware for PC and Macintosh to create technical solutions for remote controlled multiple videoconferences and shared applications. Several digital networks with different bandwidth were combined using different protocols and codecs for video, audio, text and application sharing. The organisation was located at several different places at the campus connected through a LAN. Remote students, researchers, teachers and visitors were connected through Internet and ISDN. In the test case, several different types of communication were used: distributed real time lectures with interaction, videoconference meetings, and continuous telepresence. The study shows that cross platform distance education can be achieved. There are, however, many factors that must be improved. Among these are;

- *digital real time interface between videoconferencing codecs for Internet, LAN and ISDN*
- *hardware solutions for human machine interaction*
- *industry policy for developing compatible hardware and software solutions across platforms and operating systems*

1. Introduction

Video conferencing technologies are at an early stage of development. Pioneers like Cornell University [3] came up with some of the first solutions for real-time video conferencing on the Internet already in 1995. Cornell's software was free for everyone to download and tests were made mainly at colleges and universities world wide, setting up reflectors for multiple videoconferencing. The frame was small, 160x120 pixels, the picture quality was bad and the frame rate for modem users 1-5 frames per second (fps). A small lightweight black and white camera connected to the parallel port or a video PC card could be used as video source. Audio sources from microphone, auxiliary inputs or internal CD player could be combined with the video and text/chat possibilities. The video compression used was at the beginning their own proprietary software Cornell CU-SeeMe grey.

At this stage the H.261 compression standard was dominating the videoconferencing systems based on ISDN (Integrated Services Digital Network). This was an MPEG standard within the group of H.320 and the technology gave full screen two-way video/audio on television monitors. Systems for PC cards were also developed and were mainly based on quarter size video frames on PC monitors. These two systems lived their own proprietary life for many years until recent developments and compatible compression methods on both technologies opened up for new solutions regarding telepresence in digital networking production systems (DNPS).

1.1 From proprietary systems to compatibility

In late 1997/early 1998 White Pine Software, the commercial vendor of Cornell's TCP/IP videoconferencing system, released version 3.0 for professional use including MJPEG and H.263 for compression of colour video. The video and audio quality now reached a level acceptable for further development of tools for distance education like real-time distribution of lectures, conferencing or just telepresence within LAN, WAN or the Internet. The software was released for both PC and Macintosh. The reflector software for multiple video conferences came with a release of Meeting Point for NT and Unix (beta version) including possibilities for Microsoft videoconferencing software Netmeeting to be connected. Dual platforms and the fact that the Meetingpoint could be controlled and set up for conferencing, broadcasting or other combinations from an ordinary web browser world wide opened up for flexible use. The fact that Apple H.263 video compression was added to the new release from White Pine Software, opened up for interconnection between ISDN videoconferencing systems compressions and LAN, WAN and Internet based systems. RSI videoconferencing systems [2] had developed an interesting small mobile solution for ISDN called "Video Flyer" with both stand alone use with camera and TV monitor or connected to a MAC or PC using a SCSI cable.

1.2 Problem definition

The main goal of this work was to set up and test an experimental laboratory system solution integrating two types of proprietary videoconference technologies on the market today in a digital multiplatform networking production organization. The two types of conferencing systems selected were a mobile unit from RSI Inc. for ISDN dial-up digital network conferencing based on H.320 standard compression protocols and a videoconferencing software for LAN, WAN and the Internet from White Pine software, CU-SeeMe [1].

The laboratory system should combine software and hardware for PC and Macintosh to create technical solutions for remote controlled multiple videoconferences and shared applications. Several digital networks with different bandwidth should be combined using different protocols and codecs for video, audio, text and application sharing.

1.3 Method

A laboratory model was constructed in order to study videoconferencing technology across multiple networks (ISDN, LAN, WAN, Internet) and platforms (PC, MAC). Several tests were carried out to study communication quality and the results were stored using video recorder and screen dump facilities. Text and chat messages were cut and pasted into word processor documents.

The recorded material was analysed and the results are presented in this paper. Microsoft Netmeeting compatibility was not tested at this time since this software only runs on PCs.

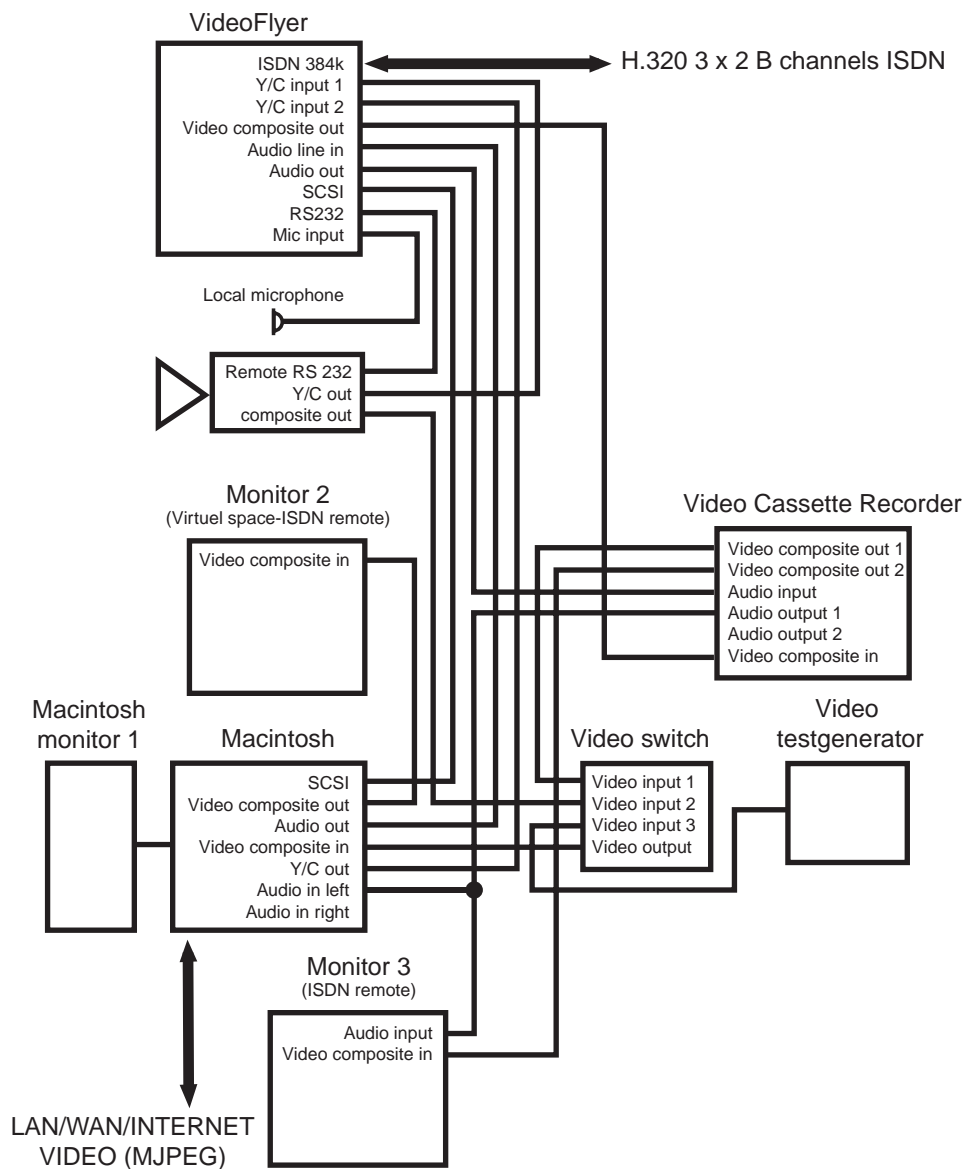


Fig. 1 The Media Laboratory test model connecting ISDN to LAN/WAN/Internet

2. The Media Laboratory test model

On a LAN network, 7 MAC workstations were set up with White Pine videoconferencing software at the (Div. Media Technology and Graphic Arts,) Royal Institute of Technology (KTH) in Stockholm, Sweden. Through the Internet, PC and MAC computers at Gjøvik College, Norway and Fachhochschule für Druck und Medien in Stuttgart (Graphic Institute), Germany, were set up with the same videoconferencing software. The Meeting Point multiple videoconferencing software was installed on a UNIX server in Stockholm. At KTH, a RSI Videoflyer connected to 6 B-channels for ISDN videoconferencing was connected to a Macintosh 8600 through SCSI and audio/video input and outputs. A Sony camera was connected to the Videoflyer unit through an Y/C connector and a video recorder was installed as a central part of the system. Because there was no software support from the two videoconferencing systems the interconnection had to be analogue, see figure 1. A PC was

set up at the Media Laboratory with an inexpensive Connectix colour camera connected to the parallel port to test out compatibility, video quality and frame speed.

Y/C video from the Macintosh screen was fed to the ISDN videoconferencing system as a second video source together with the main Y/C video source from the Sony camera. Y/C video from the ISDN videoconferencing system was connected through the video recorder to both the Macintosh Y/C video input and a video monitor. Composite video was connected directly to the Macintosh composite video input. In this way the Macintosh operator for videoconferencing on LAN, WAN and the Internet could choose between video from the ISDN conferencing unit and from the camera. The operator of the ISDN videoconference unit could choose between video from the second Macintosh screen and the camera. When audio was connected the complexity of the system model grew rapidly.

3. The testcases

One type of information distribution and two types of communication were implemented to test the laboratory model. The selection of information and communication types was based on human needs for communication quality within a digital networking production systems and on the fact that such production systems may have employees working remote (at a distance). Such virtual factories have the same need for meetings, information and feeling of presence. In this section, the system for each type is described and the results are presented in section 4.

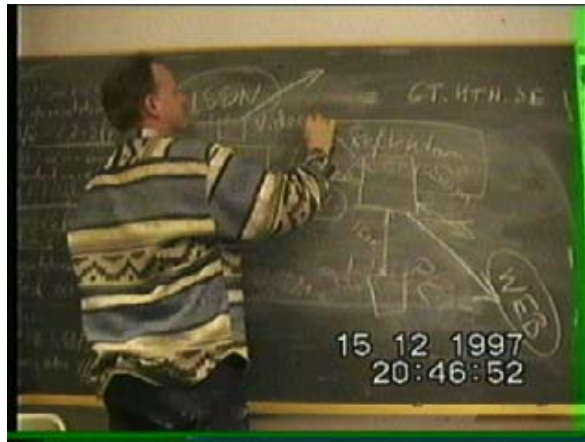


Fig. 2 Video out from distributed real-time lectures.

3.1 Distributed real-time lectures with remote student interaction.

In this study a lecture from a classroom was distributed on the LAN, WAN and Internet (fig.2). Audio and video were the media output elements and text was the media element for feedback to the lecturer with questions etc. The distributed audio and video on LAN were converted and sent through ISDN videoconference to a dialled-up remote source. In the classroom a Mac workstation was installed with a radio remote controlled camera and a wireless microphone for the lecturer. Composite video and line level audio were digitised as source for the conferencing software (CU-SeeMe, WhitePine). Presentation software (PowerPoint) was used by the lecturer from the same workstation as the video conferencing and projected on a large screen using RGB monitor output from the computer. The same PowerPoint presentation was fed as a video source too from Y/C output to Y/C input on the Macintosh workstation. The PowerPoint presentation was set up for working on screen number two on the Mac so that the main monitor screen could be used for the videoconferencing software. Through the software the lecturer could choose between the camera video source and the PowerPoint presentation video source. Audio from the wireless microphone was transmitted continuously. MJPEG compression was used for distributing the video on LAN to the Meetingpoint multipart conference server and

Delta-mode (16 Kbps) was used for audio compression. The Meetingpoint was set up for broadcast only which means that visitors logged on can use text based chat only but receives broadcast audio, video and chat. Written messages from the remote viewers (students) was monitored by the lecturer during the lecture and could be answered without any interruption.



Fig.3 Videoconference between ISDN (H.320) remote source (Nacka, Stockholm) through LAN (KTH Stockholm) to remote source on the Internet (MJPEG), Hungary.

3.2 Videoconferencing on multiple platform and networks

The multiconference server was during this study set to videoconference mode and 20 participants could connect through LAN, WAN and the Internet using video, audio and/or text. The connection point at KTH let incoming audio and video from the ISDN conference unit be sent to the Meetingpoint server. Video from the Meetingpoint server was sent back to the ISDN videoconference remote source. Audio was handled in the same way, see figure 1. The font size of the Meetingpoint text based chat was at the Mac workstation enlarged to 14 point bold for better readability on the remote source ISDN conferencing monitor. At the interface connection point between the ISDN dial-up conferencing system and the LAN based videoconferencing system, analogue video and audio gave the opportunity to record the communication on a high quality video recorder. A video mixer and a video test generator were used for quality control of the frames. Frame size on LAN was 1/8 monitor screen size (14 inches), 5-12 frames per second, and for the ISDN videoconferencing full screen frame size with 25 frames per second and H.320 compression (MPEG).



Fig.4 Video picture from the Meetingpoint.

3.3 Continuous telepresence

In the study of continuous telepresence (fig.4), the Meetingpoint received video from different workstations. Some of the participants were connected from universities in Germany, Estonia, Hungary and Norway. Those continuously connected to LAN could dial up the ISDN videoconference by using application sharing software like Timbuktu to control the Mac workstation connected to the ISDN video codec unit through SCSI cable. Incoming dialled-up ISDN videoconferences were immediately viewed on the central Meetingpoint.

4. Results and experiences

The laboratory studies show how videostreaming speed depends on the net technology used. In mixed platform networks, Mac's are consuming a lot of capacity by using AppleTalk and handshaking based protocols compared to PC based TCP/IP (Transport Control Protocol and Internet Protocol) for default wide area interconnected networks. One other bottleneck on the 10baseT LAN (local area network), WAN, Internet was the hubs because of the way they direct traffic. Data rates down to 22 kbps, 1-2 fps were measured, and the speed delivered was dependent on other data traffic. Those workstations connected to the LAN network through switches reached a much better speed level, some times up to 150 kbps, 10-12 fps. Audio had the highest priority when data-packages was sent from the CU-SeeMe software and the audio was based on simplex or duplex communication. The LAN-, WAN-, Internet based videoconference had sometimes a delay up to several seconds because of package delay in the network. Still, broadcast distributed real-time lectures were possible to follow by the participants and text based feedback to the lecturer was not dependent on exact real-time communication. However, „real-time“ conferencing with delays of more than 2-3 seconds is not acceptable for professional use. The video frames on the CU-SeeMe software can be adjusted in size and position very smoothly. A picture enlarged to full screen will of course be pixel zed but a lot of information can be obtained from the picture. Continuous telepresence from distance workers needs fixed connection to the Internet. When PowerPoint presentations were used as video source, tests showed that CU-SeeMe grey, highest quality, gave the best readability results for the Meetingpoint server participants. Changing compression and video source on the CU-SeeMe software during a lecture is too complicated and should be improved.

5. Discussion

The video quality from a Quickcam workstation camera streaming the signal through the signal chain to a remote source ISDN connection provides a better communication quality than a normal audio telephone call. Body language could be communicated although the frame rate was low on the LAN, WAN and Internet. The effects of continuous real-time telepresence in the networking organisation were interesting and communication effects known from open office environments occurred, even though the participants were working remote. One example was the feedback from others in the organisation on who visited whom during the day. Other examples were telephone calls not dialled because the caller could see the person on the other side busy talking with a visitor. Because a limited space in the offices was virtually „projected“ to the organisation's official Meetingpoint or “net entrance”, participants' behaviour changed during the experiment. At the beginning, there was "camera fright" but after some days of continuous real-time telepresence participants got used to the communication situation. PC and Mac software for video conferencing worked well together although the PC software had better functionality.

The participants made themselves accessible at many different levels of communication during a day. Experience made them stop sending video for a while or just sending video and not allow incoming audio when they, for example, had a telephone call, a visitor or just needed to be uninterrupted. The multiple text based chat in the Meetingpoint "conference room" with multiple video was easily cut and pasted into a word processing document for report use. These flexible short meeting conference possibilities were one of the positive experiences. Because of a too complicated human machine interface for the flexible use of audio, (mouse click for push to talk), audio was often only used for getting attention, like ringing on the telephone. But audio was needed for return communication on ISDN dialled-up connections. The fact that 10 to 20 video streams were up at the same time made the organisation virtual on the digital nets.

The test of flexible distance learning through real-time streaming of lectures also got positive response from the remote participants. Some of the participants were registered as lurks, having the lecture as a second element on their computer while working with something else. Others were registered as full interactive participants. Real-time audio and video from the lecturer could easily be combined with URL links on the chat. In this way remote participants could add learning material such as audio examples, video on demand, text, graphic and pictures from the web by simply clicking on the URL provided by the lecturer on the conference chat.

The experiences from remote control of the ISDN conference unit using Timbuktu software show that this is possible but the software solutions need to be developed. The incoming ISDN video conferencing pictures were automatically streamed to the Meetingpoint and it was a positive experience for the remote ISDN source users to view such a virtual entrance to a networking organisation. For full frame two-way videoconference between one participant on the LAN, WAN or the Internet and a remote source ISDN, a manual adjustment was needed by the operator at the Media Laboratory test model (fig. 1). Such adjustment possibilities should also be implemented in the remote control communication software.

6. Future work

RSI Inc. has recently introduced a solution for Netmeeting connection through a serial extension port on the "Video Flyer" codec. Serial ports for data connection opens up the possibility of data application sharing combined with videoconferencing using PowerPoint and other software. The video codec then acts as a "modem" unit on the Windows NT or Windows 95 platform.

Further investigation should be made of these new possibilities. This should be a part of finding solutions for digital real time interfaces between videoconferencing systems for Internet, LAN, WAN and ISDN. "Easy to use" hardware solutions for human machine interaction should be developed for real-time lecturing, functions such as switching video sources and audio control. Further investigations and industry developments need to focus on compatible hardware and software solutions across multiple platforms, operating systems and different types of digital network transmission.

We need to know more about human communication needs in a virtual networking production system. Future studies should explore the need for various levels of telepresence and communication in digital networking production systems. A suggestion for a sequence of communication quality levels is listed below:

- text on demand,
- text on demand with attention sound or light,
- continuous real-time simplex text (information screen),
- continuous real-time duplex text chat (Internet Relay Chat),
- continuous real-time text chat with attention,
- sound on demand (voice mail),
- sound on demand with attention sound or light,
- continuous simplex real-time sound (radio),
- continuous duplex real-time sound,
- continuous duplex real-time sound with attention sound or light (telephone),
- video on demand,
- video on demand with attention sound or light,
- continuous real-time simplex video (television),
- continuous real-time duplex video (videoconference/two-way television) and combinations of these.

8. Conclusion

The laboratory study shows the importance of visual multiway communication in networking production and learning organisations. The technology is in an early stage although the technology for digital transmission through twin copper wires (ISDN, ADSL) has been much improved during the last few years, and the latest ISDN codecs are fitted with H.263 compression protocol for videoconferencing on LAN. Digital infrastructure service providers must in the future guarantee a minimum speed for digital package exchange on digital networks for quality communication. The positive reactions of the participants using flexible digital networking conferencing and broadcasting tools needs further investigation. The analogue laboratory set-up can serve as a basic model for fully digitised solutions using new compatible compression standards for the programming.

9. References

- [1] CUSeeMe and MeetingPoint software, WitePine Inc., URL: <http://www.wpine.com/software>, 1999-03-31.
- [2] RSI Systems, Inc., URL: <http://www.rsisystems.com>, 1999-03-31.
- [3] Cornell University, URL: <http://www.cornell.edu>, 1999-03-31.