VIDEO CONFERENCING MADE EASY

D. Gail Larsen
INEL/EG&G Idaho, Inc.
P.O. Box 1625
Idaho Falls, ID 83415-1500

Paul R. Schwieder
INEL/EG&G Idaho, Inc.
P.O. Box 1625
Idaho Falls, ID 83415-1500

Prepared for the
U.S. Department of Energy
Office of New Production Reactors
Under DOE Contract No. DE-AC07-76ID01570

ABSTRACT

Network video conferencing is advancing rapidly throughout the nation, and the Idaho National Engineering Laboratory (INEL), a Department of Energy (DOE) facility, is at the forefront of the development. Engineers at INEL/EG&G designed and installed a very unique DOE video conferencing system, offering many outstanding features, that include true multipoint conferencing, user-friendly design and operation with no full-time operators required, and the potential for cost effective expansion of the system.

One area where INEL/EG&G engineers made a significant contribution to video conferencing was in the development of effective, user-friendly, end station driven scheduling software. A PC at each user site is used to schedule conferences via a windows package. This software interface provides information to the users concerning conference availability, scheduling, initiation, and termination. The menus are "mouse" controlled. Once a conference is scheduled, a workstation at the hubs monitors the network to initiate all scheduled conferences. No active operator participation is required once a user schedules a conference through the local PC; the workstation automatically initiates and terminates the conference as scheduled. As each conference is scheduled, hard copy notification is also printed at each participating site.

Video conferencing is the wave of the future. The use of these user-friendly systems will save millions in lost productivity and travel cost throughout the nation. The ease of operation and conference scheduling will play a key role on the extent industry uses this new technology. The INEL/EG&G has developed a prototype scheduling system for both commercial and federal government use.

INTRODUCTION

Network video communications is advancing rapidly, and the Idaho National Engineering Laboratory (INEL), a Department of Energy (DOE) facility operated by EG&G Idaho, Inc., is at the forefront of this development. Engineers at EG&G have been involved in the design and development of several video conferencing installations for the Department of Defense (DoD), the INEL, and DOE. These installations have included; point-to-point and multipoint NSA approved secure and nonsecure video conferencing and data networks; local and long haul communication networks; multilevel security systems; remote digital video imaging; mobile video and audio systems;and multinodal, multimedia information networks. Typically these systems incorporate multiplexed digital data traffic that can be carried over land lines, microwave, fiber cable or satellite communications media. INEL engineers have developed expertise and implementation tools in all the above areas over the past eight years, that has placed our design and installation teams in a

unique position to help government and private groups develop video conferencing and data transmission capabilities. INEL engineers have, in all cases, carried these jobs from start to finish. Using industry standard equipment and have interfaced with government and private agencies to work both the technical and operational challenges associated with video conferencing and data networks.

The principle subject of this paper is a video conferencing and data network developed for the DOE that embodies many of the features that are both common and unique to high level video conferencing and data transmission needs, including true multipoint conferencing, user-friendly design and operation, no full-time operators required, and the potential for cost-effective expansion of the system. This development is an excellent example of an information system that serves todays needs, using current technology, and at the same time looks forward to the future needs of video conferencing and data transmission. Although the conferencing system developed for the DOE was designed for a limited user community, the work performed by INEL engineers forms the groundwork for video conferencing and data communications networks of any size.

The DOE identified the need for a nation-wide video and data network and contracted the INEL/EG&G Idaho to design it. This network was to link remotely located sites through an effective use of both video and data communications capabilities. Eight sites were selected for the initial system. A dual hub topology (one in the eastern US and one in western US) was selected to minimize the number and length of communication lines and lower costs (see Figure 1). The system configuration at each user site consists of video conference equipment (monitors, cameras, etc.), a compressor/decompressor (CODEC) for bandwidth reduction, a multiplexer for multiple data input, a gateway to a nationwide communications network, and a personal computer (PC) linked to centrally located workstations for local systems and video

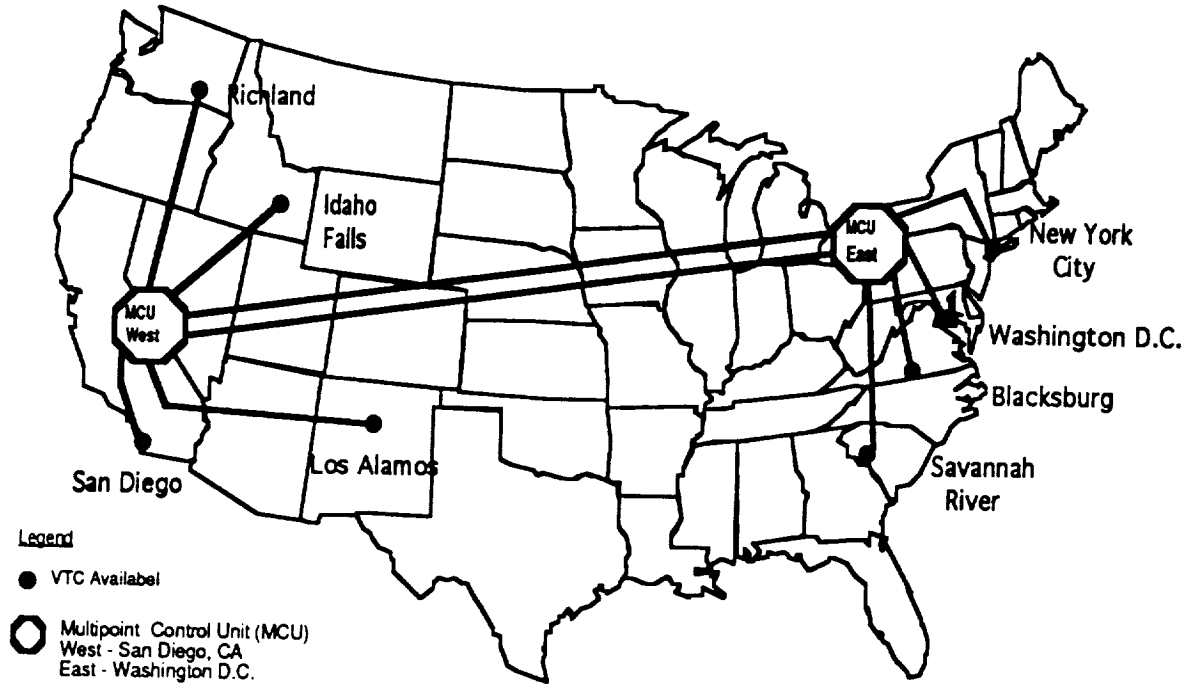

FIGURE 1

BASIC MULTIPOINT VIDEO CONFERENCING NETWORK

network scheduling. A workstation and a Multipoint Control Unit (MCU) used for video switching are located at each hub. The workstation provides control of the network-wide video scheduling database. Each site is equipped with a bandwidth multiplexer (mux) used to multiplex the video conferencing signal as well as other types of digital data transmissions on a T1 communication line leased from AT&T. The multiplexers, connected to the communications network, create a communications backbone capable of serving not only video conferencing, but many other forms of data transmission between the involved sites. Data transmission and network control interface directly to the multiplexers; only video conferencing signals pass through the CODEC units and the MCU.

THE HARDWARE

The hardware is all off-the-shelf and readily available. Rooms or studios are set up using commercial video and audio equipment, with either customized configurations or modular consoles. The communications backbone is a multiplexer based, multipath nodal system, capable of carrying many different types of data traffic, including the video conferencing. The multipath capability supports reliability, by providing more than one path for data flow, as well as supporting both point-to-point and star/hub type communications links, simultaneously. Each node's multiplexer allows for the support of computer traffic, voice, fax, high resolution graphics or imagery, or any form of digital information exchange, up to the limit of available bandwidth. Riding along on the same communications lines to perform housekeeping chores is the network wide control and data routing information provided by an easy to use control and scheduling system. Developing the network architecture into either, or both a star/hub, or point-to-point configuration is simply a matter of choice in a well designed nodal communications network. The star/hub configuration is necessary for multipoint video conferencing applications. The point-to-point applications support point-to-point video conferencing, as well as all manner of digital data traffic, and all can be served simultaneously, again up to the limit of the available bandwidth. Fractional T1, T1, or even T3 communication services can be employed to support the users needs and budgets.

The Video Conferencing CODEC is located on the equipment side of the nodes multiplexer and supports only video conferencing applications. Its primary role is to reduce the full motion video bandwidth (typically 92 mb/s) down to near full motion (1.5 mb/s or less) to allow for affordable transmission between sites. The CODEC also provides data formatting, encryption, bandwidth multiplexing and other services.

The MCU located at each hub is an audio-activated digital video switcher. This video input to output switching capability is key to multipoint conferencing. To accomplish this switching, the MCU separates each site's incoming audio signals from the video, determines which signal is the loudest (dominant) at any given time, and switches the transmission of the associated video to all participants. This results in "video-follow-voice"conferencing, in which multipoint participants see the video image of the dominant speaker. The audio is party line; all participants hear each other at all times. As another participant becomes the dominant speaker, the MCU automatically switches to broadcast their video image. The DOE configuration uses two dedicated MCUs, one in the eastern U.S. and one in the western US, linked together via redundant communication lines in a cascade configuration, with a combined potential for five separate simultaneous conferences involving up to twelve separate participant sites. A follow-on to this existing design will use the MCUs as free floating independently assigned conference servers, allowing several MCUs at each hub to serve a much larger conferencing community, all under the control of the automatic conferencing control and scheduling system.

CONFERENCE CONTROL AND SCHEDULING

One area where INEL engineers have made a significant contribution to video conferencing is in the development of an effective, user-friendly video conferencing scheduling system. A PC at each site is used to schedule current and future conferences via a windows menu package. Users are provided information on current and future conferencing schedules, conference initiation and termination, and video system status. All inputs to the system are via a "mouse" or keyboard. Following the prompts and selecting the desired options enables the user to schedule current and future conferences on the system as well as do conference

status inquiry.

Once a conference is in the workstation's scheduling database, the workstation monitors the common network time (based on east coast time, but displayed to each user in local time) and activates and terminates each scheduled conference automatically by sending commands to the MCUs at the hubs. Conference scheduling time slots are broken into 15-minute intervals. Start immediate and end immediate commands are also available for spontaneous unscheduled conferences allowing initiation and termination of a conference at any time.

No active operator participation is required once a user schedules a conference through the local PC. Under the control of the scheduling database, the workstation automatically brings up the conference as scheduled. Hard copy notification of the scheduled conference is provided at each participating site via a dedicated printer. There can be up to 5 separate and independent video conferences on the network simultaneously, however, users can participate in only one conference at a time.

The scheduling system is designed so that a central manned operation center is not needed. Individual users of the system schedule and operate the system from their own facility. Typically, any user could operate and schedule a conference after just a few minutes of training. The following example demonstrates how easy scheduling a conference can be:

> "A user at Site 1 needs to schedule a video conference meeting for Monday at 10:00 a.m. He opens the scheduling log on his PC screen and discovers that the necessary conferencing sites are free on Monday at 10:00 a.m. With a few clicks of the mouse, identifying the sites involved and the conference date and time, the conference is entered into the time slot from 10:00 to 10:30 a.m. The user selects a closed conference to ensure privacy. All sites in the conference receive a hard copy notification of the scheduled conference.
>
> A few minutes before 10:00 a.m., on the day of the conference, one of the participants involved walks into their conference room turns on a single switch to activate the local system. The system comes up in a loop-back (to the MCU and back) configuration wherein the local sites initially see themselves. Cameras at the sites are adjusted by the conference attendees until everyone in the room can be seen on the systems monitors. Microphones are arranged to make sure that all voices can be comfortably heard. At 10:00 a.m., the hub MCUs receives a signal from the workstation to complete the required conference interconnections and the conference begins. An ascending three-tone signal is automatically sent to all participating sites announcing the start of the conference. The originator makes the necessary introductions and initiates the conference.
>
> As the conference progresses, the sites' main video monitors switch between the sites of the dominant speakers, and graphics are sent and displayed on each sites' auxiliary monitors. Discussions center on the problems at hand and after twenty minutes, issues are cleared up and direction given. Since the conference is completed early, the originator brings up the scheduling menu at the local PC and selects the "End Conference Immediately" option. A descending three-tone signal is sent to all three sites, and each sites monitors return to a view of their own conference room. The conference is complete."

DATA TRAFFIC

The multiplexers and the dedicated full-time T1 (1.544 Mb/s) communication lines form the backbone of the communication network. Independent data transmission occurring simultaneous with a video conference is possible because the multiplexers share the use of the T1 bandwidth through division of

the 1.544 Mb/s between data, video, and control traffic. During off-shift times or on weekends, when video conferencing is not being conducted, all but the control portion (19.2 Kb/s) of the T1 bandwidth can be manually allocated to data transmission tasks. Work is progressing to include automatic, dynamic network bandwidth control as part of the workstation functions.

PRIVACY

Scheduling PCs at each site as well as the workstations at the hubs are password protected. Video conferencing signal encryption is optional. Encryption can be performed in the CODEC and in the MCU through the use of encryption keys. Each site receiving encrypted transmission must use the same key.

Conference privacy can also be assured by making a conference closed to all but invited participants. Open conferences can be joined at any time. However, when an additional participant joins an open conference, his presence is announced by a brief series of audio tones. Closed conferences allow only those sites scheduled by the conference originator to participate. The conference is designated open or closed when it is scheduled on the originator's PC.

SECURE SYSTEM APPLICATIONS

NSA approved security is an easy extension of the above described network. DoD networks using the MCUs in secure conferencing configurations have been established by INEL engineers at the Strategic Air Command (SAC), at Offutt AFB; the Tactical Air Command (TAC), at Langley AFB; the Pentagon; Norfolk Naval Center; Cheyenne Mountain/Peterson AFB in Colorado; and the Material Air Command (MAC) at Scott AFB in Illinois. These networks typically employ KG-94/194 encryption devices at the Red/Black boundaries of the secure facilities. It should be noted that these systems use a combination of fiber links, microwave links, commercial telephone links, and satellite links as communication media, all working through the KG devices. These secure systems have worked reliably and well.

In secure applications, the multiplexers and nodal communication equipment exists on the black side of the secure boundary and receive black (encrypted) data from the secure areas, or non secure information from non secure areas. For video conferencing the MCU and CODECs must operate on unencrypted, or red data, thus requiring the MCU and CODECs at both end station and hubs to be located in secure (Red) areas. As long as Red/Black boundaries are observed, both encrypted secure and non secure data traffic can be handled simultaneously by the network.

GOVERNMENT AND COMMERCIAL BENEFITS FROM VIDEO CONFERENCING

Although these systems are new, benefits have already been realized. Among them are:

- *** **Managers and key technical people are more reachable.**
- *** **Lost productivity due to travel is reduced.**
- *** **Less time is lost in clearing calendars and making travel plans.**
- *** **Meetings can be held that normally would be cost and schedule prohibitive.**
- *** **Meetings can be expanded to include additional personnel who would normally not travel.**
- *** **A greater number of people can benefit from special expertise.**
- *** **Meetings are better structured and more task-oriented.**
- *** **People make firmer commitments to a person they can see rather than just hear.**
- *** **Territorial issues do not have to be addressed, so the focus is more likely to be on the original purpose of the meeting.**
- *** **Decisions can be reached faster.**
- *** **Sessions can be recorded and replayed as needed.**

Although travel reduction is the most common reason for businesses and other agencies to consider

teleconferencing, it isn't the biggest factor in savings. Our experience has shown that although travel decreases, the cost of design, installation, and maintenance of a video teleconferencing center offsets the saving in travel significantly. What really improves (thereby justifying the expense of a facility) is the response time to problems in development or delivery of a product. All the best minds of an organization, not just the ones who are free to travel, can be put on the problem at once, with immediate feedback.

It is also our experience that teleconferencing enhances group decision making, and that in situations involving conflict, it facilitates negotiation. Teleconferencing participants tend to be less dogmatic, and more compromising, allowing opinions to be changed more easily, resulting in formation of fewer coalitions.

WHERE VIDEO CONFERENCING IS HEADED

The pressing need in the video conferencing world is to reduce the number of "islands" of video conferencing which cannot intercommunicate, in favor of single networks that serve larger user communities. The various architectures must look forward to emerging standards and related technical developments that will support system interconnectivity. However, a dominating adherence to these standards is still a few years in the future. Pseudo standards tend to be set up by systems that have the most equipment in place. Growth and expansion, of necessity, perpetuates the acquisition and installation of compatible, usually single source equipment. Until equipment is truly standardized, networks large or small, must acquire certain critical equipment from a single manufacturer. This is more critically true for digital multipoint conferencing hardware than for the simpler point-to-point digital links. The development of a large nationwide network requires settling on a single architecture for certain critical components, including the CODEC, the MCU, and separately the multiplexers and communication backbone equipment prior to finalizing design.

INEL Engineering propose the development of new, or the expansion of existing systems into larger networks, to be designed to satisfy the following concepts, and comply with the configuration shown in Figure 2.

- *** **Use of a large area network multiplexer backbone capable of serving a large number of sites.**
- *** **Banks of MCUs used as free-floating conference servers assigned to users on a conferencing basis and not permanently assigned to any given user, thus significantly expanding the potential numbers of users.**
- *** **Untended network accessible through any end station conference facility.**
- *** **A large, user-friendly conference control database.**
- *** **Dynamic network bandwidth control and allocation of data and video through the workstation database.**
- *** **Simultaneous use of the dedicated bandwidth for video conferencing and other user information exchange needs to better utilize expensive communications costs.**
- *** **Incorporation into the network of dial-up and switched services.**

INEL engineers contend that the network developed for DOE and the experience gained from the DoD installations provide a viable base from which new larger systems can be developed and to which older systems can migrate to establish nationwide video conferencing networks. Hardware compatibility will continue to be a problem for the next few years, however, despite these problems large multiuser, multipoint and multiservice conferencing and data networks are possible using today's technology.

This larger network would be similar in operation and application to the limited DOE networks discussed in the previous section. The primary differences would be (1) larger multinode, multiplexed communications network forming the backbone, (2) the use of MCUs as free floating servers assigned as needed to video conferencing users, and (3) the expansion of the control database to support a larger user community with multimedia, multidata, and multiuser services. The end station video equipment and network access and control equipment will remain much as it is in the above DOE system. Our existing

database and network control will be expanded, along lines already established, to serve a larger user community.

Using an innovative structure such as that shown in Figure 2 assures compatible, low-maintenance systems accessible to a large user community at a minimum cost. Video conferencing is the wave of the future. Swift action to make it accessible nationwide should be a critical priority of both private industry and government agencies.

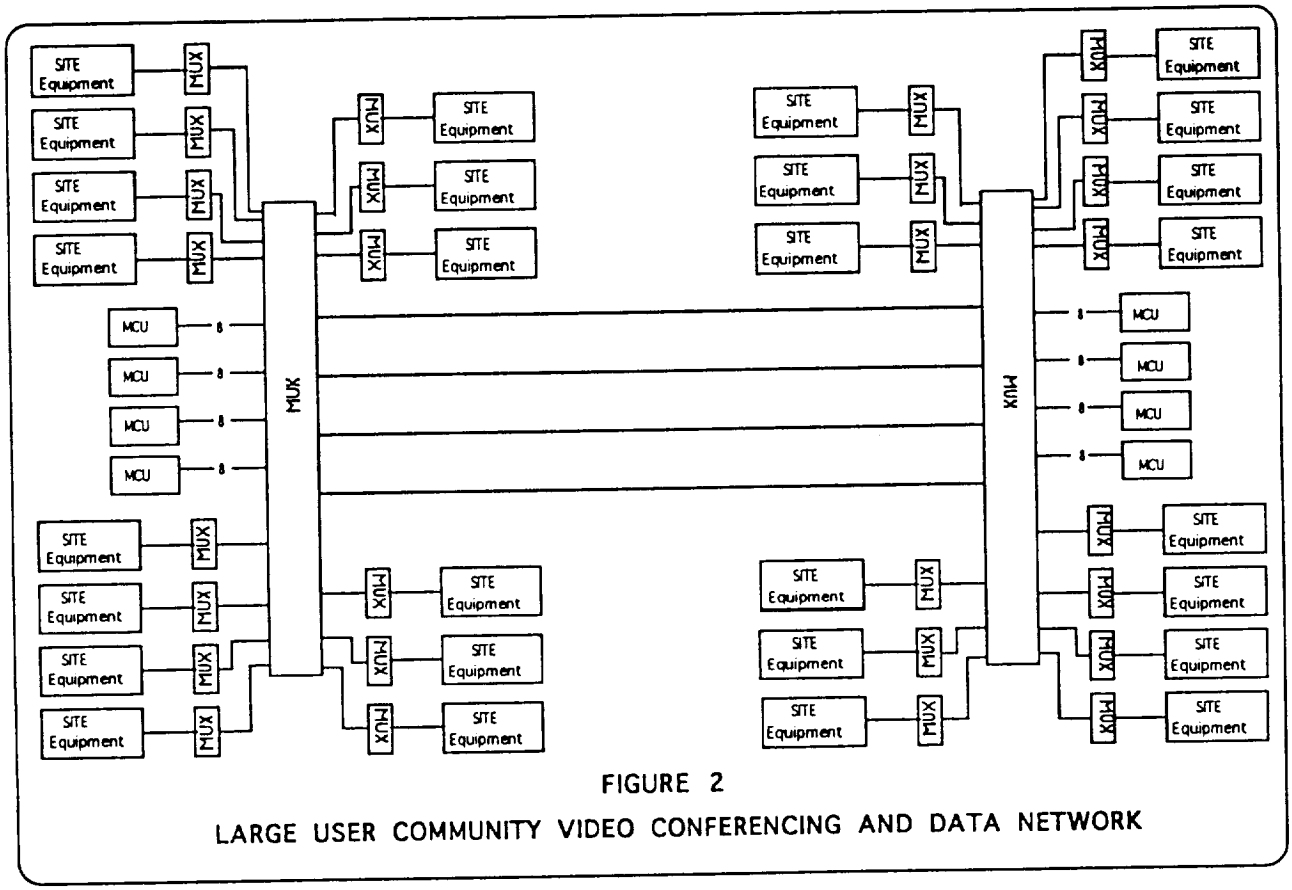

FIGURE 2

LARGE USER COMMUNITY VIDEO CONFERENCING AND DATA NETWORK