BIOGRAPHY

Martina Angela Sasse has been a lecturer in the Department of Computer Science at UCL since 1990, teaching Human-Computer Interaction and Systems Analysis and Design. Her main area of research is Multimedia Systems and Computer-Supported Collaborative Work (CSCW). She has worked on European projects in the area of multimedia (RACE CAR and ESPRIT MICE). She is currently the Project Manager of MICE, and Principal Investigator of ReLaTe at UCL, a BT sponsored Super-JANET applications project.
Roy Bennett heads the MICE-NSC at UCL.

FURTHER READING

Videoconferencing Guidelines
URL http://www.cs.ucl.ac.uk/mice/mice-nsc/tools/guide-mmconf.html
Installation and User manuals for software supported by the MICE NSCs
URL http://www.cs.ucl.ac.uk/mice/mice-nsc/tools/

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and retrieve. Artists and other people were encouraged to create new pieces of art from this starter collection, and return them to the Artaids server as a further donation for Crusaid. Artaids was launched with a through a multimedia conference on Nov. 28, 1994, between London, Stuttgart, Stockholm, Sydney, Melbourne and San Francisco. The project will continue throughout 1995, culminating in a further conference on World Aids Day in which the art pieces submitted during the year will be commended.

Hewlett-Packard European Conference on Distance Education

Hewlett-Packard wished to document European progress in the area of distance education by holding a conference between some of the major European centres. This will be achieved through a conference in April 1995 between UCL, the Royal Technical Institute (Stockholm), the University of Olso, and the Technical University of Berlin (TUB). Presentations will be made from those three sites, with further audiences at Hewlett-Packard sites in Bristol, UK, and Lyon, France being linked to the conference. The HP Labs are currently not connected to the Mbone, so this event will be a demonstration of temporary connectivity over ISDN lines and routers.

CONCLUSIONS

The technology has certainly left the experimental phase, but has not quite reached the stage where it is robust enough to expect large number of non-expert users to apply the technology without guidance and support. Within the UK, multicast technology has been tried and tested by a number of SuperJANET sites through the JIPS Mbone pilot. As a result of that pilot, UKERNA will offer multicast as a service to the academic community in Spring 1995, and is funding the UK MICE Network of Support Centres at UCL, Edinburgh and Glasgow for Scotland, and Aberystwyth for Wales to support academic users over the next two years.

On an international scale, however, there are problems with connectivity and congestion which need to be resolved. The European MICE-NSCs aim to support international user groups and act as a liaison with the national and international network providers. Users need more time and hand-on experience to apply the technology in a productive manner. Tool developers will have to tailor or advance their tools for specific applications. An example for this are projects which use the technology for remote medical teaching (TLTP project INSURRECT, funded by the HEFCE [JAMESON et al.]) and language teaching (project ReLaTe funded by British Telecom as part of the BT/JISC initiative [BUCKETT et al.]).

Technical work on the MICE project will continue. Developments of direct benefit to the users include improvement of the software tools and integrated user interfaces, incorporating multimedia servers in conferences, and security for private conferences.

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technology for weekly project meetings. Whilst regular use of the technology for real tasks (distributed software development, collaborative authoring and project management) helped us to identify and address some problems (such as setting of audio levels and bottlenecks in the network infrastructure) early on the project, a pilot service had to involve potential users from outside the project. Since seminars are a major example of collaboration between researchers, we decided to pilot the technology by setting up a distributed International Research Seminar Series on Communications, Multimedia, Distributed Systems and CSCW, and invited researchers and graduate students to participate as speakers, discussants and audience. The first series of seminars were given on a weekly basis between October and December 1993 and have continued on a fortnightly basis from February 1994. Apart from audiences at MICE partner sites, remote participants from all over Europe, the US and Australia have been attending.

The seminars have provided a valuable testing ground for the effectiveness and reliability of the conferencing tools and underlying European research network infrastructure [SASSE et al.]. We now have guidelines for conditions under which it is possible to hold such events. If packet loss, for instance, is greater than 20%, it is almost impossible to understand the speaker, particularly if the language used is not the listener's native language. In such circumstances, video transmission may be stopped completely to conserve bandwidth for the audio. Remote seminars need careful preparation and monitoring. Material displayed on the shared whiteboard tool needs to conform to certain standards in order to be readable when projected from workstation screens in remote conference rooms. New skills are required to give a multicast lecture, so some prior instruction and practise is required.

Apart from the MICE seminars and public demonstrations, the user base for multimedia conferencing has been broadened through a series of showcase conferencing events with users and audiences from non-technical backgrounds. All conferences used tools piloted and supported by MICE to provide these conferences, and were multicast on the Mbone.

Minimal Invasive Surgery Workshop

A two-day workshop on novel minimal invasive surgery techniques, attended by surgeons specialising this area, was held at the Middlesex Hospital in London on Nov. 10 and 11, 1994. The workshop consisted of talks and a number of live operations to demonstrate surgical techniques. The workshop sessions were transmitted from the Middlesex Hospital to Sahlgrenska Hospital in Gothenburg (Sweden). On the second day, a surgeon in Gothenburg and at the University Hospital in San Francisco (US) demonstrated novel surgery techniques in live operations which were watched by the workshop participants in London. The video transmission showed either a view of the surgeon or internal pictures from endoscope or scanner. A question-and-answer session between members of the London audience and the surgeons in Gothenburg and San Francisco were followed the operation. Due to limited bandwidth available on the international links, video rate had to be limited to around 100 kb/s and audio suffered from occasional packet loss. Nevertheless, both operating surgeons and members of the audience were impressed with the potential of the technology for medical teaching and consultancy.

ArtAIDS Launch

The Artaids project [ArtAIDS] involves number of renowned artists, who agreed to donate a piece of electronic art to Crusaid, a UK Aids charity. These art pieces were to be used in a long-term project on cooperative art: they were made available on a World-Wide Web server for anyone to view

SuperJANET Mbone Pilot Sites, December 1994

Aberdeen
Aberystwyth
Aston
Bath
Bristol
Brunel
Cambridge
Daresbury
Durham
East Anglia
Edinburgh
Exeter
Glasgow
Hertfordshire
ICRF
Imperial College
Lancaster
Leeds
Loughborough
Manchester
Newcastle
Nottingham
QMW
RAL
Sheffield Hallam
St Andrews
Strathclyde
UCL
UKERNA
ULCC

room, you will need some means of displaying the workstation screen image onto a larger screen and possibly a radio microphone to allow easy change of speaker. For basic conferencing the costs are not excessive.

What you need to do

If you have sufficient access to the Internet, you need to have your network provider connect you to the Mbone. This is done by creating a new tunnel to an adjacent mrouter already on the Mbone.You will certainly need help to do this, and in the event that something goes seriously wrong in the future.

What help is there

Building on the experience of the MICE project, a series of MICE National Support Centres have been established throughout Europe. The UK centres are at University College London, Edinburgh and Glasgow universities and the University of Wales at Aberystwyth. Each of these centres can provide advice, contacts with network providers and access to the free software. Help is provided through World-Wide Web pages [MICE NSC], through electronic mail (email) and over the telephone. Demonstrations can be arranged to give prospective users an indication of the quality and scope of the technology first-hand. There is also support for the use of these tools on the SuperJANET network from the EMMA project (Enhanced Multicast for Multimedia Applications) at UCL which is funded by JISC. This support will be accessible through the English National Support Centre at UCL.

APPLICATIONS

The use of the technology for international research cooperation between European researchers, and with colleagues in the US and Australia, has been demonstrated successfully in public events at a number of conferences (JENC'4 in Trondheim, Norway; 27th Internet Engineering Task Force in Amsterdam, The Netherlands; Interop in Paris, France; INET95 in Prague, Czech Republic). In February 1995, UCL and INRIA demonstrated the use of the technology over the new generation of high-speed networks (using Asynchronous Transfer Mode (ATM)) at the G7 Summit Exhibition in Brussels.

Apart from public demonstrations, MICE partners and other European projects use the

At the foot of the window are controls for managing the pages and importing either text or postscript files.

In addition to the whiteboard window itself there is a separate control window shown as Figure 8. The upper section, *Activity*, shows those who have contributed with current contributors highlighted. All *Participants* are show below this with details of a highlighted participant shown in the *Participant Info* section. Checking the box to the left of each participant prevents the display of that persons contribution - a useful feature in an open environment wheree the whiteboard is vulnerable occasionally to anonymous graffiti. Under *Network* are the details of the user and finally some more controls. Of these latter, the significant one is *Mute New Sites* which allows you to prevent the contributions of any new people joining the conference from appearing on the whiteboard. The feature complements that provided for individual in the *Participants* section.

Figure 8 : wb control window

HOW TO GET STARTED

What you need to have

The prerequisites may be categorised under the headings of justification, connectivity and equipment.

Justification. The most important need is a justification. Especially, these days, there must be a financial one. This can be made in terms of saved travel expense where there is a need for regular meetings with colleagues at remote locations. Multimedia conferencing cannot yet replace the need for *real* meetings, but it can reduce that need. In the MICE project [HANDLEY et al.] which links partners all over Europe, the regular weekly meetings over the network have reduced the need for full-scale face-to-face meetings at a common location.

Connectivity. You and your prospective partners in conferencing will need a good connection to the Internet. The minimum recommended by MICE Support Centres is 256 Kbps, but the more you have, the better. In the UK the SuperJANET network is providing excellent connectivity to universities and other academic and research institutions.
The panel shows the list of institutions currently connected to the SuperJANET Mbone pilot network which provides them with at least 10 Mbps between each other.
Shortly all universities will be connected.

Equipment. You will need a workstation similar to that described earlier. If you need to have a number of people in a conference

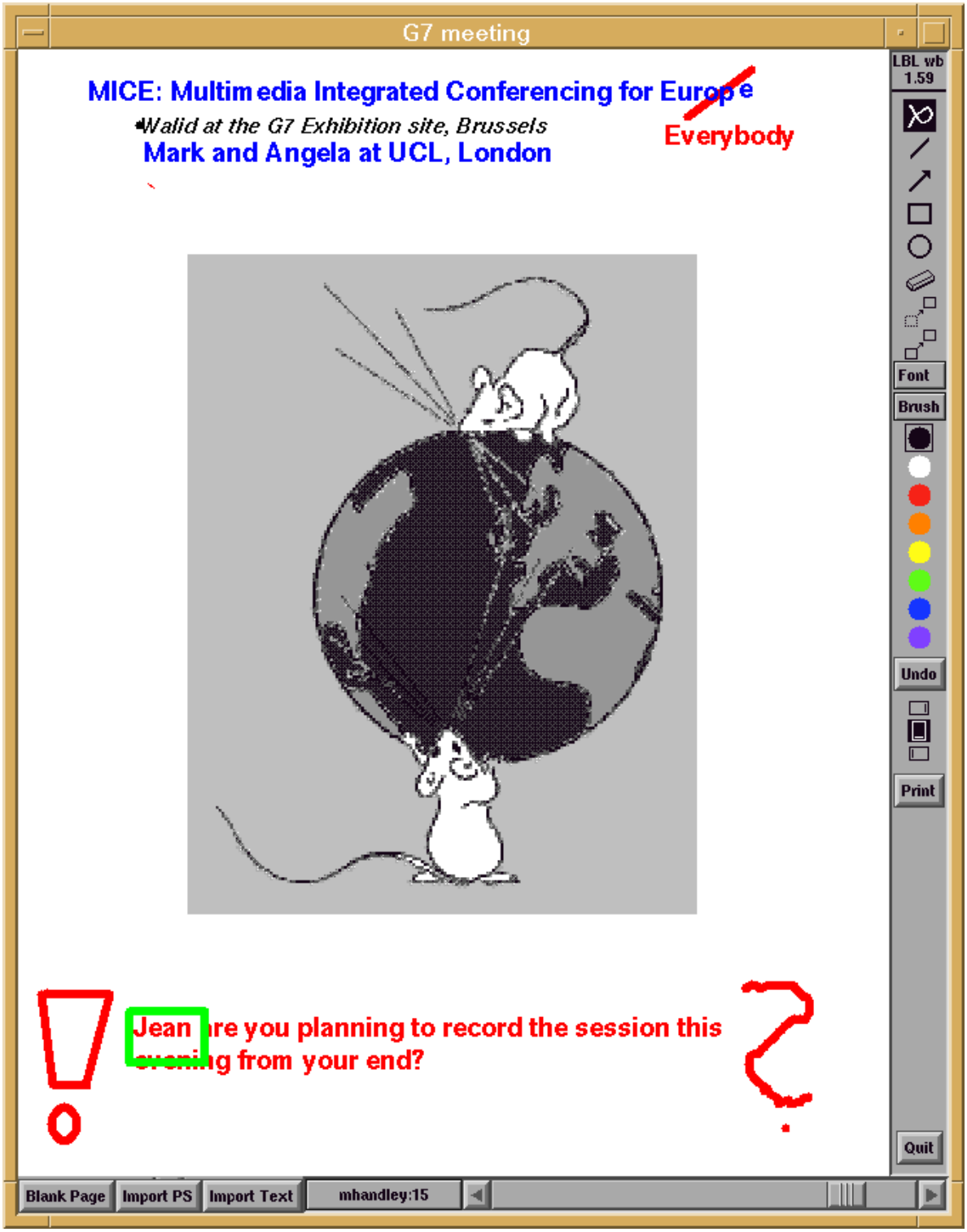

Figure 7 : wb main window

the same source. Wbimport allows for more control over the display of the images. An example of a postscript image with annotations is shown as Figure 7. The controls of the whiteboard are intuitive, most of them being set on the right side of the main window. At the top are the drawing tools, then two pop-up menus for f*ont* and *brush size*. Below is the colour palette, an *undo* button, the orientation controls and a *print* button.

Figure 6 : vat menu window

the *Menu* and *Help* buttons. The menu window, shown as Figure 6, contains the controls and switches needed to run the tool. These include testing, transmission and network controls. They allow the user to set the encoding and to select between *Conference* and *Lecture* mode. Since the Mbone is implemented over a datagram network, there is every chance that packets will be missing or misordered at the receiver. It is pointless resending lost packets since the need is for smooth and timely playout of audio. However, sometimes misordered packets can be retrieved if the receiver delays playout for a short time. Increasing playout delay may improve quality and is practicable in the case of a lecture where the flow is in one direction, but not where there is a need for interactive dialogue as in a conference. Hence the two settings. The final panel of the window contains the details of the user. An encryption key may be used to maintain confidentiality.

4. Shared workspace

There are several tools for using shared applications in a multicast environment. Some are based on shared text management and others are for sharing images. Only the most widely used of these, wb, will be discussed here.

Whiteboard (wb), from LBL, Berkeley [JACOBSON4] is a full-colour, shared display function for teleconferencing over the Mbone. For meetings, it provides a normal shared whiteboard on which participants may write, draw and type with all contributions visible to all participants. In a seminar it can be used to display a sequence of slides by using its capacity to import PostScript pages. This provides the functionality of an OHP. In this mode there is a support tool from the same authors called wbimport from

shown as Figure 4, includes Conference details and the transmit options. Grabber controls and receive defaults may also be displayed or hidden. **nv**, the original Mbone video tool, is widely used and valued for its simplicity. It has the additional advantage of interworking with CU-SeeMe [COGGER], the unicast videoconferencing software for PC and Mac.

3. Audio

The primary tool for audio conferencing over the Mbone is vat, although use of audio from within IVS is increasing. With vic now able to interwork with vat to display the video image of the person currently speaking in a conference, the stage is set for an increase of such interworking.

There are an increasing number of programs available which are being promoted as a telephone conferencing substitutes. These are mainly commercial products and will not be discussed here.

Visual Audio Tool (vat), from LBL, Berkeley[JACOBSON3] is another straightforward tool with a simple user interface. The main window is shown as Figure 5. It has a title, a list of participants and, to their right, some controls. If a participant is speaking, a dot is shown in box to the left of the name. Clicking on this box will suppress the audio from that person, clicking on the name will pop-up a window of statistics relating to reception from the person. The main controls are two vertical columns to the right of the participants - one for receiving, the other for transmitting. Both allow you to mute the channel and provide a volume control slider. On the input side either loudspeaker, headphones or line-out may be selected by sequentially clicking on the button shown as headphones in Figure 5. The *Release* and *Keep* buttons allow the user to switch the audio device between several concurrent vat sessions. At the foot of these columns are

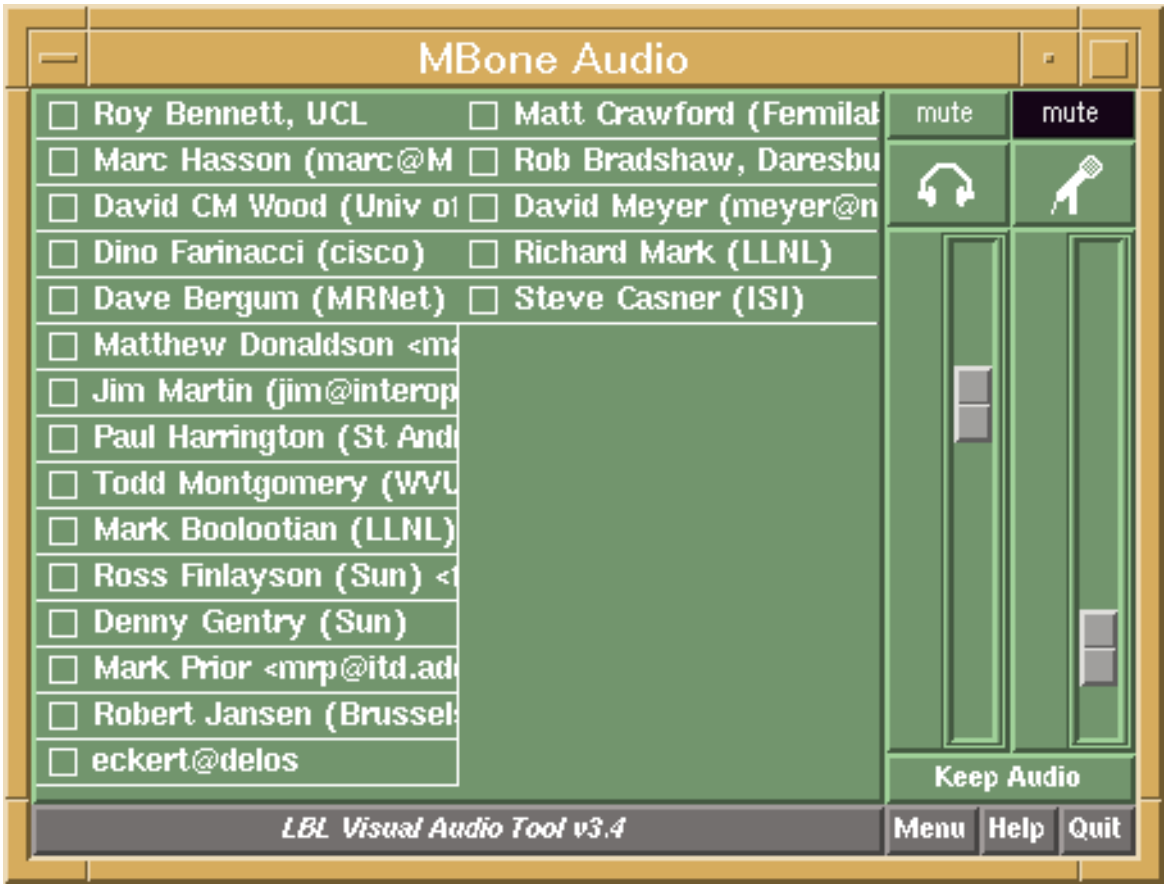

Figure 5 : vat main window

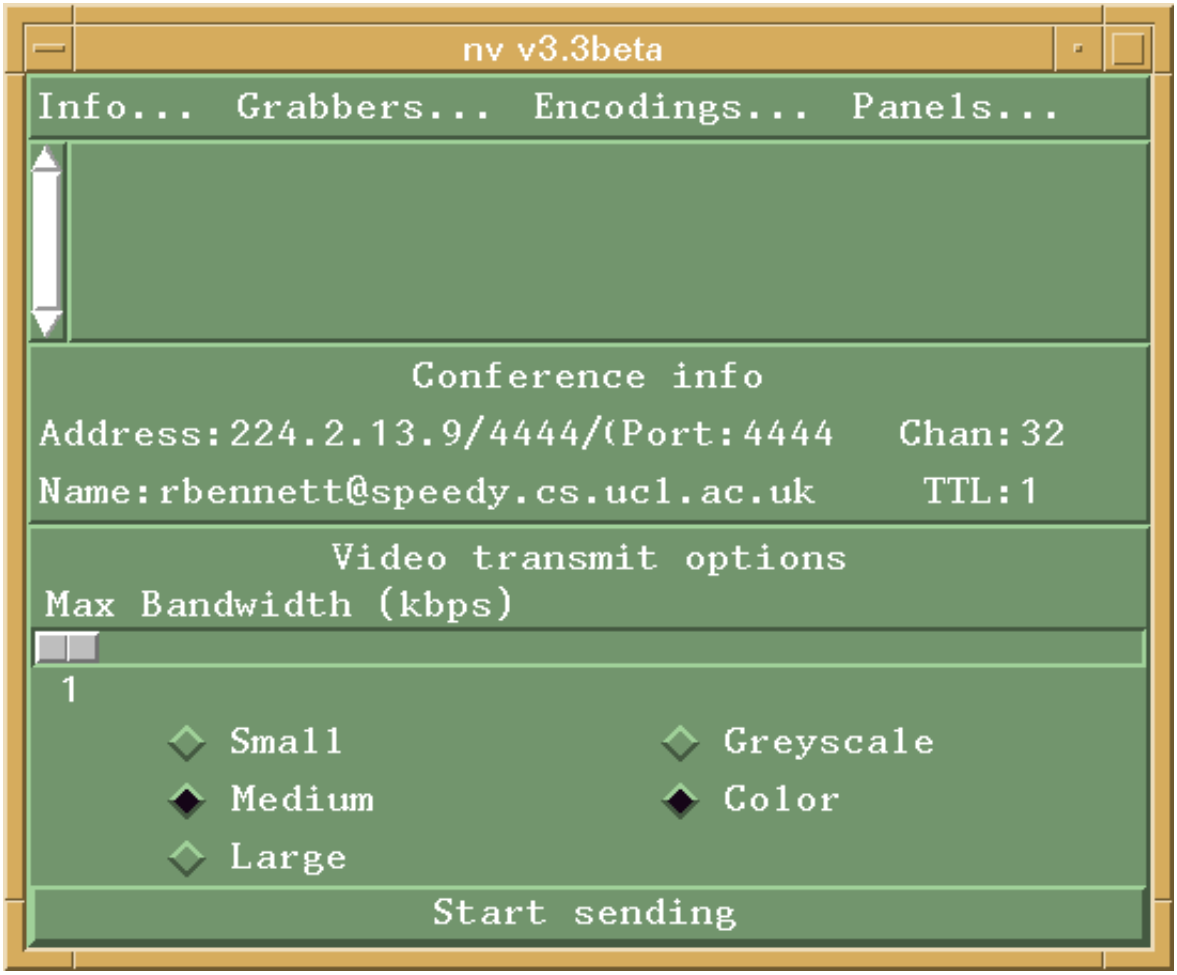

Figure 4 : nv main window

rent speaker. The buttons at the base of the window offer *Help* and a *Menu*. The menu provides the means to initiate video transmission by selecting the encoding method, the size of image and the maximum rate of transmission. It also offers options for the presentation of the main window elements and a list of all members of the conference which includes those participating as receivers only.

IVS, from INRIA, Sophia Antipolis [TURLETTI] provides an integrated audio and video interface. The main window, shown as Figure 3, displays the list of participants and indicates their participation status with icons for video and audio. These allow users to accept or suppress video and audio from each participant independently. IVS also allows point-to-point as well as multicast conferencing. Panels at the top of the window are used to control the display of images through the *Video Panel*, and the transmission of images through the *Grabber and Rate* panels. Having set the parameters, the user selects *Encode video* to transmit. The audio side of the interface is similarly simple to use and is controlled from the second line of buttons. The output type (loudspeaker or earphones) is controlled by an icon and to start the audio the user selects *Get audio*.

Net Video (nv), from Xerox PARC [FREDERICK], provides video-only conferencing as point-to-point or multicast. It has a main window with all the video streams displayed from which any individual stream may be selected. The window has four buttons at the top to allow the user to select *Grabbers, Encodings* and, using *Panels*, the format of the window itself. The default window,

video and shared workspace programs among members of a conference and releases them at the end. It complements the open approach of advertising public sessions used by sd with a more private session style for smaller conferences. Thus, session advertisement is internal to the group of participants.

2. Video

There are currently three main video tools in use on the Mbone, INRIA Videoconferencing System (IVS), Net Video (nv) and vic. IVS offers integrated audio with the video whilst the others are video only. IVS uses the ISO standard H261 video encoding, nv uses its own encoding or the Sun format. VIC offers a range of encodings for the transmitter and selects the correct decoding option for the receiver.

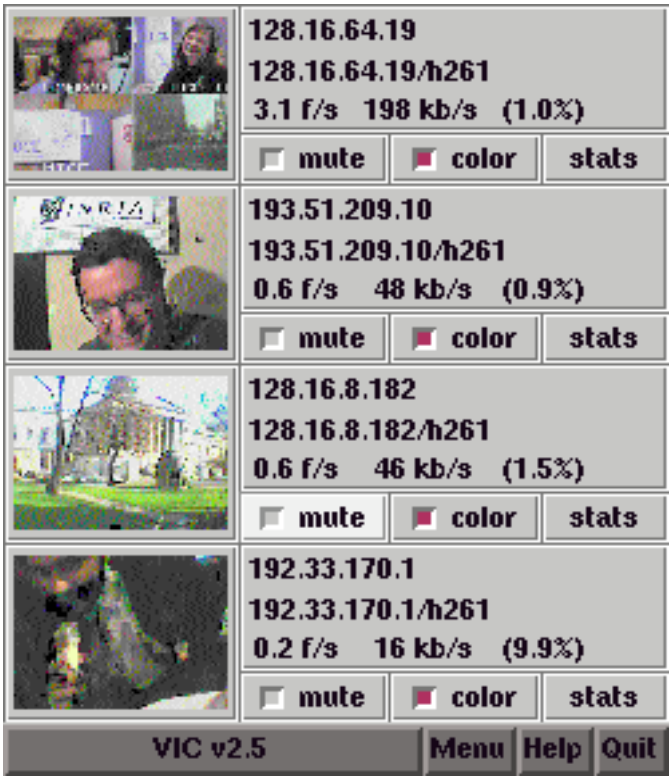

Figure 2 : vic main window

vic, from LBL, Berkeley [JACOBSON2], provides a main window showing the active participants in the conference with details of their address, video encoding, transmission rate and loss rate. vic will transparently decode video from a range of encodings. An example of the main window is shown as Figure 2. Each image can be selected from the list shown and displayed at sizes up to SCIF and NTSC. If users are using the vat audio tool, the image displayed can be determined automatically as the cur-

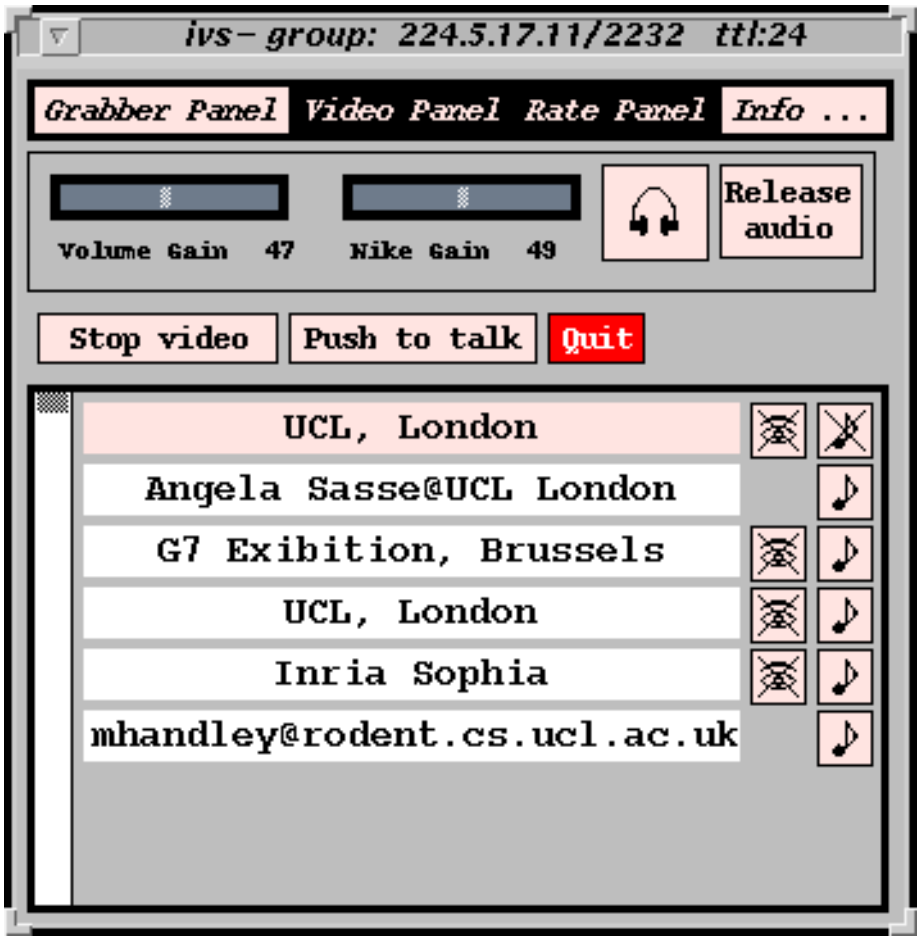

Figure 3 : IVS main window

grated user interface to control these tools so the user needs to handle each tool separately. The tools may be classified into the following groups:

- conference management
- video
- audio
- shared workspace

1. Conference management

There are no tools to actively manage conferences on the Mbone. Resource management, quality of service guarantees and a conference booking system are for the future. There are two programs, however, which, in some sense help to manage conferences. They allow an event to be publicised and provide a simple way to join. There is no conference protocol for participants mandated by these programs. Floor control is not automated and each event must decide on a plan of action to suit its particular needs. The approach is very flexible, but requires more sophistication from users than would a more controlled environment.

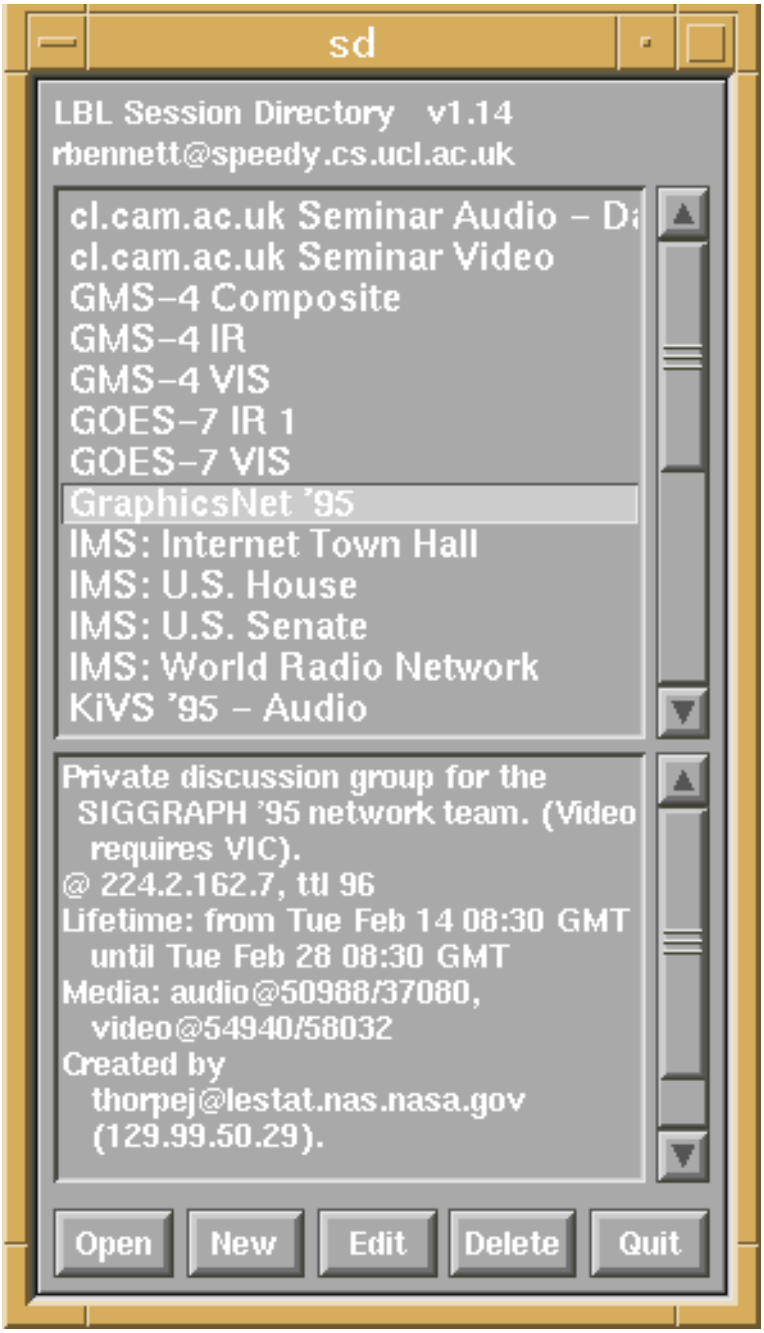

Figure 1 : Session Directory main window

The **Session Directory (sd)** tool, from LBL, Berkeley [JACOBSON1], provides the basic advertising and invocation only. It is widely used by the Mbone user community and is the default standard tool. It has a simple format - the main window is shown in Figure 1. The list of available sessions is in the upper half of the window; details of the highlighted session is shown in the lower half. The buttons at the base of the window allow you to open a session (i.e. to join in), to set up a new session, to edit sessions which you created and to delete them.

The **Multimedia conference control program (mmcc)** from USC/ISI, Marina del Rey [SCHOOLER], provides point-to-point or multipoint teleconferencing. In contrast to sd it allows a caller to explicitly invite others to participate in a conference, and alerts them to accept or decline. Like sd it automatically sets up the underlying audio,

workstation platforms - Sun, HP, SGI and DEC. For these platforms there are a number of possible hardware combinations each with characteristics and costs which must be considered in detail when a project is proposed. A zoomable camera is not mandatory but is sometimes useful to scan documents. A different camera can be used to show documents when the first camera is fixed on the workstation. Currently, only one camera can be used at a time, so the video must be switched.

Typical workstation. The Sun SPARC is widely used and the equipment shown in Table 1 is offered as a typical platform, not as a guarantee of superiority over the others mentioned above. It is offered as an indication of a good quality configuration rather than the minimum required.

Sun SPARC 20/50	£12,710
SunVideo framegrabber	£1,200
Panasonic Camera wv-GL 350	£500

Table 1: Sun SPARC configuration

This configuration includes 64 Mbytes of memory and a software CODEC. It would allow transmission at around 10 frames/sec for CIF and 30 frames/sec for the smaller QCIF. Price of Sun equipment is list (before any academic or other discount) as at February, 1995. Camera cost is estimated.

PCs and Macs

Internet videoconferencing in the world of PCs and Macs is mainly provided by the video application CU-SeeMe [COGGER et al.] and the audio application MAVEN [KLINE]. Neither of these applications are based on multicast and therefore do not optimise the use of the network. Multicast software will be available for both platforms in the near future, but in the meantime it is possible using NetVideo (nv) [FREDERICK]] to interwork with CU-SeeMe and using Visual Audio Tool (vat) [JACOBSON3] to interwork with Maven. Descriptions of the multicast tools are included in the next section.

TECHNOLOGY & TOOLS

The Multicast backbone (Mbone)

Multicast [DEERING] has long been available on broadcast networks such as Ethernet LANs. IP multicast using Class D addresses maps to the underlying hardware multicast services of a local area network. Currently the internet routers cannot recognise multicast addresses and deal with them properly. This means that distribution of multicast traffic has to be done by encapsulating the multicast packets to send them between the isolated local networks which can handle them. Each local network has a special multicast router, normally a non-dedicated workstation, which routes multicast traffic to its peers on adjacent local nets and receives packets from them. Thus the multicast backbone consists of a network of connections between these *mrouters* along which the encapsulated multicast traffic can flow. These connections are known as *tunnels*.

A key point to remember is that the traffic in the tunnels is part of the regular Internet traffic - the Mbone is a virtual or overlay network which uses the real bandwidth of the Internet. For this reason, moderation is always necessary in using the Mbone tools. Multicast eliminates the need to send separate streams to machines which share a common route from the sender, but as routes diverge, the traffic has to branch to reach all receivers. A user-level introduction to multicast and how it is used for multimedia conferencing is given in [BRUTZMAN & MACEDONIA] and [ERIKSSON].

Tools used

The Mbone tools are just that - separate tools for each of the elements of a typical multimedia conference. There is no inte-

vary at each location and all variants will interwork where there is a common network. This allows machines with different CODECs to interwork. However, for devices on ISDN lines to be integrated with conferencing over IP networks there has to be conversion in a facility such as the MICE CMMC (Conference Multiplexing and Management Centre) [CLAYMAN et al.].

Factors affecting requirements

There are a number of factors which will help to determine whether an application will work over the Internet, and, if so, what equipment is needed. The final decision may depend on compromises being made and on individual subjective assessments of the quality factors. To transmit and receive in a conference, the workstation must be of sufficient power to handle high speed streams from video frame grabbers or CODECs and lower speed streams from the network. Typically, the network speed is the limiting factor at present, but in future, with the increasing deployment of high speed networks, the workstation may become the bottleneck.

Quality required. The number of separate video images which need to be received simultaneously will partly determine the hardware needed to receive and display them. This is closely linked to the quality of image needed since the two factors trade off against each other. There are three video encoding formats under the H.261 standard, CIF, QCIF and SCIF.

The use of QCIF is common where only a simple *head and shoulders* view is required. The larger formats require more processing power in the hardware.

Another factor influencing the quality is the relative stillness of the image. Since most of the data transmitted for a given video stream consists of changes to a datum image, the fewer the changes, the lower the required bandwidth to transmit the video and the lower the processing power needed at each transmitter/receiver.

For this reason it is important to select a camera which does not have auto-focus set permanently, since autofocus tends to see all small movements as major changes to the image.

Shared applications. In many audio visual interactions there will be the need for a shared application on which all may work or comment. Typically this will include a *whiteboard* application on which all may write and which is simultaneously updated for all participants. Several such applications are available and they make minimal demands on the workstations and the network. Other applications may require many more resources. Remote retrieval of large images or stored audio/video material, for simultaneous review at many separate sites, will affect both the cost and practicality of such an application on a network with limited bandwidth.

Interaction type. The cost of setting up a video network is dependent also on the type of interaction needed between the participants. If they need to participate actively, as in a conference, then each must be provided with the means to both send and receive. If a simple one-way transmission, analogous to TV broadcast, is all that is required, the receivers' equipment will be simpler and can be cheaper. Decode only can be provided in software and receive-only locations will not require a camera or frame-grabbing hardware.

Grouping of participants. Whatever the interaction type, the grouping of the participants must also be a factor. Each location may have a single person at a workstation, several sharing a workstation or a larger group in a room equipped with a single set of suitable equipment. In the latter cases, there are obvious equipment savings to be made.

Workstation configuration & cost

The software runs on all the main UNIX

GLOSSARY

CIF Common Image Format with dimensions of 352x288 pixels
CODEC (COder/DECoder) converts analogue to digital and digital to analogue
Framegrabber is a device which captures video a frame at a time from an analogue video source.
Mbone the Multicast-capable backbone of the Internet. It consists of a network of tunnels linking the islands of multicast-capable sub-networks around the world.
Motion vectors provide the information to a video decoder on where in the current frame to place the individual blocks which have moved since the previous frame
Mrouter the workstation running the *mrouted* program which routes multicast traffic between multicast-capable subnetworks.
Pixel a *picture element* on a video screen. It is the smallest component of a screen image.
QCIF Quarter Common Image Format with dimensions of 176x144 pixels
Router is a device for routing packets through a packet-switched network.
SCIF Super Common Image Format with dimensions of 704x576 pixels
Tunnel a connection between two Mrouters to carry encapsulated multicast packets between multicast-capable subnetworks.

ferent ways of capturing, digitizing and compressing the analogue streams produced by the camera and microphone. These variations are also reflected on the receiving end of the interaction where the process must be reversed to provide analogue video and sound.

Analogue video and audio must be captured and digitized before it can be transmitted. Digitising may be achieved in several different ways. The generic term for a hardware device for conversion of an analogue stream to digital and back is a CODEC. A CODEC may handle both video and audio together or either separately. It may be implemented as either hardware or software. Many workstations use a *frame grabber* to supply the video, frame by frame, to a software CODEC program. Audio may be digitized by a software chip in workstation hardware.

After the digitized data has been captured it is compressed to reduce the quantity of information which needs to be transmitted. Video compression may involve several stages. Basic compression is applied to each frame. Further compression is achieved by calculating differences between successive frames and sending only those differences. Yet more savings in bandwidth can be made by predicting such changes and sending only the information which modifies the predictions. This technique uses motion vectors to predict changes due to motion in the picture. In both these cases there is the need to periodically send full reference frames (INTRA frames). These frames provide a new point of reference for the succeeding *difference* frames (INTER frames). This compression process may also be performed in hardware or in software. After compression, the data is segmented into small fragments - *packetized* - before transmission over the network.

At the receiver the data is stripped out of the packets, uncompressed and converted back into the analogue domain. In some cases the uncompressed video is passed directly to the window management software for display (e.g. Sun workstations). In other cases it may be converted to a TV standard format such as PAL and redirected to a standard TV monitor.

It is in the area of conversion between analogue and digital that most of the difficulties are found. Hardware and software may

INTRODUCTION

1994 was the Year of the Internet in the general media, and the interest shows no sign of abating. After three decades of being a run as a network of the research and academic community, the Internet finally went mainstream, featuring not only in the national press, but in programmes from Newsnight to Jewish London - even Vogue ran a feature on Women on the Internet. It also went commercial: apart from companies providing access to the Internet for the paying users, publishers and media companies are trying to use it to attract customers around the globe.

Much of this attention has focused on services which support asynchronous communication - electronic mail, bulletin boards and the World-Wide Web (WWW). It is less well known that computer networks such as SuperJANET can be used to transmit voice and video in real time, making multimedia conferencing on the Internet possible. Telephone companies offer videophone and videoconferencing services. Most of these require the purchase of special equipment (videophones and videoconferencing suites) and set up multi-way conferences as a series of point-to-point connections. This is an expensive and often cumbersome way of holding remote meetings, and does not scale to supporting large user groups who want to have interactive meetings. In multicast technology, the Internet community has an economic way of supporting multi-way multimedia conferences between large numbers of participants. Multimedia conferencing via a computer on your desktop has the potential to change the way in which we work and communicate.

The aim of ESPRIT project MICE (Multimedia Integrated Conferencing for Europe) is use this technology to enable interworking between European researchers, and with their colleagues in the US [HANDLEY et al.]. This has been achieved by piloting and developing a number of public domain software tools for multicast-based multimedia conferencing. The software tools have been used regularly by MICE partners (UCL is the leading partner in a consortium of 9 research and development institutions in Belgium, France, Germany, Norway, Sweden and the UK) and other European projects for holding remote project meetings since Spring 1993. A network of Support Centres now distributes and supports these tools to interested users in the UK and Europe. To promote the technology to wider user groups, the project has held a number of successful public demonstrations and showcase conferences which show the application of the technology in areas such as distance education, medical training and consultancy, and even a collaborative arts project.

SYSTEMS AND CONFIGURATIONS

In this section we review the process of capturing, sending and receiving the multimedia streams used in a multimedia conference on the Internet. We then consider the factors to be evaluated when deciding how to implement Multimedia conferencing. We describe the configuration and cost of a typical workstation hardware platform. The multicast technology described in this briefing requires multicast capable UNIX workstations to operate. Although it does not currently run on PCs or MACs, some tools will interwork with them and we describe the interactions. This is a technical area where a glossary is appropriate so the main terms are defined in the panel.

Transmission processes

In defining the configuration options it is helpful to explain the basic processes necessary for an interaction to occur. The main variations between options relate to the dif-

Multimedia Conferencing over the Internet

The MICE Project

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Abstract

The Internet has received much attention in the media and from the commercial sector over the past year. Much of this attention has focused on services which support asynchronous communication - electronic mail, bulletin boards and the World-Wide Web (WWW). It is less well known that computer networks such as SuperJANET can be used to transmit voice and video in real time, making multimedia conferencing on the Internet possible. Telephone companies offer videophone and videoconferencing services which require the purchase of special equipment and set up multi-way conferences as a series of point-to-point connections. In multicast technology, the Internet community has an economic way of supporting multi-way multimedia conferences between large numbers of participants. Multimedia conferencing via a computer on your desktop has the potential to change the way in which we work and communicate.

This Briefing will present an introduction to the technology and the suite of conferencing tools which are available to users today. It summarises experiences from the MICE (Multimedia Integrated Conferencing for Europe), which has piloted the use of these tools in the European research community. It gives information on how to obtain the tools, documentation and support advice for installing and using them. Finally, it presents current and future applications of the technology in the areas of remote collaboration, teleworking, distance education and healthcare.