Shrink-wrapping Internet Multicast Packages

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Introduction

This article is concerned with the work of the SHRIMP [1] project, funded by UKERNA to improve the usability of the Mbone videoconferencing tools by providing *shrink-wrapped* software and comprehensive documentation.
It begins by describing the project – its background, activities and deliverables. The work begins with the evaluation of suitable tools for shrink-wrapping, followed by the actual packaging and documentation. Prior to delivery, all of these deliverables will be verified by users typical of those to whom the efforts are directed; these are, primarily, new users without experience of the Mbone environment or even of videoconferencing.
Since the initial deliverable has been completed, though not yet approved officially by UKERNA, there follows a summary of this evaluation of the tools examined in each category.
Finally there is an overview of the continuing research effort in this field by the European Telematics for Research project MERCI [2] and that planned for MECCANO [3] which will continue the work of MERCI during the next two years.

The Project

Background

The JANET Videoconferencing Strategy [4], recently approved by the ACN and JISC, recognises that there is a need to provide IP-based videoconferencing packaging improvements to provide user friendly, easily installable, well-documented software to users.
This activity is a prerequisite to the piloting activities planned to develop an understanding of the potential issues which will be encountered in running a large scale IP videoconferencing service. The piloting activity will focus on network congestion and users' perception of the service.
Although there is a tendency to refer to *videoconferencing* in discussing the Multicast tools available for use on the Mbone, the preferred term is *multimedia conferencing* which embraces the concept of using shared workspace tools. These are needed in most conferencing scenarios, especially desktop applications.
The SHRIMP project was set up to address the need to work with all of the IP-based videoconferencing software tools available in the *public domain* to make them more usable by the non-expert user. For the tools to gain widespread acceptance, they need to be packaged to a standard that is acceptable to such users - i.e. they need to be shrink-wrapped. A shrink-wrapped tool set is required for use as the basis of a stable platform for the IP videoconferencing piloting activities described above.
The project will address this need by providing packaged software solutions for the following platforms:

- PCs running Linux, Windows'95 and Windows NT
- Sun workstations running Solaris.

The aims of the SHRIMP project can be summarised as:

- To improve presentation of the tools for the selected platforms to make them easier to install and, in some cases, installable by a non-technical user.
- Provide high-quality user documentation on how to install, configure and use the tools.

Project team

The first Principal Investigator is M. Angela Sasse, currently a Senior Lecturer at UCL. She holds an M.Sc. in Psychology from Sheffield Univ. and a PhD in Computer Science from Birmingham Univ. She has been conducting research on design and usability of multimedia conferencing tools since joining UCL in 1990. She was the project manager of MICE and PI of the UKERNA funded MICE-NSCs; current projects in this area include JTAP ReLaTe [5] (with Exeter Univ.) and BT/JISC HIGHVIEW (with Essex Univ.)

Professor Peter T. Kirstein is the second Principal Investigator. Peter received his B.Sc. from Cambridge Univ. in Electrical Engineering and Mathematics, Ph.D. from Stanford Univ. and his D.Sc. from the Univ. of London. For 15 years he was Head of the Department of Computer Science, where he is currently Professor and Director of Research. Professor Kirstein has been both Technical and Administrative Director of many European and National projects. Currently he is the Director of the MERCI project.

Since it is impractical to provide all the skills needed for this project in one or two people, they will be provided by several members of the Multimedia team in the Computer Science Department at UCL who are currently working on a number of related projects including the MERCI project. The technical lead on the Software shrink-wrapping will be Colin Perkins. Dr Perkins received his Ph.D. from York U in Computer Science, and is the chief technical research fellow on the MERCI project. For documentation and usability, the main effort will come from staff who were on the MICE National Support Centre and ReLaTe projects.

Activities

The main activities of the project will be evaluation, packaging, documentation and verification.

Tool Evaluation

This activity is completed and a deliverable has been sent to UKERNA. Some of its contents are summarised later in this article. Only the multi-media tools in widespread use over the Mbone were included in this evaluation for possible shrink-wrapping. These were limited to the session announcement, audio, video, and shared workspace tools, in their several variants, which were available at the beginning of September.

With the limited time and effort available, only tools which already ran on the designated platforms, or those which were considered to be capable of porting with negligible effort, were considered.

The criteria used for the evaluation of the tools were:

Functionality

Stability

Platforms

Usability

Cost of deployment

Availability of technical support from developers

Tool Packaging

Packaging is now underway and it will consist of the following tasks:

- ensuring that each tool selected in the evaluation works correctly on each of the four platforms.
- constructing scripts to allow the tools to be started simply for each environment - assuming that the network supported is Ethernet, connected to an Mbone-enabled LAN. No network software will be included in the Releases, but Ethernet cards, which are known to work correctly, will be listed.
- providing a User Interface similar to that originally created for the ReLaTe Project. This will allow control of video and audio and the user to toggle between a shared editor and a drawing tool (when such a tool is available). There will be minimal options for the novice user; the interface will be set up in only two modes for video transmission:
    - up to 4 simultaneous users of video
    - between 4 and 8 simultaneous users

  Others may join and participate without sending video, using the separate tools or participating only in the audio and shared workspace elements.

  The user interface will be written in Tcl/Tk.
- packaging a release for each platform in binary and source form (where the source is available).

Bugs in the tools will be documented, but there will not be time to do extensive bug fixing on the tools themselves within the short timescale of this project. The degree to which developers are willing to produce bug fixes will be one of the criteria in the choice of tools.

Documentation

The documentation will cover the following areas:

Hardware descriptions

For each environment, there will be an indication of

- minimum size and power of system needed
- peripheral cards which are known to work, with their drivers

This is particularly important for PCs where there are enough idiosyncrasies in the way interrupts work on particular machines, and certain peripherals like audio are installed, that it will still be necessary to have local expertise available on the specific platform. This should be no more than is needed for the setting up of any sophisticated application on a Windows PC.

Network Environment

The Mbone tools require the Mbone for use over the wide-area by more than two people simultaneously. They may be used on a LAN without needing the multicast routers although they will still need multicast support in the individual workstations. It is assumed that sites wishing to use multicast and the Mbone will make it available. Whilst other facilities like ISDN can be supported, no specific advice will be given on this although reference will be made to the MERCI documentation. It would be much too complex to describe all the components required for the use of ISDN, because this needs also gateways.

Tool Installation

This documentation will give full details on the tool installation for each platform. On the whole, the installation should be self-documenting with on-line prompts generated by the installation scripts; nevertheless, the meaning of failure messages will need to be explained.

Session Initiation

Documentation will describe how the sessions are initiated. This will be from SDR in most instances, but manual start-up will also be described.

Tool Operation

There will be instructions on how the system must be operated. Again,

Although many of the tools' operations are self-documenting and the full potential of the tools is often hidden from Users, there will be somewhat better documentation on the tools themselves than is provided by their developers.

Error Conditions

There will be information on potential error conditions and appropriate remedial action will be suggested.

Bug Reports

Known bugs in the *system* will be listed whether they are related to the environment or to the tools.

General Guide

A general guide to the tools will be provided for the novice user.

Documentation will be provided not only as separate printable documents, but also as an integrated set of web-based resources.

Testing

Testing will occur at several times during the course of the project. There will be extensive testing of all the packages which pass the initial screening on other grounds. This process will identify specific problems in the tools which will be included in the actual packaging phase. The aim will be fix the problems, work round them, or ask the tool providers to act.

Those responsible for packaging the tools will do a considerable amount of testing. When they declare the systems finished, the systems will be passed to the team which previously ran the English MICE National Support Centre [6]. Their job will be to test for installation correctness, operating stability and validity of the main functionality.

Finally the software and documentation will be given to more naïve users, either in the context of the new ReLaTe trials, or in that of normal videoconferences. It is hoped that UKERNA will nominate guinea pig users who can do this testing outside the actual contract. Volunteers are welcome to contact

the project to assist with testing all the functions of the packages: installation, session initiation and operation of the tools.

Deliverables

There are four specific Deliverables which encompass the work of the project. Deliverables, including the software, will be available on the WWW both from the Project server at UCL and the UKERNA server.
Tools are defined as those Mbone tools which allow interactive video, audio and shared workspace activity.

1 Assessment of the available tools

This has been completed and will be available shortly. The assessment was made to determine the most appropriate tools and versions on which to base the packaged products.
It addressed the availability of the tools on Digital, Silicon Graphics and HP platforms, but did not undertake any experimentation on potential problems in their implementations on those platforms.
The study did not consider the multicast conferencing software for the Apple Macintosh since it is proprietary and can be obtained from the manufacturer. The Telematics for Research Project MERCI project initially intended to port the Mbone tools to both Mac and PC.
After much effort to collaborate with Apple on this, the German partner, RUS, had to abandon its efforts since Apple would not provide the assistance needed to port the Mbone software to the Macintosh.
The tools identified for packaging are described below.

2 Packaged software

A version for each platform will be completed by the end of November. However, this will then be improved as a result of both internal testing and of the expected feedback from outside users throughout December. In view of the disruption caused by Christmas vacation, final delivery will be in mid-January.

3 Documentation of the software

Documentation of the software products, including how to install, configure and use the software tools, will be validated by people not responsible for the implementation or documentation for technical accuracy and readability by a non-technical user. A draft of this will be delivered before Christmas, with final delivery at the end of January.

4 A general guide

This will be a general guide to the tools and their operation aimed at a novice user. The document will have a technical bias but will also be readable by an interested lay person.
The first version will be delivered in early December after which a final version will be developed, based on the results both of internal comments and those of UKERNA, and will also be delivered by January 31, 1998.

The tools proposed

The initial report will soon be available from the project server site and at UKERNA, but this summary provides a preview of the findings.

Video

We considered only two video tools: VIC from Lawrence Berkeley National Laboratories (LBNL) and Rendez-Vous from the Institut National de Récherche en Informaqtique et Automatique (INRIA). VIC has been in widespread use for several years, Rendez-Vous is a recently released successor to INRIA's original IVS tool.

VIC

Functionality
The tool provides encoding for H.261, M-JPEG, nv and cellb. The key distinguishing functionality is defined in the features section on the web site.

Features unique to vic include:

- an *Intra-H.261* video encoder
- voice switched viewing windows
- multiple dithering algorithms
- interactive *title generation*
- routing of decoded video to external video ports

The H.261 version does not generate or decode motion vectors which results in poor performance when interworking with a video tool which generates them.

Platforms

VIC runs on PCs (both Microsoft and Unix), and the following workstations: Sun (Solaris and SunOS), HPUX, Dec (Alpha and Ultrix) and SGI Irix.

Usability

VIC has a simple interface which can be used for essential functions like receiving and transmitting video with little or no training. The default settings are sensible and allow VIC to be used for most purposes without requiring any training or use of a manual. However, to master more complex features like rate control, encoding and display options, and how to deal with any problems which may occur as a result of network congestion, knowledge of networks and other technical matters is required. Work is currently underway at UCL to determine what aspects of VIC could be changed to improve its usability.

URL: http://www-nrg.ee.lbl.gov/vic/

Rendez-Vous

Functionality

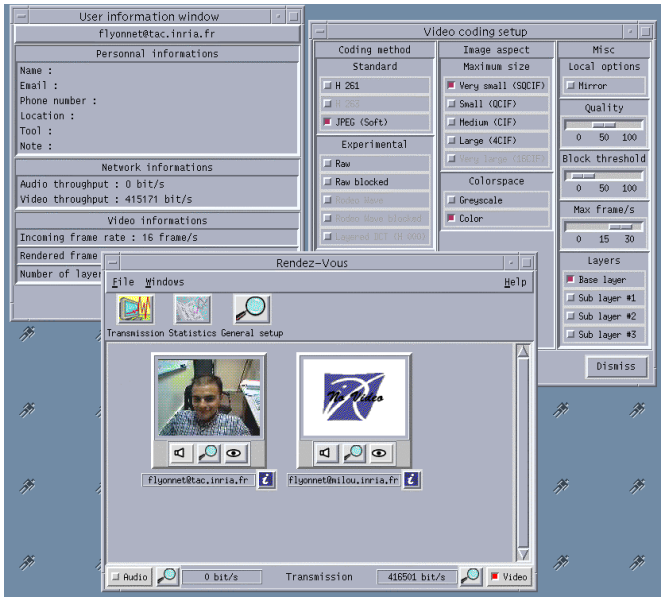
The key feature of RV is that it is an integrated tool as was IVS and incorporates the audio tool FreePhone in a single interface with the video. We consider only the video features here.

RV currently provides encoding for H.261 and M-JPEG; under development are wavelet and layered DCT encoders. The key distinguishing functionality is defined on the web site. Due to French legal restrictions, it does not support encryption. A further advanced feature is an integrated scheduler to optimise video and audio flow management and processing.

Platforms

This is the support noted in the web documentation and illustrates a limited support for video transmission:

- Sun Sparc Solaris machines, internal audio hardware, SunVideo and VigraPix grabbers SGI Irix machines, internal audio hardware, no video grabbing
- Sun Sparc SunOS machines, internal audio hardware, no video grabbing
- x86 Linux machines, no audio, no video grabbing
- x86 FreeBSD machines, no audio, no video grabbing
- Dec OSF1 machines, no audio, no video grabbing
- Windows 95/NT machines, no audio, no video grabbing



Usability
The user interface is well constructed and allows a novice user to avoid hard technical decisions by presenting a simple default environment.
URL: http://www.inria.fr/rodeo/rendez_vous/

Conclusion for video

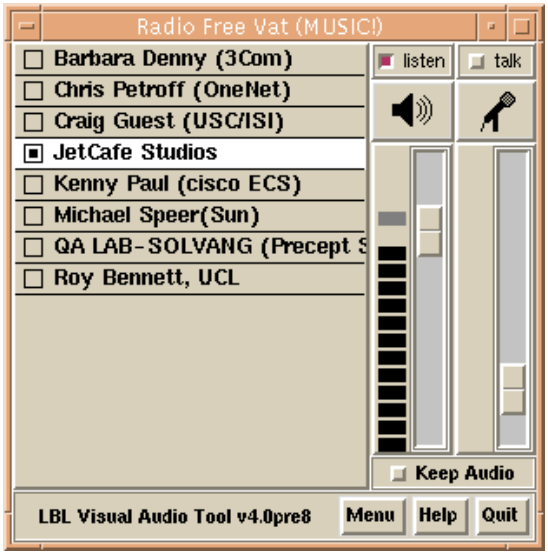
The time-scale for the shrink-wrapping is such that VIC is the only tool which could be recommended at this time. RV will be of more interest in the future as it is developed to provide wider functionality on all platforms. It also presents an integrated user interface for Video and audio which will be attractive for some users and/or applications.

Audio

The audio tools considered were Visual Audio Tool (VAT) from LBNL, Robust Audio Tool (RAT) from UCL and FreePhone (FPhone) from INRIA.

VAT

Functionality
VAT was the original Mbone audio tool. It has 4 possible encodings and many options to control participation such as silence suppression, lecture mode and receive-only. Full details of the functionality are available from the web site. It does not support redundant audio encoding, but interworks with RAT and FreePhone in non-redundant mode. Encryption is not RTP compliant, but it will interwork with other VATs.

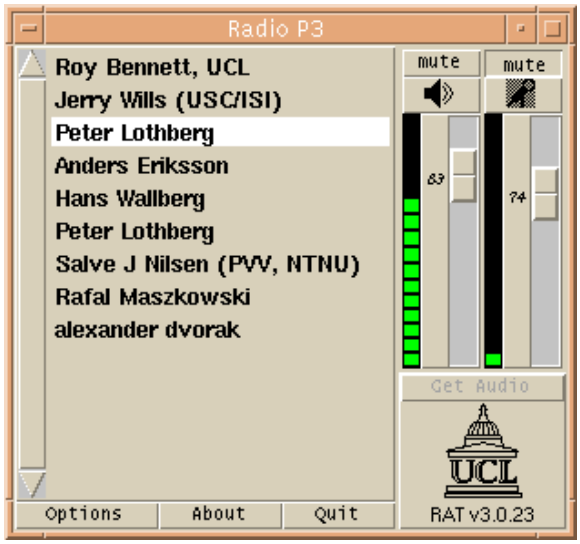


Platforms
Unix platforms are SunOS, Solaris 9.x, Dec (Ultrix & OSF-3) Irix, AIX, Linux, FreeBSD and SCO UNIX. It has been ported to Windows 95/NT.

Usability
VAT has a simple interface with the complexity well hidden. The main window of VAT can be used with little or no training for essential functions like receiving and transmitting audio. The Menu Window is where the default settings can be changed. This window is very complex and requires technical knowledge to master.
URL: http://www-nrg.ee.lbl.gov/vat/

RAT

Functionality
RAT is similar to VAT but offers extra functionality to improve the performance over the Mbone by providing redundancy (packet loss protection) and adaptive scheduling protection. It interworks with VAT if redundancy is not used and with FreePhone with or without redundancy. It can also, working with a modified version of VIC, provide lip synchronisation. It offers 5 encodings plus redundancy options and a record/playback facility. It also supports encryption.



Platforms
Runs on PCs and the following UNIX platforms: SunOS, Solaris, HPUX, SGI Irix, Linux and FreeBSD.

Usability
It has a simplified user interface with intelligent defaults. The RAT interface looks very much like VAT. The difference lies in the Options menu which is slightly more accessible than that of VAT. This combined with the fact that the default options in RAT are better makes RAT more usable as the user will rarely need to make any changes in the Options menu.

URL:http://www-mice.cs.ucl.ac.uk/mice/rat/

Fphone

Functionality
Distinguishing functions are: management of multiple unicast and multicast sessions; user contact of other users; automatic selection of the level of redundancy needed to keep the loss rate, after reconstruction, between some watermarks specified by the user; encodes for PCM, VADPCM, ADPCM, GSM, and LPC.

Platforms
Unix versions are available for SunOS, Solaris, SGI Irix and Linux. FreeBSD and PC versions are planned for autumn 1997.

Usability
Presents a simple interface with the complexity hidden in separate windows.

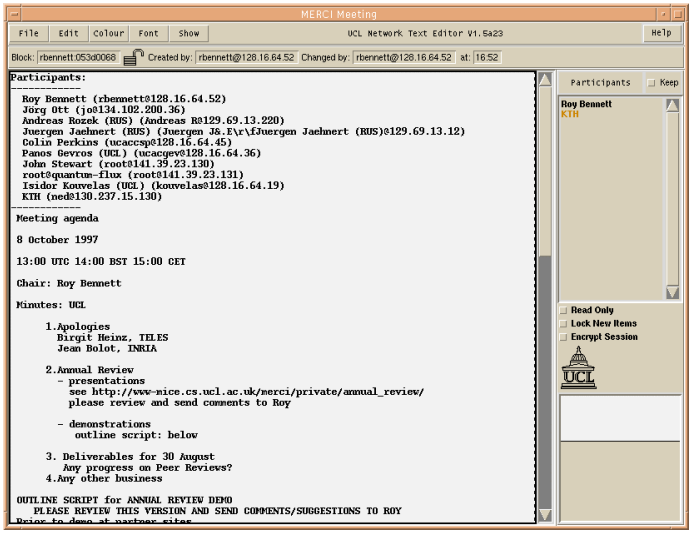
URL: http://zenon.inria.fr/rodeo/fphone/

Conclusion for Audio

Of the three tools discussed, the most stable is VAT. This would normally be the key criterion for selection. However, RAT is comparably stable, though not as long in use and has the major advantage which it shares with FPhone of providing redundant encoding to give improved performance under adverse network conditions. FPhone is a more recent development which does not yet provide a PC version. RAT is therefore the choice for audio.

Shared Workspace - Shared Text Editor

We distinguish text editors by their ability to import, edit and save ASCII text, as opposed to shared whiteboards which would not allow the editing of imported text nor the saving of any text as ASCII. In this category we have found only one tool the Network Text Editor (NTE) developed by Mark Handley at UCL.



Network Text Editor (NTE)

Functionality
It was designed to be used in conjunction with other communications channels. Human protocols which make use of these must be developed in order to get the best use from NTE.

Platforms
SunOS, Solaris, SGI, HPUX, Linux, Windows 95/NT.

Usability
NTE is good for meetings, especially for those with some experience of network applications.
URL: http://www-mice-nsc.cs.ucl.ac.uk/mice-nsc/tools/

Conclusion for shared text editing

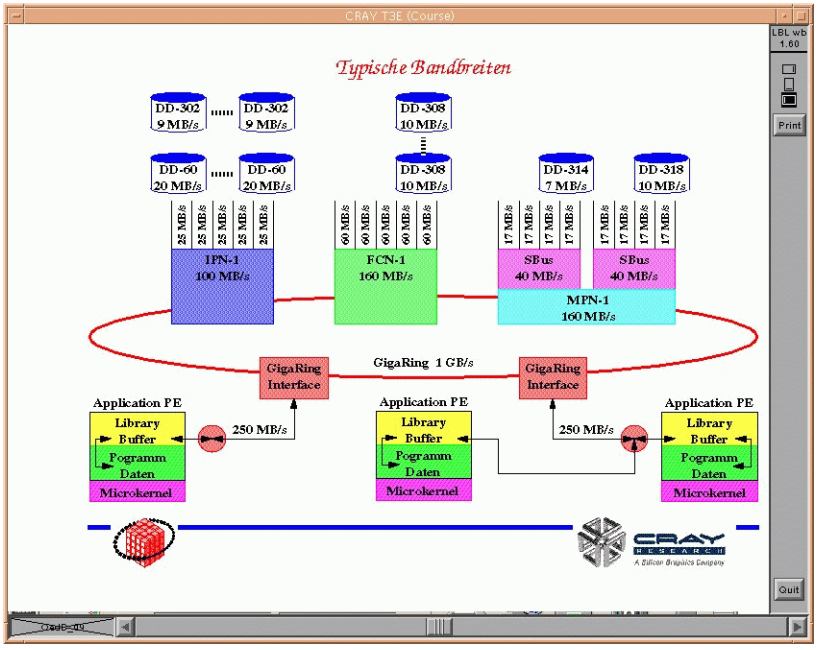
NTE has been in regular use by the MERCI project, and the late MICE NSC project, for the interactive minuting of meetings, a task for which it is ideally suited. It has also been used regularly in the language teaching of ReLaTe. It is robust and runs on both workstation and PC platforms (with minor changes for the mouse mapping). For these reasons it will be included.

Shared Workspace - Shared Whiteboards

Shared whiteboards have been written in the past, but the most widely used and still the most robust is the tool wb from LBNL. This is only available on Unix platforms, but there are three new tools in early release which operate on PCs. TeleCanvas from Stuttgart University Computer Centre (RUS), a partner in the MERCI project, and the whiteboard in mDesk from Luleå University of Technology are both Java multicast applications. Julian Highfield at Loughborough University Telecommunications and Computer Human Interaction Research Centre (LUTCHI) has developed a new whiteboard, called wbd, which can interwork with wb.
Included in a recent release of the MASH tools from Steve McCanne's Group at the University of California, Berkeley (UCB) is a shared whiteboard, MediaBoard, that run on both UNIX and PC platforms.

wb

Functionality
wb provides a shared whiteboard on which participants may write, draw and type with all contributions visible to all participants. In a seminar, its capacity to import PostScript pages allows it to act as an overhead projector. The program provides a print option, but "no save to file".
Although all participants can use wb simultaneously, it is not possible to modify what another person has written. It is also not possible to see other participants' cursors.



Platforms
SunOS, Solaris, SGI, DEC (Ultrix/OSF), HPUX, FreeBSD, NetBSD, Linux.

Usability
The fact that all functions are visible and accessible from the main window makes it easier to learn how to use the tool. Its simple functionality also helps.

URL: http://www-mice-nsc.cs.ucl.ac.uk/mice-nsc/tools/

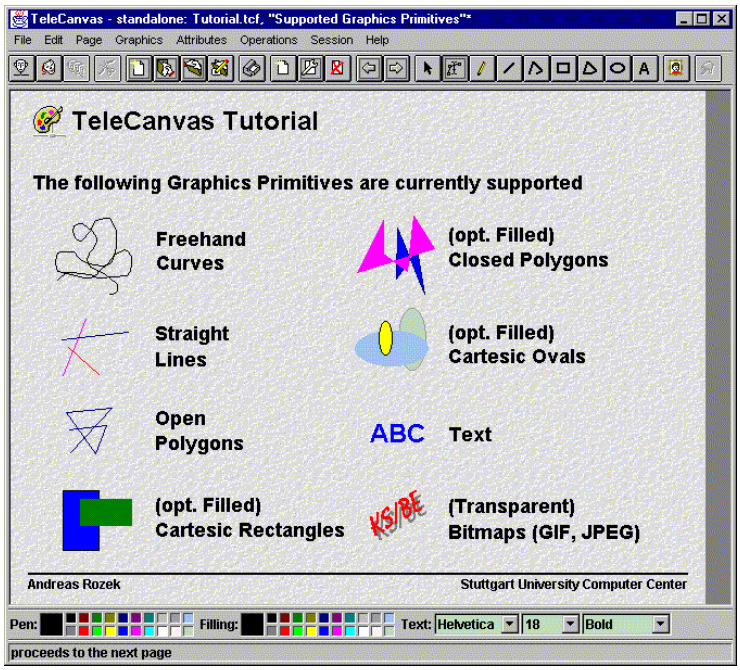
TeleCanvas

Functionality
TeleCanvas, written in Java, is the preliminary version of a *platform-independent* shared whiteboard called TeleDraw. These key features are implemented in TeleCanvas:

- look-and-feel of a standard drawing tool
- session participants may use telepointers
- reliable multicast with real-time support to allow transmission of drawings and telepointers
- access control prevents multiple users from modifying the same object simultaneously whilst being able to cope with network partitions
- distributed undo/redo of user actions

Platforms
All platforms supporting JDK.

Usability
The interface is somewhat busy, but the features that are actually working in this version of the tool are standard and easy to identify.
URL:**http://www-ks.rus.uni-stuttgart.de/PROJ/MERCI/TeleDraw/TeleCanvas.html**



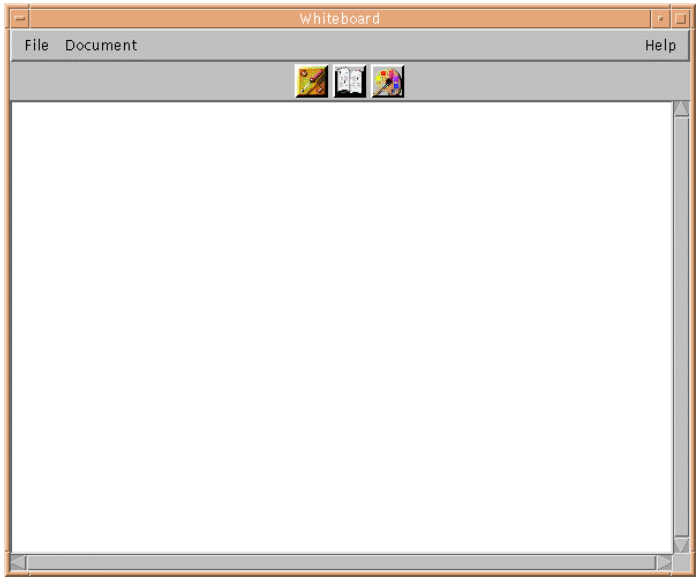
mDesk Whiteboard

Functionality
mDesk is a distributed multicast collaboration tool, written in Java. It consists of a framework into which you may easily plug agents conforming to the mDesk API. Agents are loosely coupled programs of which the following are currently available in mDesk:

- Chat - a simple text-based chat utility
- Membership - a listing of currently participating members with some statistics
- Vote - a voting tool with real-time results graphically displayed
- Whiteboard - a whiteboard with telepointers, mini-views, etc.

It is the whiteboard that we assess. A number of its more distinctive features are outlined below:

- The whiteboard supports a number of graphics file formats, including GIF and JPEG.
- Text and graphical objects can be selected and modified after creation. It can, however, take some time to update every participant's screen when modifications are made.



- A telepointer can be selected and this is visible to all participants. At present it is always coloured red and therefore individual pointers are not distinguished.

Like wb, mDesk has a concept of pages and these are easy to create and select. Users are not forced by the tool to look at the same page, although it could be that this simply happens very slowly. Another nice feature is that the user can open a "mini-view" of a page, which is like a small document map. This could be useful, although the fact that this can be done for every page might increase screen clutter.

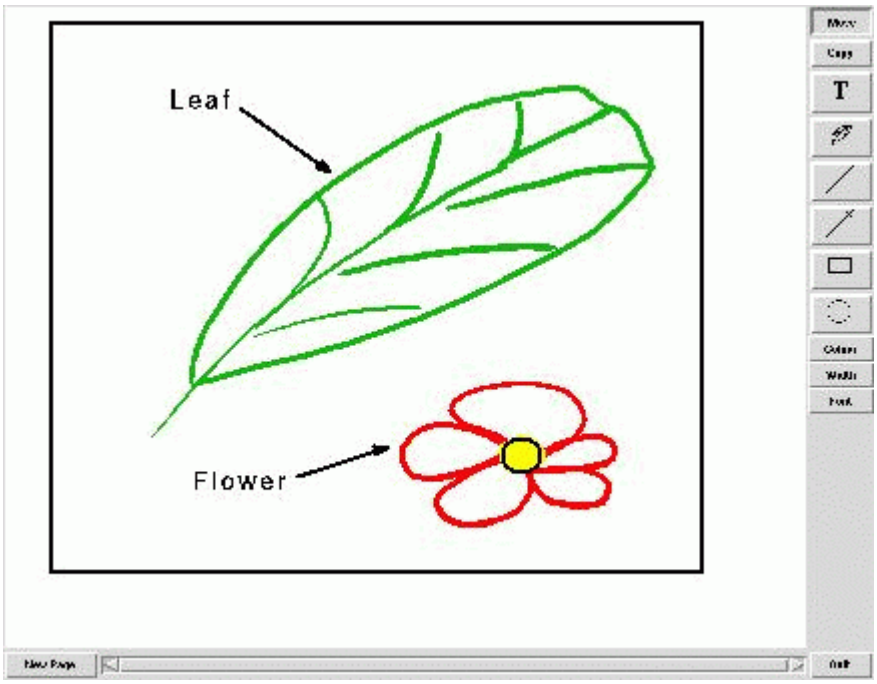
Platforms
All platforms supporting JDK.

Usability
The designers have tried to keep the interface simple by allowing the user to choose which parts of the application to open. The whiteboard tool itself also has a simple main window but here the approach is less successful. The main window contains three buttons only. To use the tool, however, it is more or less essential to use these buttons to open the palette, toolbox and page-navigation windows. These, in

turn can lead to further windows and dialog boxes, so that soon the screen may look very cluttered. Using this whiteboard with multicast audio and video tools would be likely to compound any existing window-management problems.
The icons used in the application could be clearer. The ones on the main window and in the whiteboard are not instantly recognisable and the teapot icon in one of the whiteboard toolbars was a mystery for some time. (It brings up a dialog box for importing image files, when selected with the right mouse button).
At present, importing an image takes an unpredictable length of time, sometimes more than five minutes. The length of time appears to increase as more objects are created in the whiteboard, although this observation is based on limited experience.
URL: **http://mates.cdt.luth.se/software/mDesk/**

wbd

Functionality
It was written as a wb compatible whiteboard and has much the same functionality as wb. Although wbd is fairly complete it has a couple of problems, particularly with drawing speed on pages with more than 500 items (i.e. freehand drawings).



Wbd was written to allow better integration with the ssd session directory / simplified conferencing environment. When built for the ssd conferencing system, using a modified tk library, wbd also has one feature that wb does not: it supports the use of a pressure-sensitive drawing tablet.
Since wbd was written with Tcl it is easily extensible. The first use of this feature has been to incorporate input from a Softboard, (a physical, wall-mounted whiteboard which senses pen position and colour). The Softboard driver program is completely separate from wbd, simply sending it draw commands via Tk's send command.

Platforms
Unix versions exist for SunOS, Solaris, SGI Irix, Linux, NetBSD. A version for PC is being developed.

Usability
It provides the same functionality as wb and is equally easy to use.

URL: http://bashful.lboro.ac.uk/ROPA/wbd.html

MediaBoard

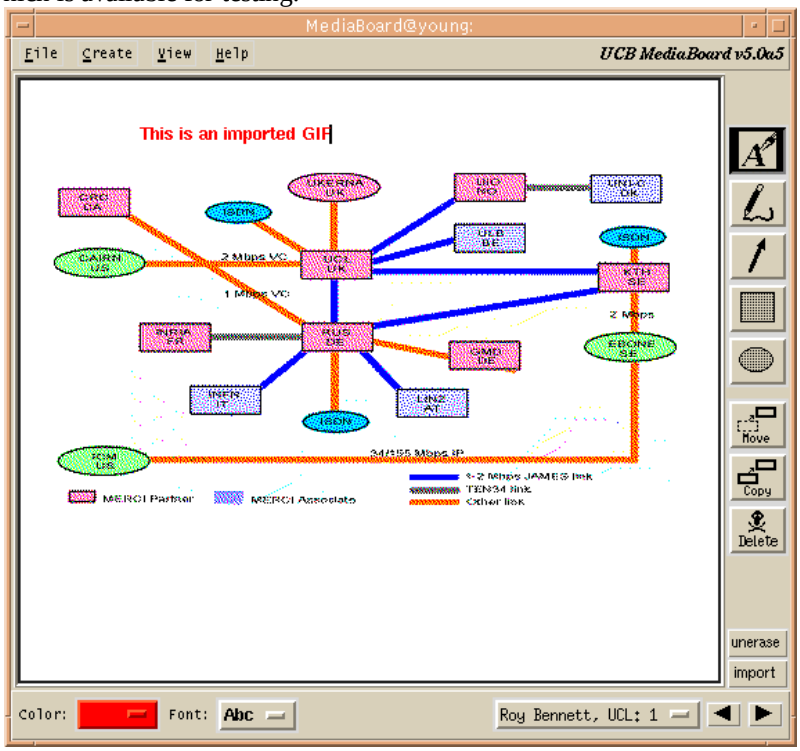
Functionality
It was written by the developers of the original wb and has extended the scope of wb in this new tool. A major improvement is the ability to import GIF files in addition to the Postscript of wb. It provides the basic drawing tools for a whiteboard: typing, freehand drawing, straight lines, arrows, rectangles and ellipses; each may have fonts, colours and widths defined as appropriate. Objects may be copied and moved, deleted and restored. As with wb, it has the model of "pages" between which it provides navigation methods. It provides much improved diagnostic information although we have not

investigated this in detail yet. There is little documentation with this Alpha version which has not yet been formally released, but which is available for testing.

Platforms
Solaris, SGI Irix, HPUX, BSDI, Linux, FreeBSD, Windows95/NT.

Usability
On initial use it seems to be easy to use. It has the basic functions placed clearly in the right hand frame of the window and their options in the lower frame. Its simple functionality is clearly revealed despite the absence of any "Help" in this version.

URL: http://www-mash.cs.berkeley.edu/mash/



Conclusion for shared whiteboards

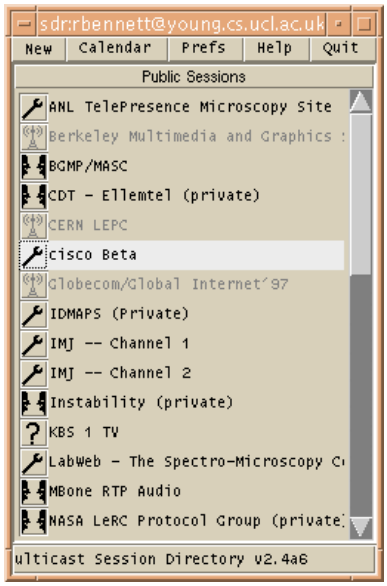
The shared whiteboard tools are all in various stages of completion with only wb in a final, stable, released version. TeleCanvas and wbd are in early alpha releases, which are not suitable for shrink-wrapping, and mDesk whiteboard is still somewhat unstable. The use of Java for TeleCanvas and mDesk is promising for interoperability in the longer term although mDesk whiteboard has the problem that it runs as part of a combined application interface (mDesk) which does not include video or audio. Wbd is compatible with wb. Since the application is written in Tcl/Tk and C, we anticipate that it would port relatively easily to PC. Its untried and somewhat buggy alpha status presents more of a problem, but in view of the very stable nature of wb, this new tool could be included if a reliable PC port is at all possible. This would mean the inclusion of both wb and wbd.
MediaBoard, which runs on both UNIX and PCs is the most promising of the tools evaluated. However, it is only an alpha release and it will change a lot over the next three months. Whilst very significant in the longer term, it is yet stable enough for shrink-wrapping. It will be kept under review during the period of the project and a final decision may be made later.
Thus wb is the only tool to be definitely included.

Session Announcement

Several session announcement tools having been developed apart from Session Directory Rendezvous (SDR). Examples, some of which are embedded in composite tool interfaces, are

- Simplified Session Directory (ssd), LUTCHI http://bashful.lboro.ac.uk/ROPA/ssd.html
- MAnnouncer, Luleå University of Technology http://www.cdt.luth.se/~peppar/progs/mAnnouncer/
- multikit™ http://www.lvn.com/multikit/

However, the tool in almost universal use on the Mbone is SDR developed at UCL.



SDR

Functionality
SDR is a Session Directory designed for announcing and scheduling multimedia conferences on the Mbone. It is loosely modelled on sd - LBNL's Mbone Session Directory. SDR

extends the sd model in a number of ways. Full details of the functionality can be obtained from the User Guide.

Platforms
SunOS, Solaris, SGI, DEC OSF, HPUX, FreeBSD NetBSD, Linux, NeXT, RS6000/AIX Windows 95/NT.

Usability
The program has been extensively studied for its usability and major changes have been made to the user interface following this work. There is extensive built-in help.
URL: http://north.east.isi.edu/sdr/

Conclusion for session announcement

This is the only current serious contender for this function and we therefore propose it for shrink-wrapping.

Overall conclusion

This summarises the conclusions and recommendations for the individual types of tool to be shrink-wrapped. Some conclusions are defined by the timescale for the exercise, in other cases there is a genuine choice.

Video
The timescale for the shrink-wrapping is such that VIC is the only tool recommended at this time. Rendez-Vous will be of more interest in the future, especially as it also presents an integrated user interface for video and audio, which will be attractive for some users and/or applications.

Audio
RAT is selected as being comparably stable to VIC and having the major advantage of redundant encoding to give improved performance under adverse network conditions. Fphone, with comparable redundancy, does not yet include a PC version.

Shared workspace
NTE is the only tool found to be capable of shared text editing.
Most of the shared whiteboard tools are still under development, with only wb in a final, stable, version.
TeleCanvas, MediaBoard and wbd are in early alpha releases unsuitable for shrink-wrapping. wbd is compatible with wb, unlike any other application assessed, and might port relatively easily to PC. MediaBoard runs on both UNIX and Microsoft platforms and is the most promising of the shared whiteboard tools evaluated.
mDesk whiteboard is still somewhat unstable.
In view of this only wb will definitely be included.

Session directory
SDR is, the only real contender for this function, will be included.

Shrink-wrap list
The recommended list is therefore:

- VIC
- RAT
- NTE
- Wb
- SDR

Future developments

The MERCI project will end on November 30, 1997 and the MECCANO project will begin soon after. The projects focus on developing the use of Multicast Multimedia conferencing within the European Research community. Their aim is make the use of multimedia conferencing much easier to use and more reliable. These aims are very much in line with those of UKERNA in their funding of a project such as SHRIMP. MECCANO will continue to develop new tools and to improve those developed within MERCI, but this will be done with the overall aim of usability in mind. New tools will not be developed for their own sake, but rather to fill observed gaps in those tools available and to improve those already available.

For this reason the reworking of SHRIMP to produce an updated list of well-developed and usable tools at some time in the future is something of interest to MECCANO as to UKERNA. This is especially true in the fields of shared-workspace tools. MECCANO will continue to work on the TeleCanvas tool at RUS and plans to release this as a usable multi-platform tool during 1998.
The following areas of research within the MECCANO project are of particular relevance to the user community and some have already begun to impact the conferencing tools:

- support for Quality of Service (QoS)
- the provision of security
- the introduction of gateways to allow interworking between videoconferencing standards
- the provision of multimedia servers to provide facilities for the storage and retrieval of conference materials

Quality of Service (QoS)

Work has begun in MERCI on the deployment of Resource reservation using RSVP [7] within local networks to gain experience of its use prior to wide area deployment. This work will continue within MECCANO.

Security

The whole question of secure conferencing is complex; a prerequisite is the ability to encrypt the streams produced by the multimedia tools. Eventually this will be done in a tool-independent way using secure IP (IPSEC) [8], the extent to which it will be implemented in IPv4, and the timescale of the implementation, were too uncertain for our purposes. We have chosen to secure the individual tools; this has the advantages that it can be done using the full infrastructure of the RTP transport protocol and of Multicast.
We have arranged for encryption to be provided for the audio tool RAT, the video tool VIC, the shared text editor NTE and the shared whiteboard (WB). The media tools use symmetric single DES [9] encryption, and the only parameter needed is the encryption key. Because the Pass Phrase is 7bit printable ASCII, as are all the other parameters provided by the tools, it is possible to provide the whole Directory Payload, as a printable block.
Another aspect of security is the distribution of the Pass Phrase mentioned above. Mechanisms have been devised using Public Key systems for secured session announcements and invitations. These methods rely on issuing a Group Secret Key (GSK) to authorised participants in a set of sessions. The Session Encryption Key (SEK) is then transmitted encrypted with the Group Public Key; as a result, only authorised parties may participate in the conference. The distribution of the GSK may itself be done in different ways; one is the use of secure e-mail. Again all the mechanisms above are being standardised in the IETF.

Gateways

These have been the subject of work within MERCI which has produced two prototype gateways, one for H.320/Mbone interworking and the other to allow a remote user to link to an Mbone conference over N-ISDN. Fuller details of these two gateways can be found in the Annual Review Report 1997 [10] of the MERCI project.

H.320/Mbone gateway

In the MERCI project, the general aim has been to implement a gateway that allows multimedia terminals (typically Windows or UNIX-based workstations) that are based on either of the two standards to interoperate seamlessly. Specifically, H.320-based end systems connected to the ISDN are able to communicate with Mbone tools running on workstations connected to the Internet. The fundamental differences to be resolved include line-switched vs. packet-based transmission of audiovisual and control information, different control protocols, and different conferencing paradigms.
Architecturally, the MERCI gateway is constructed of two gateways:

- an H.323 to Mbone gateway as developed within the MERCI project
- an H.323 to H.320 gateway, developed in the EU project DIVINE and extended for MERCI

The Mbone to H.323 gateway functionality comprises

- converting the control protocols
- adapting transport protocol types
- providing a mapping between the two conferencing paradigms

The H.323-MBone gateway implements

- the adaptation of the H.323 call setup and control protocols to the corresponding Mbone protocols (if available)
- new mechanisms for mapping the H.323 functionality where no Mbone counterparts exist.

This work has so far produced an early prototype which will be further developed during the MECCANO project.

ISDN gateway

UCL has developed a Transcoding G/W to enable users join the Mbone sessions over low speed links such as N-ISDN (using one or two B-channels). It consists of three major components and a client user interface to control the server.

Audio mixer/transcoder.

The audio mixer/transcoder is now an integral part of RAT. It works as an RTP transcoder/mixer in which RTP packets received from a multicast group are transcoded into a user specified format. The transcoder can work with encrypted streams. The multicast capable server mixes multiple sources and the result is transmitted unicast to the client at the remote site. Currently six encoding/decoding methods are supported by the audio transcoder: PCM, DVI, GSM, LPC, L16 and redundancy.

Video filter/transcoder.

The Video filter/transcoder is adopted from the video gateway engine developed at UC Berkeley. Two operations are applicable: passing through or filtering by reducing frame-rate or transcoding (M-JPEG to H261, NV to H261)

Relay for SDR.

An sdr relay server has been developed which listens for session announcements on a well-known multicast address and passes SAP packets to the remote unicast client. It can also pass cached session announcements to the remote site to speed the delivery of announcements.

User Interface for transcoding/relay control.

A user interface is provided on the gateway client to allow the user to invoke services from the relay server. The MERCI tools can be started from sdr on the client as in a multicast-enabled host.

Servers

The provision of a multimedia server is considered vital to the MERCI and MECCANO projects. This should have the capability to record sessions, and to introduce material previously recorded. Early versions of such servers were created at UCL during the MICE project, and also at many other sites including UC Berkeley [11]. The UCL tool, called MMCR [12], currently has a basic, but robust, functionality with many extensions still required. It can participate in a conference - but it must be started manually; eventually this initiation will be automated. All operations can be operated remotely through the Internet. Since standards for remote operations are still being developed in the IETF [13], some functionality must await their agreement.

The architecture of MMCR allows for annotation and indexing of each media stream; it allows also for synchronisation between streams. Further developments envisaged include an index of the stored material, which can be searched in a sophisticated manner, and tools for editing stored material. The considerations for secure operation of the Server are complex. Whilst there is no problem in storing encrypted media streams, though it would be necessary also to store the encryption keys used, there remains the need to consider carefully mechanisms of access control and key management for accessing the data stored.

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