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Tele-conferencing for the EFDA Laboratories

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INTRODUCTION

Since early 2000 JET has been operating as a shared facility; several other European fusion experiments will follow. This requires tools for Remote Participation and in particular for Teleconferencing in the widest sense. Similar requirements exist for ITER and JET design and construction activities as well as for administrative and management areas.

The 23 EFDA Associations are now making significant use of such techniques. Many technical and scientific meetings are regularly organised as distributed meetings with audiences and speakers spread over several locations.

While presentation (electronic slides) sharing has converged on a single approach based on the open-source VNC [1] software, two different technologies have been adopted for audio and video conferencing. Many labs in the JET collaboration are using the VRVS [2] infrastructure, originally developed by Caltech for the CERN LHC community, with the open-source MBone tools VIC and RAT [3] as clients for video and audio. Several other labs have opted for an approach based on the H.323 [4] umbrella standards. The two systems are not fully interoperable. Hence, an EFDA working group has been created to explore and compare the two approaches, and to produce recommendations for the future.

The paper presents the functional requirements for teleconferencing, taking into account the different application scenarios that are expected in the European Fusion community and describes the proposed approach.

1. TELECONFERENCING FUNCTIONAL REQUIREMENTS

1.1. SCENARIOS

Teleconferences can be classified according to their use and requirements as follows:

- ***Multi-point office-based meetings*** (typically ad-hoc meetings) where all participants interact from their office desks,
- ***Seminar or lecture-type meetings*** with formal presentations and discussions where participants and presenters are distributed over several locations, including at least one seminar room or lecture hall, and individual offices,
- ***Management-level meetings***, including formal committee meetings.

Teleconferencing, in combination with other remote participation tools, such as remote computer access, can be used to provide *remote control room participation.*

In addition there is a much-felt requirement for *Real-time meeting broadcast* and *Meeting recording and on-demand replay.*

1.2. TELECONFERENCING "STATIONS"

Teleconferencing "stations" to be used in the different scenarios can be broadly classified as follows:

- A ***Single-user Desktop Station*** is based on an office computer and provides text-dialogue (chat), basic-quality duplex audio (via headsets), video viewing capability, and application sharing to view and transmit slides electronically. Management-level meetings may require higher-quality audio and video transmission.

- A ***Small Meeting Room Station*** has to accommodate up to 15 people, typically sitting around a table. It has to cope with all teleconference scenarios. The requirements are as for Desktop Stations, appropriately dimensioned for the room size, plus speaker & microphone-based audio with echo cancellation, and electronic projection facility. Additional, optional facilities include interactive whiteboards and a scanning document camera to cater for presenters with conventional transparencies. A separate station for slide sharing is recommended.
- ***Seminar Room / Lecture Theatre Stations*** require basically similar equipment as Small meeting rooms, but appropriately dimensioned for the room size. It requires a fully computer-connected room audio system with speakers, fixed and portable microphones etc. and should have the possibility to connect additional video cameras
- For ***Remote Control Room Participation*** the experiment control room needs to be equipped with "single-user Desktop Stations" for the local interlocutors plus a facility to stream via web specific operations-related computer screens, and web camera(s) transmitting overview image(s) of the control room. A"*Remote Control Room Extension* has to be provided for the remote participants, equipped with desktop stations for session leader and physicists, several workstations equipped and enabled for remote computer access to the experiment's computer systems, several fixed screens to relay information from the main control room, and an (optional) web camera transmitting an overview of the control room extension.

1.3. TELECONFERENCING TOOLS

The teleconferencing scenarios sketched above require a number of tools.

- ***Real-time Text Dialogue*** ("Chat") is a very useful, self-documenting tool halfway between telephone and e-mail exchange, and particularly useful for non-intrusive communication during teleconferences. Many different and sometimes mutually incompatible *Audio & Video* ("videoconferencing") tools exist. Full-duplex, telephone-quality *audio* is sufficient for many of the considered scenarios, except for formal lecture-theatre scenarios and formal meetings. *Echo cancellation* needs to be provided at all participating stations. Often *video* is optional and considered a "comfort" facility just to allow one to see who is present in a meeting. Video is not intended for the transmission of presentation slides. Satisfactory audio and video transmission to/from a single station should not require more than 384 kbit/s, and 64 kbit/s for audio only.
- ***Application Sharing*** is essentially a remote display system that allows viewing of either a computing 'desktop' environment or (preferably) a specific computer application from anywhere on the Internet with the same high resolution as the source. In addition to being used for interactive sharing of documents in discussions, this is used for presentation of *electronic slides.*
- Several ***Administration Tools*** are required: a self-service *booking facility* that works via the Internet; a *directory service* for all participants, *remote monitoring* of network connectivity and of the performance of the teleconferencing tools, and comprehensive documentation.

2. ASSESSMENT

A working group was established to provide guidance on standards for the implementation of teleconferencing to establish economic, reliable and compatible interfaces that provide the facilities and the flexibility required by the European fusion programme. It was to provide guidance on the use of VRVS and H.323 in the future implementation of teleconferencing facilities by:

- Reviewing the present experience in the use of these standards;
- Examining the facilities and limitations provided by systems using these standards;
- Investigating the expected future development paths;
- Investigating compatibility issues;
- Reviewing the possible cost implications.

2.1. H.323

H.323 is an umbrella ITU standard for Internet (IP)-based videoconferencing released in early 1998, and is based on the earlier H.320 [5] standard for ISDN-based videoconferencing. The video is an important and primary part of the system. H.323 allows point-to-point and multi-point conferences. All hardware clients[1] have built-in echo cancellation. The quality of the video adjusts to the available bandwidth.

Many H.323 hardware clients are dual-standard and can also operate via ISDN lines according to the (older) H.320 standard. H.323 hardware clients can be classified according to their use:

- *Desktop systems* for up to 5 people;
- *Set-top systems* for up to 15 participants;
- *Systems for large meeting rooms*

Multi-point conferences require a Multi-Point Control Unit (MCU). Some of the set-top and most of the room systems have built-in MCUs for up to four participating stations. For larger numbers an external MCU is necessary. There are two modes of operation:

- *Voice-activation*: The video of the station producing the strongest audio signal is routed to all other stations;
- *Continuous presence*: typically 4 (up to 16 on newer MCUs) video subwindows are displayed on a split screen.

Point-to-point conferences are established by direct dialling. Multi-point sessions can be set up either by individual users inviting other users to a conference; alternatively any authorised user can dial in and leave the conference individually, and finally an administrator can invite and disconnect individual users.

2.2. VRVS

VRVS (Virtual Room Videoconferencing System) is a web-oriented, low-cost, bandwidth-efficient, extensible means of videoconferencing and remote collaboration over IP networks. It has been developed by Caltech originally for use within the CERN LHC community and is now in widespread

[1]In principle, software clients are also available, but at present they do not work properly in multi-point conferences and also present other compatibility problems. For this reason they have been excluded.

use in the HEP community in general, and also increasingly in other research areas (Astronomy, Fusion, Medicine).

VRVS is a proprietary infrastructure that supports a number of collaboration tools: MBone (VIC/RAT), H.323, QuickTime, Desktop/Application sharing and Chat on various platforms. Gateways to parts of the H.323 sub-standards are available. This enables connection to individual H.323 clients and to MCU-based conferences.

The basic concept is that of a virtual meeting room. VRVS uses a set of 38 (in 2002) distributed “reflectors” located in such a way on the Internet as to optimise the IP traffic between participating sites. It comes with a web-based, intuitive room booking system.

VRVS transmits all active MBone-tool based video and audio channels to all participants. Users have the choice whether to transmit their own video, and can leave it switched off to reduce bandwidth usage.

2.3. FINDINGS

The findings are based on present user experience, documentation, and some ad-hoc interoperability tests.

Generally, in order of *priority*, sound is the most important functionality and also the one that requires the most experience and effort to design, install and set-up, as well as requiring the most discipline to use. Conference telephones connected to the IP teleconferencing system can be used in small meetings; these also provide backup via the standard telephone system. Larger H.323 stations come with dual H.323/H.320 mode, but H.320 requires ISDN. In bigger conference room set-ups where an audio system is installed, a telephone interface unit can be incorporated for little additional cost.

Screen sharing is used for slide transmission and has the second highest priority.

- **VRVS *bandwidth*** is defined by the sum of the transmitted streams under the control of each user, and does not have at present any additional bandwidth limitation. All transmitted video and audio streams are sent to all users. In H.323 MCU-based and in H.323-MCU-to-VRVS conferences the MCU only sends one video/audio stream with a fixed bandwidth (typically 384kb/s) to each station.
- ***Security**:* H.323 requires the full range of high UDP ports to be (dynamically) allowed, proxy-gatekeeper solutions are available. Communication between VRVS reflectors is restricted to a well-defined and restricted range of port numbers.
- ***Room booking**:* VRVS provides a complete room booking facility. For H.323 this has to be purchased as a separate product.
- ***Addressing**:* At present VRVS stations are tied to their IP address or DNS name. In the H.323 community the ViDeNet addressing [6] is widely accepted.
- ***Voice Activation**:* The sometimes delayed and sporadically uncontrolled switching of video to non-speaking participants as a result of extraneous noises was found to be annoying/distracting by several test participants.

- ***User Interface:*** VRVS with MBone tools is technically flexible, but as a consequence is less user-friendly for the non-technical user. It scales easily from one-to-one to multi-centre meetings. H.323 point-to-point meetings are simpler to set up and could be operated by non-technical persons whereas H.323 multi-point conferences need an MCU.
- ***Future developments - VRVS:*** From discussions with the VRVS developers it seems likely that *VRVS* will undergo continuous development. They perceive their system as an infrastructure for multi-protocol videoconferencing. Whilst currently the VRVS servers are sited centrally, having more servers distributed (with the reflectors) will reduce the likelihood of complete failure and will allow the possibility of dedicated rooms and booking systems for separate communities (i.e. the fusion community could have a virtual private VRVS system). Also it is planned that VRVS will distribute the VNC based stream(s) to the reflectors, hence reducing the overall Internet traffic and reducing the load on the VNC server.
- ***Future developments** – H.323:* In view of the high acceptance of H.323 in the commercial and scientific communities (Internet2 etc.) it can be expected that the cost of MCUs will come down to more acceptable levels. Also the already available proprietary H.323 meeting administration tools can be expected to be standardised and allow the control of clients and MCUs of different brands.
- ***Compatibility Issues***- VRVS provides an infrastructure and is not client dependent. In particular the VRVS team does not develop and/or maintain client systems. Although it was first used with the MBone clients (VIC and RAT), the VRVS system has been designed to allow the interfacing of different client standards and it is likely that more will be added. VRVS provides a gateway to the base H.323 audio and video protocols. From the tests it appears that there are no compatibility issues when operating in basic modes. However, an H.323 client connected to a VRVS-based conference cannot see more than one video stream at a time, and similarly VIC/RAT based VRVS stations linked to an H.323 MCU will also receive only one video stream from that MCU. Also, standards development is in rapid flux. In particular, it is not quite clear what effect the introduction of the SIP standard will have on either H.323 (the SIP-based Messenger [7] approach is being marketed by Microsoft in Windows XP; gateways between H.323 and SIP have been available since end of 2001) or VRVS (the VRVS team intend to add SIP as supported client to VRVS).

2.4. COST CONSIDERATIONS

Teleconferencing cost is difficult to assess in totality because it overlaps with many internal needs including office communications and equipping of general meeting rooms. The elements to be taken into account are:

- Equipment costs
- Installation costs - especially seminar room audio systems
- Support - local and central
- Lifetime (this is a rapidly moving field and systems become obsolete very quickly)

- Upgrade-ability
- Can some of this work be outsourced to contractors?

2.4.1 Materials and Software cost

The simplest *Desktop Stations* for single users with UNIX, Linux or Windows computers are using the VRVS/MBone tools (cost below ¤ 100). Single user H.323 hardware clients start at about ¤ 500.

H.323 *small group stations* for up to 5 people require a computer plus an H.323 hardware client (¤ 500); H.323 set-top clients cater for up to 15 people and cost from ¤ 3500. VRVS/MBone stations require a computer for audio and video, plus an IP-conference phone (¤ 800). For both solutions it is preferable to have a separate computer for the presentation of slides. The cost of other devices, such as projector and interactive whiteboard, needs to be added.

In *large meeting rooms* custom-made systems are required. In these cases the major cost is in the local multimedia equipment, independent of the actual videoconferencing standard used.

In the H.323 scenario the *central infrastructure* for multi-point sessions uses an MCU. In a pure VRVS scenario or in a mixed VRVS-H.323 scenario the VRVS reflector structure and the booking and user administration facility need to be taken into cost consideration.

2.4.2. Manpower costs

Irrespective of the selected solution we need to consider three types of manpower:

- ***Development (programmer) cost***: A number of software components may initially not be available or not be well adapted to our needs (booking facilities, address books, slide sharing arrangements, etc.).
- ***System running cost:*** It is not clear what order of magnitude the future costs will be for VRVS. In the H.323 scenario we would need to budget for the use (purchase or lease) and support of at least one MCU.
- ***User support:*** During the set-up and running of any teleconferencing, the users need support in case of technical problems. There should be a network of professional-level support commensurate with the meeting.
- ***Equipment handling support:*** Technician–level support is needed for larger meetings, as they require the operation of room audio systems, monitoring of availability and quality of remote connections, etc. Note that the support required for participants from management or other non-scientific staff is differing strongly between H.323 and VRVS solutions. H.323 is easier to use, provided that no slides are to be handled.
- ***Outsourcing:*** While this may be conceivable for the support within one (national) organisation it seems to be impossible to globally cover this for the European fusion community under present contract administration regulations.

CONCLUSIONS.

Given that

- the requirements at the participating locations span a very wide range,
- none of the individual technical solutions can deal with all the requirements and that all will require substantial support manpower plus some development manpower or purchase of additional products,
- the VRVS/MBone approach and the corresponding equipment have worked reasonably well for the scientific users in the EFDA-JET collaboration,
- the H.323 approach is particularly well suited to high-quality needs and that IPP has already decided to invest in H.323 equipment and has a very high user acceptance,
- either due to security restrictions or network bottlenecks, there are sites who can not participate in IP-based teleconferencing and therefore would benefit from having a H.320 gateway in a central EFDA MCU,
- limited, but sufficient, interoperability has been demonstrated between H.323 and VRVS based conferences,
- developments are in very rapid flux,
- outsourcing of services for the Fusion community as a whole seems not really an option,
- the long-term costs of both approaches cannot be established at present,

a pure H.323 (plus VNC) solution for the European fusion community seems to be unrealistic at this stage as the immediately required cost would be unacceptable. A pure VRVS/MBone (plus VNC) installation is also excluded because of the existing large H.323 installation-base in some labs. In view of the above we recommend:

- to continue for the time being with the split approach, and use the available interoperability where necessary;
- to review the situation after one year.
- to recommend to those users who need high-quality videoconferencing to purchase H.323 hardware clients;
- to go ahead with teleconferencing room installations at all labs in such a way that a VRVS and/or H.323 infrastructure could be operated, depending on the local institutions needs;
- to ensure that all EFDA labs are connected with adequate bandwidth;
- to install adequate network monitoring at all labs;
- to ensure that local firewall and network throughput and structure be made compatible with the expected teleconferencing needs;
- to maintain the teleconferencing ad-hoc group to act as an expert “forum” to follow developments in the field and to continue intra-fusion dialogue on the subject;
- to link and extend into a common facility for all labs the existing VNC-based slide sharing facilities at the JET Facilities and at DRFC;
- to investigate and implement audio broadcasting and complete meeting recording and on-demand replay.

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