

# **Recommendations for Research and Development into e-Science Advanced Collaborative Environments (ACEs)**

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# 1 Executive Summary

Section 2.1 of the UK e-Science Technical Report *Multi-Site Videoconferencing for the UK e-Science Programme* ([http://www.nesc.ac.uk/technical\\_papers/UKeS-2002-04.html](http://www.nesc.ac.uk/technical_papers/UKeS-2002-04.html)) recommended investigation into a UK effort on Research & Development into Advanced Collaborative Environments:

*As the country with the second highest number of Access Grid nodes, an established international reputation and influential contacts, we believe that the UK is uniquely placed to make a valued contribution to research and developments in the field of advanced collaborative environments. This will not only be of visible benefit to the e-Science programme, but also to other UK and global projects. The effort should examine ways to improve the productivity of remote collaborations through an increased sense of presence. This might involve developments in the areas of video (towards standards such as HDTV), audio (involving multi-channel and virtualised audio), interoperability, and the integration of collaborative applications, among other possibilities. The aim is not to concentrate solely on a single technology, but to look at developing each of the technologies considered by this report.*

The focus of this report is to suggest immediate areas of future funding and research for the further advancement of Advanced Collaboration Environments (ACEs) in the UK. The research, through the nature of the tools, should also have global impact.

This report has been compiled from two main activities. First, we have studied the latest technologies and trends related to ACEs, principally in videoconferencing tools but also in supporting mechanisms such as messaging and web-based tools. Second, we conducted surveys of ACE users with a view to gaining feedback from the “coal face” for the technical support staff and the end users. In combining the outcomes of these activities we have produced a set of recommendations for further work.

The recommendations are presented first, in no order of priority. These are presented ahead of the discussion section on the basis that many readers will be familiar with the basic issues and may be primarily interested in the recommendations. We recognise that two areas are perhaps worthy of specific focus. One is the requirement to study how existing tools can be further integrated to a cohesive single environment for the participating users, and to identify missing tools. This should be conducted with close consultation with end user groups. The other is the need for tools to simplify the management and operation of the ACE systems, including the often problematic issue of fault diagnosis when ACE sessions encounter technical hitches. This includes development of QA tests to help minimise the chances of such problems arising, and remote management tools to alleviate the need for constant operator presence.

The specific recommendation areas and indicative budgets for work are:

- Supporting collaboration with heterogeneous devices (£120K)
- Automated quality assurance testing for Access Grid and VRVS (£110K)

- Develop an excellent means for sharing presentations (£90K)
- Develop a lightweight client interoperable with the AG Toolkit (£30K)
- Management of floor control and interaction with ACEs (£240K)
- Support for people with disabilities (£80K)
- Security and robustness (£80K)
- Remote node management (£120K)
- Support for differently resourced end systems (£80K)
- Impact of network technologies (£120K)

We then discuss the technology related to the recommendation areas in some more detail, to offer the reader further background behind the recommendations. There is some overlap with other reports in this series, e.g. network technologies, but we assume any such overlap will be considered by those groups making the funding decisions, and that both differences and commonalities may be beneficial to such groups.

Finally we present the results of the ACE surveys, with analysis of the responses. The original questionnaire is also included (Appendix C), along with useful sources of information (Appendix A) and unreferenced collaborative systems (Appendix B).

## **2 Recommendations**

In this section we present a set of ten recommendations for future research areas for ACEs. We include an indicative estimate of costs for the recommended projects. All costs are based upon a costing of £80,000 for one full-time equivalent (FTE) for one year.

Many of our recommendations aim to produce tools that will be of great benefit to UK users, particularly users of Access Grid. However, for users to be aware of these tools and make use of them within facilities at their local site a rollout strategy is required. The most obvious strategy to employ is to use the Access Grid Support Centre (AGSC) in this role. It must be recognised that this function of the AGSC has not been directly funded and, to be effective, it is not without cost implications. Rather than produce a specific funding recommendation for this role, we note that the AGSC has a mechanism for price review that should be employed if rollout proves to be a large overhead.

We have checked our studies against the recommendations of JISC's Virtual Research Environments Programme ([http://www.jisc.ac.uk/index.cfm?name=programme\\_vre](http://www.jisc.ac.uk/index.cfm?name=programme_vre)), and we do not see any conflicts between the findings or the roadmaps suggested by workshops organised by that programme. One of the commonalities was the strong suggestion to make user-focused studies of where existing tools are lacking. Other recommendations particularly in common with our own findings are:

- Be loosely coupled, and interoperable
- Meet user requirements including accessibility
- Be capable of running on PDA/desktop platforms, and easy to install
- Use open standards
- Be secure and trustworthy
- Work with cross-institution authentication schemes
- Be compatible with other systems, from wikis to AG

Other recommendations by the VRE programme workshops are less relevant because VREs are beyond the scope of this report, which was one of six reports briefed to report on the topic of "Multi-site Videoconferencing for the UK e-Science Programme" (see <http://www.ja.net/development/e-Science/eScienceVC.html>).

All of our recommendations that involve future developments of ACEs and their component parts should consider as prerequisite requirements:

- The needs of people with disabilities
- Security and vulnerabilities to hacking/denial of service attacks

- Integration of new components; it is clear that many tools are currently used in a non-integrated manner.

The following recommendations are not presented in any specific order of priority, though we believe there are two specific topics warranting special attention. One is the requirement to study how existing tools can be further integrated to a cohesive single environment for the participating users, and to identify missing tools. This should be conducted with close consultation with end user groups. The other is the need for tools to simplify the management and operation of the ACE systems, including the often problematic issue of fault diagnosis when ACE sessions encounter technical hitches.

## **2.1 Supporting Collaboration with Heterogeneous Devices**

Despite the potential power of the Access Grid and VRVS, the use of these technologies has often been limited to sharing audio and video. This may be due to the lack of availability of applications for achieving other kinds of collaborative activities in such a fixed context, or, where applications do exist, to a lack of support for integration into ACEs. Current understanding of how ACEs are used in practice is insufficient to address the requirements for such collaborative tools and their integration, particularly when considering potential support for both distributed and co-present synchronous and asynchronous collaboration.

Therefore, a prerequisite for developing a broader set of applications is to determine their requirements. Based on current research in CSCW (see section 3.4), these would focus particularly on understanding how participants currently bring in other resources from their local context in order to support collaboration. These resources might include documents such as books or field notes, the use of computer applications such as presentation slides or videos, or might involve other types of delivery platforms such as mobile technologies. An interesting example in the e-Science area is the Smart Tea activity within the CombeChem project, which studied how chemists conduct experiments and then record and share results<sup>1</sup>.

We recommend that a project be initiated to undertake a range of investigations:

- Using a variety of methods to ascertain requirements for collaborative devices, the project should investigate the current use of ACEs in order to ascertain where problems and issues arise
- The focus of a more detailed investigation will be to understand the requirements for a first set of core potential users, such as users from three diverse scientific domains, e.g. scientists that work remotely in the field, in laboratories, or between collaborative laboratories. This would be done in order to ascertain support for:
  - The types of documents that are used in collaborative work such as laboratory books
  - Tools for visualizing complex scientific information

- A broader investigation should be undertaken in order to determine the requirements for a range of users that place particular demands on the critical requirements for collaboration. These users, for example artists, musicians and architects, may have specific demands for increased sensitivity to visual materials, audio resources, or for education and training
- An investigation into the potential for greater asynchronous collaboration. This may take the form of being able to replay presentations at a later date, or to replay videos and other material for further investigation. A major requirement is to enable such materials to be accessible to others who may not have been present at the initial discussion, but who nonetheless have a need to view the outcomes. This might entail developments to tools such IG Recorder or Access Grid Voyager (both of which record audio and video streams in an Access Grid environment) to make them more able to support asynchronous collaboration, e.g. by integrating data sharing applications, as well as the integration or development of other tools such as meeting note takers, to do lists, etc. Asynchronous collaboration will probably include the capability to:
  - Manage asynchronous streamed information
  - Store different types of data
  - Provide facilities to access that data
  - Segment the data
  - Edit the data
  - Be able to pass the data to other platforms
- An investigation into the use of alternative tools such as Jabber<sup>2</sup>, wikis, blogs, message boards etc. This would investigate how these might fill existing gaps in current ACE's and provide offline or near realtime modes of working, for example a mobile user within limited internet access (such as via GPRS) might be able to access a transcript of a ongoing meeting and send some form of messages to the participants. This would also investigate how such tools can be integrated into a single communication environment encouraging both realtime and non-realtime communications.
- An investigation into the requirements and desirability (or non-desirability) of allowing anonymous or pseudonymous participation in ACE based meetings and discussions, as would be allowed by authentication mechanisms such as Shibboleth.

This investigative project will then delineate findings into core sets of requirements or key requirements for capabilities to be developed and investigated in further projects. There should be proposals for coherent and substantive further investigation, for example, to identify particular domains where key applications for heterogeneous resources should be developed, integrated and evaluated. This should be produced from a thorough understanding of the current state of the art in non-ACE systems, progress in CSCW, ubiquitous computing and Human-Computer Interfaces.

The project will be integrated with other projects recommended in this report. It should be set up so as to interleave with other projects in order to disseminate its outcomes and to consider how findings are related. Thus, this project may be continually revised during its lifetime – it is not a conventional requirements activity because of the constant developments in this field.

### **2.1.1 Costs**

In the first instance, we recommend an initial one year's work to perform investigations and make recommendations as stated above. The estimated cost of this work is **£120,000**.

## **2.2 Automated Quality Assurance Testing for Access Grid (and VRVS)**

Quality Assurance (QA) testing is one of the major services being offered by the AGSC, which becomes fully operational in July 2004. It is anticipated that QA testing will dramatically improve Access Grid sessions within the UK by ensuring that participating nodes have a high level of quality of each component of a typical session (video, audio, networking, etc.), as a mechanism for ensuring best practice by technical staff responsible for the node's maintenance and to rollout new standard technologies.

We recommend that this manual QA testing programme be supplemented (i.e. *not* replaced) by an automated QA testing system that can be used by sites to ensure the quality of their facilities, without the necessity of involving other sites or the AGSC. Because of the similarity of VRVS to Access Grid, certain aspects of the system may also be useful to improve the quality of VRVS nodes.

The authors note the recent development within the JANET Videoconferencing Service (JVCS) of an automated QA testing system for H.323/H.320 facilities, upon which a similar system tailored for Access Grid could potentially be built, perhaps by reusing certain components, but at least by building upon the experience of this development.

The automated Access Grid QA testing system would typically be used when the configuration of a node has been altered to check that quality is maintained, perhaps prior to a manual QA test. In addition to this, it would be desirable for it to be usable as a diagnostic tool during sessions to help troubleshoot any problems that arise. There should also be investigation by the development team into the feasibility and desirability of whether the system might be able to remotely recalibrate levels and/or alter the configuration of the node to remedy problems that are discovered during the automated test.

### **2.2.1 Costs**

In the first instance, we recommend an initial one year's work to investigate the JVCS system and current practices by the AGSC; produce functional and technical specifications of the proposed system; specify associated hardware; develop the system; and deploy the system. The estimated cost of this work together with the purchase and deployment of associated hardware is **£110,000**.

## **2.3 Develop an Excellent Means for Sharing Presentations**

There are many attempted solutions to the problem of distributing presentation slides to a remote audience, such as Distributed PowerPoint, Virtual Network Computing (VNC)<sup>3</sup>, ISABEL<sup>4</sup> and inSORS IG Pix, to name just four. Each has its own disadvantages, such as refresh rate, limitations of functionality compared to local slide shows, lack of interoperability across operating systems, the need to distribute files beforehand, and so on.

We recommend the development of a shared presentation tool that overcomes these drawbacks. This solution may well build upon an existing technology, rather than attempt to develop something entirely new. It might possibly include or utilise emerging peer-to-peer file distribution technology. The features of this new tool are:

- Cross platform interoperability (i.e. at least Windows and Linux)
- Excellent quality and resolution at remote nodes
- Support for features such as embedded movies, animations and transitions
- No need for distribution of presentation files prior to sessions
- The use of multicast as the most appropriate distribution mechanism, though it should also be accessible through a multicast bridge

The use of source-specific multicast (SSM) might be appropriate through a reliable multicast file transfer protocol (e.g. Mad-Flute<sup>5</sup>, which has recently been ported to SSM – and IPv6 – within the 6NET project).

### **2.3.1 Costs**

In the first instance, we recommend an initial one year's work to perform a thorough investigation of current solutions and the technologies upon which they are built; the production of a functional and technical specification; development of a shared presentation tool based upon these specifications. The estimated cost of this work is **£90,000**.

## **2.4 Develop a lightweight client interoperable with the AG Toolkit**

The Access Grid toolkit has been developed as a research project by Argonne National Laboratory. Access Grid Toolkit Version 2 (AG2) is based upon a central server that provides connection details, authorisation, and a repository for shared files, applications and services. AG2 uses Python and Globus as core technologies. The architecture is heavily reliant on the server. The evidence from [ag-tech@mcs.anl.gov](mailto:ag-tech@mcs.anl.gov) (the main e-mail list for the Access Grid community, archives available at <http://www-unix.mcs.anl.gov/web-mail-archive/lists/ag-tech/maillist.html>) shows that although it provides many interesting concepts for future collaboration environments, it can be difficult to install and configure. Robustness also remains a problem (this is particularly so of the server components, upon which AG2 is heavily reliant), as evidenced by the results of our user/site survey.

Because of the difficulties associated with AG2, many users have been reluctant to move away from AG1, or have developed ad hoc solutions (such as 'luddite' [produced by Matt Harvey of University College London], which was used for SC Global 2003 and utilises configuration features of VIC and RAT).

We recommend an immediate activity into the rapid development of a lightweight alternative to AG2 that might be used in the short term by UK users. This short term alternative should be produced in a pragmatic manner making use of existing tools and simple scripts and batch files, etc. It is an obvious prerequisite that this alternative must remain interoperable – at least in terms of core media tools – with the Access Grid Toolkit. It is possible that a lightweight and simplified (complementary) alternative to AG2 could be produced quickly – within a matter of months – and would prove a popular means of connection to Access Grid virtual venues, even if some features are lost in the process. Some investigation has already been performed by Mike Jones at the University of Manchester into using GridSite (<http://www.gridpp.ac.uk/gridsite/>) as the basis for an alternative to AG2. This could be used as a starting point for this development.

On a medium term basis, if difficulties with AG2 remain, consideration should be given to the specification, design and construction of a UK led alternative to AG2 that utilises lightweight clients, peer-to-peer communication and flexibility in the choice of middleware components. These more research-oriented aspects of this recommendation would, of course, take longer. If appropriate, this will incorporate relevant components of the temporary lightweight alternative based on GridSite, ICENI (<http://www.lesc.ic.ac.uk/iceni/>), ReLaTe (<http://www-mice.cs.ucl.ac.uk/multimedia/software/relate-ui/>) and/or other developments.

#### **2.4.1 Costs**

We recommend two month's work as a short term activity to develop a temporary lightweight, interoperable alternative to AG2, perhaps using GridSite. The estimated cost of this work is **£15,000**.

In addition, we recommend a further two month's work to produce a functional and architecture specification together with funding recommendations for a UK based product that would be an alternative to the Access Grid Toolkit that takes advantage of lessons learned from the ANL product. If appropriate, this will be based on extensions/modifications to the temporary lightweight alternative developed as the first part of this recommendation, ICENI, ReLaTe and/or other developments. The estimated cost of this work is **£15,000**.

## **2.5 Management of Floor Control and Interaction within ACEs**

We recommend a project to enhance floor control and distance interaction within distributed meetings. The specific requirements for this project are driven from user feedback, including the survey within this report. Specifically, this project would develop:

- A "distributed pointer" that would enable pointing actions made at one site to be viewed by all participants in a distributed meeting has been identified as having high value. The solution is not trivial. With Access Grid for instance,

video window layout and layout of other visual elements might easily be completely different at different sites; a distributed pointer would need to take this issue into account.

- In a system showing video that is arriving from multiple sites, a clear requirement has been identified for having a visual indication of the currently speaking participant.
- Improved "surround sound" audio whereby sound from a distant site appears to emanate from wherever that site's video is displayed would have high value
- In a multiple site conference, acquisition of the right to speak is not easy. With audio delays inherent in the system, verbally interrupting is not always successful. The project should investigate possible solutions that would enable the electronic "raising of the hand" as a possible means to request the floor
- Chairing of distributed meetings is not currently supported electronically with commonly used ACEs such as Access Grid. Attention should be given to providing features to support enhanced floor control

### **2.5.1 Costs**

We recommend the establishment of a two year project to research and develop tools for the management of floor control in ACEs. The estimated cost of this work is **£240,000**.

## **2.6 Support for People with Disabilities**

ACEs currently in use make little allowance for use by people with disabilities. As an absolute minimum, it is clear that an individual with disabilities should be no more disadvantaged in an activity conducted via an ACE than they would be in a face-to-face alternative. Indeed, it seems possible that disadvantage experienced by a user with disabilities has the chance of being reduced in ACE sessions.

We recommend the establishment of a project to perform the following tasks:

- An examination of current legislation to quantify any statutory regulations concerning people with disabilities that might apply to ACEs
- An examination of common usage of ACEs to determine whether they meet current legislation and further, whether there are reasonable technical adjustments that might be made so as to improve access.
- Create best practice guidelines to advise users of ACEs of techniques that they might adopt so as to maximise accessibility
- Identify and make proposals for future technical work to improve access
- Examples of technical issues that might be addressed include:

- Higher quality audio – this could easily assist the hard of hearing or make the voice of a speech-impaired participant more audible to others
- Local colour palettes – the ability to specify locally colour palettes being used by presentation tools could assist people with sight-related disabilities
- Braille input/output devices – such devices could improve accessibility for people with visual impairments

The work would draw on information and resources currently available via the JISC funded "Technology for Disabilities Service" (see <http://www.techdis.ac.uk/>) and feed back conclusions to them.

### **2.6.1 Costs**

In the first instance, we recommend an initial one year's work to perform investigations and make recommendations as stated above. The estimated cost of this work is **£80,000**.

## **2.7 Security and Robustness**

We recommend the establishment of a project, in liaison with the e-Science Security Task Force, to capture the security and confidentiality needs of ACE users and in addition, examine the robustness of ACE environments to hacking and denial of service (DoS) attacks.

A large variety of work is expected to be conducted by the e-Science community using ACEs. Some of the users will have confidentiality concerns. In addition, there may be issues of identification, authorisation and non-repudiation associated with activities. The project would commence by capturing these requirements. The project would then propose future actions to address any deficiencies in ACEs in this area.

It is clear that ACEs could become the target for various forms of hacking and/or DoS attacks. As ACEs become more mission-critical, any such attacks would have serious negative impacts. The project would conduct a risk analysis of ACEs in use within the UK, recommend good practice guidelines for the configuration and use of ACEs and identify any issues to be tackled by future projects.

Some work has been done in this area by the UKERNA Video Technology Advisory Service (VTAS), but this is limited to H.323 conferencing. The JANET CERT is a UK academic focused team for network security incident handling, who may have expertise to assist in such a wider ACE study.

### **2.7.1 Costs**

We recommend an initial one year's work to perform investigations and produce recommendations and identification of issues as stated above. The estimated cost of this work is **£80,000**.

## **2.8 Remote Node Management**

Currently the operation and management of ACE nodes is very manually intensive, in that during a multi-site meeting there is usually one node operator per site, and that operator is often present, or immediately on call, for the whole meeting. We recommend the establishment of a project to investigate, and subsequently develop systems that provide for remote management of nodes. Such a system could significantly ease the management burden of the node by enabling remote management both intra- and inter-site.

A typical site may have a multi-display node with a variety of media inputs and outputs. For full remote management certain local systems may need the addition of remote operation functionality. Such systems may also integrate with high level floor control. Currently general machine management tools exist but are lacking in terms of integrated management functionality for use in ACEs. Some existing work has already been undertaken such as that developed within the ICENI project (<http://www.lesc.ic.ac.uk/iceni/>) although that is currently limited to remote control of AG software rather than devices. This work would include relevant components of such solutions.

### **2.8.1 Costs**

We recommend an initial one and a half year's work to perform investigations and provide pilot solutions as stated above. The estimated cost of this work is **£120,000**.

## **2.9 Support for Differently Resourced End Systems**

The current generation of ACE systems is typically aimed at large-scale, highly resourced environments. We recommend the establishment of a project to investigate, and subsequently develop, systems that provide for interfacing to a range of end systems. Such end systems may be limited in resources such as all or some of: network bandwidth, processing capacity, and physical dimensions (in the case of mobile nodes). Additionally, such an end system may be challenged by the provision of network entities between it and other nodes, such as Network Address Translators (NAT) or restrictive firewalls.

Potential developments to facilitate such connections may include provision of gateways and systems for dynamic media adaptation. In the case of network connectivity issues, end nodes may require some form of connection resolution service like Simple Traversal of UDP through NATs (STUN), although we would recommend that such sites strongly consider the deployment of global addressing and/or IPv6 in place of NAT. As discussed below, IPv6 is now in production deployment on the JANET backbone. The key focus of this activity should be the media adaptation. This includes choices as to which streams or connections to receive or prioritise when bandwidth is limited.

### **2.9.1 Costs**

We recommend an initial year's work to perform investigations and provide basic solutions to a subset of resource limitations. The estimated cost of this work is **£80,000**.

## 2.10 Impact of Network Technologies

All ACEs share a common requirement to utilise the underlying network resource, whether simply as a means of communication, or through various protocols aimed at giving a better user experience or Quality of Service (QoS).

We recommend short studies into particular areas of emerging network technology that may be beneficial to ACEs, in particular where the resultant deployment may be simpler to support and operate, and thus be more robust:

- **IPv6.** This study should include investigation of IPv4 dependencies in existing ACE tools, and analysis of IPv6 porting requirements (adding IPv6 capability, such that nodes can operate over either protocol). The benefits of IPv6 for the ACE context should be demonstrated, e.g. in reducing the need for NAT, for making peer-to-peer operation more straightforward and allowing support for Mobile IPv6 capable roaming nodes. Avoiding NAT should make deployment simpler, e.g. by removing address ambiguities when virtual organisations are constructed connecting different sites that would otherwise use Private IP(v4) address space. Existing work on IPv6-enabling tools should be studied (e.g. the work by 6NET<sup>6</sup> on making AG2 IPv6 capable).
- **Source Specific Multicast (SSM).** The deployment of SSM should simplify multicast operation, removing the need for Any Source Multicast (ASM) Protocol Independent Multicast-Sparse Mode (PIM-SM), Rendezvous Points, Bootstrap Router (BSR) and inter-domain Multicast Source Discovery Protocol (MSDP). This has an impact on applications, thus ASM dependencies in existing tools should be reported along with proposals for obtaining matching functionality using SSM. An SSM porting guide should be included, with discussion and guidance on the implications of transition from ASM to SSM on the architecture of the applications. Other SSM considerations should be reported, e.g. availability of Multicast Listener Discovery version 2 (MLDv2) in hosts/routers/switches (snooping) for IPv6 SSM. SSM may have uses for ACEs, e.g. reliable file transfer using the Mad-Flute protocol (as discussed in the recommendation on Powerpoint distribution).
- **QoS and Multicast.** The UKERNA QoS Trials have done good work on Premium IP and Less than Best Effort (LBE), but have not yet investigated QoS and multicast together in detail. A study should trial and report issues for QoS and Multicast (Premium and/or LBE) on common platforms.
- **Multicast diagnosis tools.** Many problems with ACE tools, in particular Access Grid, are caused by failures in the multicast network provision. User-friendly fault diagnosis tools for multicast (ASM and SSM, IPv4 and IPv6) would be welcomed; this study should address this important issue.

### 2.10.1 Costs

We estimate that each short study would require 3-6 person months of effort, noting that inter-site evaluations would be beneficial where trials are required. Therefore,

funding this recommendation would cost £20,000-£40,000 per study, or **£120,000** in total.

## 3 Current Developments in ACEs

### 3.1 Introduction

In this section, we provide some background, and thus justification, for the above recommendations.

There are a vast number of activities being conducted in the area of collaborative technologies. This makes it a difficult task to summarise and elicit areas of work that may prove useful for end users. For example, the headings of Computer Supported Cooperative Work (CSCW), Computer Supported Cooperative Learning (CSCL) and Groupware encompass whole genres of research and development. The focus here has primarily been on issues of developing infrastructures, applications and studies of technologies in use. By and large, these technologies have not been widely deployed and have met with mixed success, even when deployed in developers' own laboratories.

### 3.2 The e-Science Environment

The developments initiated by the e-Science programme (<http://www.rcuk.ac.uk/escience/>) have provided new opportunities and challenges for collaborative working. The programme emphasises collaboration between individuals and groups across organisations and funding has been forthcoming for certain collaborative technologies to help users with distributed working. A major element of this has been the continuing rollout of Access Grid nodes. Whilst this has undoubtedly been of benefit to users through savings of time, energy and money and enabling productive collaborations, it has also served to highlight gaps in this and related technologies.

E-Science provides a great potential for accelerating the productivity of distributed working, because of large-scale systems and large numbers of users. Effort has already been made to improve the quality of the Access Grid network by the creation of the recently announced UK Access Grid Support Centre and a series of reports (of which this report is a part) that has emanated directly from the UK e-Science Technical Report *Multi-Site Videoconferencing for the UK e-Science Programme* ([http://www.nesc.ac.uk/technical\\_papers/UKeS-2002-04.html](http://www.nesc.ac.uk/technical_papers/UKeS-2002-04.html)).

### 3.3 Developments in Collaborative Technologies

In this report we consider developments in the broad categories of:

- Infrastructure
- Security and Authentication
- Software Applications
- Hardware Applications
- Studies of technology usage

Our aim in this section is not to focus on the core technologies of Access Grid, VRVS and H.323/320, because these have already been examined in depth within *Multi-Site Videoconferencing for the UK e-Science Programme*. The aim is to focus on technologies that may be used in addition to, underneath, or alongside these core environment systems. Specific technologies that may be of particular interest to end users within the UK academic community are listed more completely and briefly summarised in Appendix A, but there is no attempt to be exhaustive.

### 3.3.1 Infrastructure

Developments within the category of infrastructure are frequently ambitious attempts to provide an entire platform within which users can work in a collaborative fashion. Some of these integrate audio and video within a wider collaborative environment (e.g. Microsoft ConferenceXP<sup>7</sup>). Others are aimed at providing a data-sharing platform (e.g. EQUIP<sup>8</sup>) or support for many elements within the workflow (e.g. I-X Process Panels<sup>9</sup> within CoAKTinG). One of the most ambitious is perhaps Croquet<sup>10</sup> that offers a completely new computer software architecture that may be the next evolutionary step in computer interfaces beyond Windows-type systems. Croquet is a multi-user environment where users move between shared virtual worlds in which they work.

There are also projects underway that promise improvements to the infrastructure of environments already in use, such as Access Grid. Notable examples of these include work to enhance the audio tool used by Access Grid (by the Admire Group in China<sup>11</sup>) and enhancements of the quality of video streams by using Digital Video and High-Definition TV (e.g. DV-Capable Access Grid<sup>12</sup> and UltraGrid<sup>13</sup>). Developments are also underway that are interoperable with, but may be used as alternatives to, the Access Grid toolkit (e.g. perhaps using elements of ICENI<sup>14</sup>).

In the UK context, the Access Grid has proven very successful because of the quality of conferencing experience it offers (when working at its best), the push given to key e-Science sites to deploy the nodes, and its use by an impressive list of research sites worldwide (<http://www.accessgrid.org/community/nodes/nodes.html>).

The deployment of Access Grid has also been a driver for the UK academic network and attached sites to make one more push get a reliable IP multicast service working, and to deploy robust bridging technology where it cannot.

This is a good example of why ACE infrastructure also encompasses network provision. ACEs have various dependencies on the network, e.g. for multicast functionality, or for availability of QoS methods. Emerging technologies such as IPv6 and Source Specific Multicast (SSM) may make deployments simpler (e.g. no NAT with IPv6, no Rendezvous Points or MSDP with SSM), and thus more reliable and robust. It is important that these new technologies be embraced.

IPv6 is now widely deployed (dual stack) natively across European National Research and Education Networks (NRENs) and the pan-European GEANT backbone network, and will soon appear on university campuses. SSM is also beginning to see use, and may benefit from introduction with IPv6 (in the IETF Multicast Backbone Working Group, many believe that SSM is the only way forward for IPv6 and multicast, and that the IPv6 opportunity to streamline multicast should be seized). The problems with

ASM multicast (PIM-SM) are all too evident on the Access Grid scene, and user-friendly tools to diagnose PIM-SM faults would benefit from improvement.

Sandwiched between the ACE platforms and the network technologies are various breeds of middleware, including those for authentication (e.g. Shibboleth) and those for standardization of service presentation (e.g. web service frameworks). The new Open Middleware Infrastructure Institute, based at Southampton, seeks to become the best source for reliable, interoperable and open-source Grid middleware, ensuring the continued success of Grid-enabled e-Science in the UK. Any future work in middleware should liaise with the OMII, and be aware of JISC initiatives in this area, including the Core Middleware Programme.

### **3.3.2 Security and Authentication**

Security needs to be taken into account at the inception of collaborative environments. Security systems potentially provide Identity, Authentication, and Authorisation management, which may be coupled with confidentiality systems.

Typically, entities are issued with asymmetric cryptography-based certificates for identification purposes. The authenticity of these certificates may be guaranteed through a designated Certification Authority (CA), in the case of Public Key Infrastructure (PKI) systems, or potentially in an ad-hoc manner, as is the case with Pretty Good Privacy (PGP). Additionally, policy-based and role-based access systems may be implemented as part of the security framework to provide for more sophisticated, and potentially distributed, control over security systems. With the advent of Web Services based deployments, consideration of WS-Security and Liberty Alliance frameworks may be useful, especially as the industry moves to support the Web Service Interoperability Security profile.

Moreover, to provide for network level security, including DoS protection, consideration needs to be given to the provision and control of firewalls and proxies. The operation of ACEs over Virtual Private Networks (VPN) technologies may also provide for security in some deployments.

Generally in an ACE there are session descriptions which may be distributed to participants via some form of "venue server" or via a controlled broadcast channel such as multicast. The transport and contents of the session description may be signed and/or encrypted. The subsequent media exchange that constitutes the session may additionally be encrypted with symmetric encryption which may require dynamic key distribution and re-keying functionality.

The e-Science community has already initiated various security related activities, headed by the e-Science Security Task Force. One relevant development is the establishment of a UK e-Science CA with a number of associated Registration Authorities (RA), which may be used in securing of ACE systems.

In Access Grid X.509v3 certificates are signed by a CA and are used to identify nodes and end users. The virtual venues transport level security is handled by Globus Security Infrastructure (GSI). The certificates provide for authentication and authorisation for access to a particular virtual venue. The venue may also be configured to provide for encrypted media sessions using Advanced Encryption Standard (AES) based stream encryption.

VRVS provides username/password-based authentication, with the option of using machine IP based authentication. Additionally, secure virtual rooms are protected by passwords with an option to use Data Encryption Standard (DES) based encryption for the media.

The JISC is now investigating the use of Shibboleth<sup>15</sup> for authentication and authorisation when using JISC services. Shibboleth provides a framework in which authentication is devolved to the users host organisation. Shibboleth provides a model where authorisation can be based on what you are rather than who you are, in that the service has an opaque identifier which can be used to query a database of user attributes without the service necessarily knowing the identity of the user. This allows for pseudonymous use of services (in that the user is anonymous, although can be tracked, but only with the combined co-operation of both the service provider and the user's host institution).

Some 50% of the 20 or so recently funded JISC Core Middleware projects include some consideration for Shibboleth. It is expected that reasonably widespread use of Shibboleth could emerge in UK academic environments by 2006-07. Thus consideration for Shibboleth authentication and access control in ACEs is an important issue.

### **3.3.3 Software Applications**

Software applications assist collaborative processes in a variety of different ways. There are applications that aid document creation or modification between multiple authors. Some of these provide shared repositories for documents (e.g. Wikis<sup>16</sup>); others help with multiple users editing the same documents and deal with issues such as version control and annotation (e.g. Chandler<sup>17</sup>).

Interesting examples of other projects that work to improve the collaborative experience are:

- BuddySpace<sup>18</sup>, which aids communication between users by providing an advanced contact list that includes the availability status of colleagues
- Compendium<sup>19</sup>, which is an advanced agenda and minuting tool that supports the whole workflow in the form of a 'visual map'
- Blogs<sup>20</sup>, which enable users instantly to publish web content from any web browser in a similar way to message boards, but are easier to use and read.

One large area of work is in Collaborative Virtual Environments (CVEs), where people meet and interact with others, agents, or virtual objects. CVE research encompasses 3D graphical spaces and the use of avatars (virtual representations of participants), but also 2.5D, 2D and text-based environments. The promise of CVEs in the future covers their instantiation on desktop devices, mobile or wearable devices, public kiosks, immersive virtual reality interfaces, and the mixing of avatars and video technology. The aim of CVEs is to provide a rich 'virtual reality' environment for collaboration.

A basic yet effective working categorisation has been made within CSCW between synchronous technologies (those that support real time communication and

coordination of activities) and asynchronous technologies (where communication is not immediate). Access Grid - usually used for synchronous communication - could also support asynchronous distributed communication if it were to provide different resources for collaboration where participants are not communicating at the same time or space. The Access Grid might prove most useful in asynchronous scenarios where resources used in collaborations are information-rich materials such as video data or presentations of graphs, lab books, and photographs to academics or the public (see particularly FXPAL – Fuji Xerox Palo Alto Labs<sup>21</sup>). Enabling this requires functionality not yet fully developed such as archiving, indexing and segmenting of video, audio and other streaming data.

### 3.3.4 Hardware Applications

Hardware can also be enlisted to aid the collaborative experience and there is an increasing amount of research and products available in this area.

One persistent problem is in the distribution of presentations and other software applications to remote videoconferencing facilities (also known as the 'display push' problem). A number of *software* solutions are in use, including (for Access Grid) Distributed PowerPoint, InSORS IGPIX and VNC. However, each of these has its drawbacks, associated with resolution, refresh rate and supported features. The TeraVision<sup>22</sup> project and NCAST Telepresenter<sup>23</sup> both offer hardware solutions whereby the user plugs a laptop or other computer into a specialised box that pushes the entire display across the network. These overcome many of the drawbacks of their software counterparts and provide a higher quality experience, but are more expensive and, in this case, place a heavy burden on the network due to the large amount of data transferred. Hardware solutions come with their own associated issues, such as storage.

Some projects have examined the integration of specific pieces of hardware into distributed collaboration scenarios. The ICWall<sup>24</sup> project has developed a 'collaborative blackboard' that outputs specialist equipment such as electronic whiteboards to Access Grid users. Microsoft has integrated notepads within its ConferenceXP research project to enable students to interact with lecturers, for example to enable them to ask for clarification on certain points the lecturer may make.

Another area of research is in the participation in distributed meetings from handheld devices such as PDAs. These offer the opportunity to enhance and personalise the meeting experience. For example, Motorola<sup>25</sup> are working on services for PDAs that include chat functionality and speech to text translation.

A major focus of research and development has been in the support of face-to-face collaboration. Due to difficulties experienced by users in doing productive work through these systems, there have been growing efforts to support collaboration using the materials and resources that people commonly employ doing their work. This has included supporting variable and multiple accesses to other domains. These types of systems have often required multiple cameras to show people, objects and documents relevant to the meeting. As there is more than one camera, some control mechanism needs to be determined to select which cameras are variable and which are fixed as well as enabling users to switch flexibly between different views. Other research has

extended this further by examining different ways to point or gesture into remote domains such as lasers or projected images. Ambitious extensions to this work include using robot proxies, which provide video, audio and other capabilities such as pointing<sup>26</sup>.

### 3.3.5 Studies of Technology Uses

It is generally recognised in the CSCW and CSCL communities that there is often a lack of extensive user assessments and evaluations of collaborative technologies. Whilst there have been some assessments that focus on the technical aspects, difficulties in using these systems often reflect organisational and social deficiencies. Evaluating systems at distributed sites with multiple users can be extremely complex and demands thorough and systematic analyses. Some progress has been made within CSCW for example, but for e-Science applications we need to take the matter of evaluation seriously, and investigate systematic and detailed approaches to future studies in the field.

Extensive studies have been conducted into different aspects of video communication, though many of the technologies have not enjoyed full bandwidth for distributed communication and often comprise communication across two sites using analogue. Assessment has concerned investigation of such technical concerns as frame rates, and results have been equivocal. In general it has been very hard to ascertain the advantages of video communication. If as one study states<sup>27</sup>, 80% of communication is conducted though visual contact, we would expect a significant improvement in such matters as the time taken to do a task, or a reduction in the number of errors. However, there has been very little evidence of this in terms of quantitative measures. Investigations into the use of video as a resource for collaborative work that draw upon qualitative measures also conclude that there is no significant advantage. The main findings of such studies state that it may not be appropriate to focus video mediated communication on the notion of informal or face-to-face communication. Rather, there should be strong integration with the resources and artefacts that people use in collaborative work, such as documents and computer screens<sup>28</sup>.

E-Science provides the opportunity for moving to Access Grid technology where the focus for research should be on more than simply providing support for shared meetings. We need to support flexible and seamless access to the materials that scientists use as resources for collaborative work. In order to determine what such resources may be, we need to conduct systematic studies into the *in situ* assessment and evaluation of both current Access Grid technology and emerging development prototypes.

## 3.4 Discussion

This report makes much mention of the Access Grid, but there is a diverse set of applications and technologies available beyond the Argonne product. Work done to improve technologies already in use, such as the improvements of audio and video in Access Grid, will clearly be of benefit to users. Rollout strategies for these technologies are not trivial, although this could be a useful role for the new Access Grid Support Centre. However, it is more difficult to see obvious benefits in some of the other technologies examined above. Users will tend to pick available technologies

off the shelf to meet a need, sometimes to plug a perceived gap in a particular technology (e.g. using Jabber alongside Access Grid).

It is unclear whether lessons are being learned - there are many instances (e.g. in CSCW) of technologies looking for an application. Extended studies of end-user experiences using the technologies would be extremely beneficial, but are currently rare. This would help with the gap analysis and also in identifying where integration of systems would be most beneficial. The Access Grid has been successful in the UK because a community (e-Science) adopted it, on the back of growing worldwide adoption. However, our survey shows that the end sites and users feel the AG is not as robust as it should be, and there is room for improvement in areas including fault diagnosis.

The Access Grid has some growing pains. As it evolves to AG 2, it has become more complex, and as a result many sites are hesitant to upgrade from AG 1. Some of the complexity can be eased by developing new tools, e.g. to automate QA tests on sites, or to allow remote management of AG nodes by remotely located experts (rather than requiring immediate operator presence). There is an opportunity for the UK to assemble a lightweight, interoperable tool or system to be built from existing components to allow sites to more readily take part in ACE sessions which may or may not include other AG sites. Similarly, adaptation and mediation tools that may allow devices such as PDAs to be used in Access Grid and other CSCW environments would be highly beneficial.

Some of the existing gaps are known. It would be very useful to have additional tools integrated, e.g. to know who wishes to speak next, to point at virtual resources, or to distribute shared files (often MS PowerPoint slides). Provision of such components could all be improved through research and development effort.

From existing literature in CSCW, CSCL and groupware, this report has identified a variety of applications ranging from those that support groups by asynchronous distributed collaboration through to those that support synchronous communication. The type of communication being supported within these applications may range from those that are categorised as unfocussed (face-to-face support) to those that have more focussed communication (around a document). These applications can also vary in the types of objects that are being shared by participants that could include shared documents, graphics, or visualizations of data.

At present it is unclear how various features ought to be combined to support collaborative distributed or co-present scientific work. Though studies have been conducted in other domains, we believe there is a need to carry out focussed studies in order to understand the demands of information rich and complex work settings such as those characterised by, but not limited to, e-Science. We need to understand how to bring heterogeneous resources together to support scientific collaborative work, using different materials at different times supporting different forms of access. These resources may be provided through combinations of audio, video and/or computational capabilities, and they may be fixed or archived. Infrastructures should allow developers to combine various resources to allow for experimentation with different combinations in order to determine which scientific activities to support.

Another point of concern is the issues surrounding the large number of virtual communication systems that are emerging. Different software projects, standards and research groups make use of different collaborative software, many of which perform similar roles. If an individual is involved with more than one of these groups, then they may have to install and use many software tools in order to join or work with each community. Tools such as Microsoft Messenger, AOL Instant Messenger, Skype, IRC, VNC, Blogs, and so on are all in use by different research and project groups. Although there are moves to develop an instant messaging standard<sup>29</sup> and there are some clients available that can handle multiple protocols, there remains a need to register separate accounts with each product, often with different (but similar) contact addresses.

It is important that new tools are embraced where appropriate. Skype is an example of a particularly successful recent innovation. It is likely that we will also see new peer-to-peer based systems being used for collaborative working, but this will require understanding of how decentralized systems will function, e.g. for service discovery. Underneath the applications, new emerging middleware (e.g. Shibboleth, and web service frameworks) and network technology (e.g. IPv6, and source specific multicast (SSM)) will have implications for the potential services.

As the number of potential tools grows more diverse, systems integration is, and remains, a critical issue. The systems must be scalable, robust and easily managed. The use of open, interoperable standards-based tools is highly desirable. Understanding the most optimal way to utilize such tools is a challenging task that needs further research, led by analysis of end user requirements and current patterns of use.

## **4 ACE User Surveys**

### **4.1 Introduction**

A key component of our work was to survey existing users of ACE technologies with the intent of eliciting their views on those technologies and their thoughts about current deficiencies and their ideas for future enhancements. The target user base for our survey is focussed on users of Access Grid and H.323 videoconferencing.

We also summarise the findings of the VRVS user survey and a survey of first time Social Scientist Access Grid users that was conducted by the Fast Track project to feed into the National Centre for e-Social Science (<http://www.ncess.org/>).

We had no intention to generate statistical support for specific hypotheses; we were interested in locating all valuable opinions, even if held by a single user, if this could help the enhancement of ACEs in the future. Our analysis as presented in this chapter is therefore designed to support that aim.

### **4.2 Questionnaire Structure**

The questionnaire was presented as a stand-alone document and as a web form. In almost all cases, the users that responded used the web version. The questionnaire is reproduced in Appendix C.

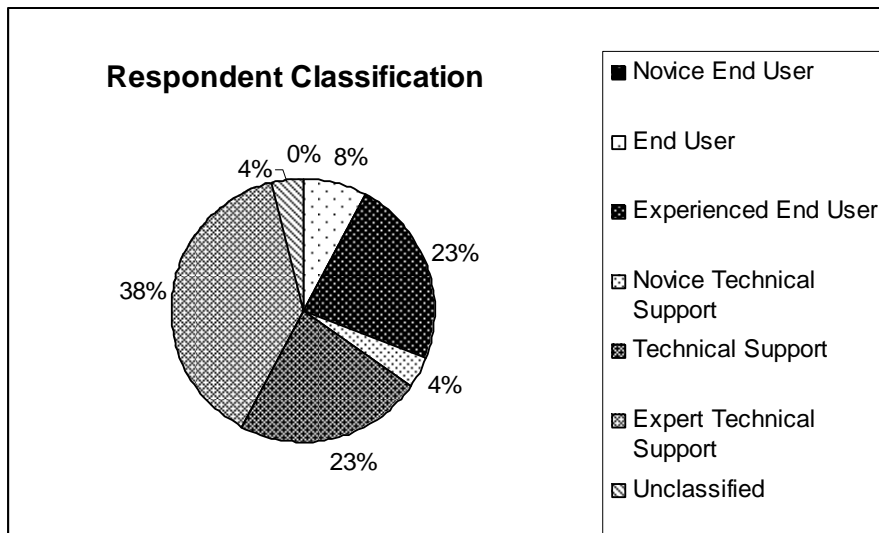
The questionnaire was in multiple sections: section one elicited user identification; section two gathered a record of how often respondents have used a variety of ACE technologies within the last year; section three gathered their opinions on an identified ACE technology (respondents were asked to complete one copy for each ACE technology they had used); section four asked for their overall views of ACE technologies in general and any specific ideas that could lead directly to future UK R&D projects in the area; section five gathered factual details of any ACE environments they had used (respondents were asked to complete one copy for each technology). The questionnaire had 36 main questions.

Users were asked to complete as many sections of the questionnaire as they felt able and to leave blank any sections where they did not have information, opinions, experience or resources for full completion. A partial answer with good ideas and observations was more important to the project than rejecting an incomplete response. Because of the partial answers, the analysis below does not always tally to the same total. Although the users targeted were Access Grid or H.323 users, some report experience of VRVS and three had comments on use of H.320 technologies.

### 4.3 Section 1 – Respondent Classification

The respondents were asked to classify themselves into the six classes shown in the table below.

User Type	Number	%	User Type	Number	%
Novice End User	0	0%	Novice Technical Support	1	4%
End User	2	8%	Technical Support	6	23%
Experienced End User	6	23%	Expert Technical Support	10	38%



Although this appears to show that more respondents were "technical staff" than "end users", the answers make it clear that, in almost all cases, technical staff responded based on their own usage of the technologies rather than as supporters of usage by others. One respondent did not classify themselves. In total, 26 responses were received.

### 4.4 Section 2 – Overall ACE Usage

#### 4.4.1 Types of Usage

Respondents were asked to classify their use of ACE technologies during the last 12 months against ten areas as shown in the table below.

Usage Area	Number	Usage Area	Number
Research	22	Project Meetings	21
Teaching	11	Informal Discussions	18
Administration	14	Artistic Events	1
Commercial Discussion	6	Viewing Seminars	12
Management Meetings	18	Other	2

#### 4.4.2 Amount of Usage

We asked respondents to indicate the numbers of times that they had used a number of types of ACE technology over the last year and the replies were as shown in the following table.

ACE Technology	Number of users of this technology	Number of users as a % of those responding	Minimum number of sessions per user	Maximum number of sessions per user	Average number of sessions per user
Access Grid	19	73%	2	60	17
VRVS	7	27%	1	20	6
H.323	11	42%	1	20	5
H.320	11	42%	1	20	8
Other	4	15%	2	20	12

The answers indicate that respondents who use Access Grid use it more often than the those respondents who use other collaborative technologies. It is interesting to wonder why this might be the case, but that issue has not been explored further. The "Other" usage was in general some variant of the main classes, although one respondent reports "Multi-user Virtual Environment with embedded video (MASSIVE-3)<sup>30</sup>".

#### 4.5 Section 3 – User Opinions on Specific ACE Technologies

As mentioned above, we asked respondents to complete a separate copy of section 3 for each ACE technology that they had used.

#### **4.5.1 Opinions of H.323 Based Systems**

Eight respondents have given us further information and opinions in this area. The respondents report that sessions using H.323 lasted between one and three hours with the average being 1.5 hours.

In general, they all reported that the technology was easy or not too difficult to use with only one user reporting it as "took a long time to settle". Some commented that they were more aware of "body language", including their own as they appeared in confidence monitors, than they might have been in a face-to-face meeting. Many reported that "audio latency" led to some problems and a difficulty to interrupt others in a meaningful way. Some also commented negatively about voice activated video switching and the possibility of "forgetting" about some quiet sites in a multi-site session. One user mentioned the idea of having mechanisms so that someone wishing to speak can "raise their hand" in a technology assisted way. The authors are aware of at least one web based ACE system, CENTRA<sup>31</sup> in which buttons are provided on the user interface so that others or a chairman can become aware of a user's desire to speak.

As their experience of the H.323 technology has grown, respondents have become more relaxed in its use. All users described the typical user interface as acceptable or very intuitive.

When asked about what most impressed them with the technology, respondents commented on the ease of use and the fact that it was now readily available at the sites of most of their collaborators. When asked about what least impressed them, one respondent commented on the need for wired control pads to become wireless, some commented on the difficulty to interrupt a conversation and others commented that it did not really handle multi-site sessions well. The general need to handle data sharing and Microsoft PowerPoint slides out-of-band was also criticised. The documentation available was rated as fair to good with only one user noting it as excellent.

In the answers to the question "What aspects of this technology would you like to see improved?", two respondents selected documentation, four selected the user interface, four selected collaborative tools and three selected tutorial provision.

Overall, it appears that many of the replies identify improved collaboration tools and a better level of integration of those tools into the general H.323 framework as the things that most need addressing.

#### **4.5.2 Opinions of Access Grid Based Systems**

16 respondents have given us further information and opinions in this area. Respondents report that sessions using Access Grid lasted between one and four hours with an average being two hours, some 30 minutes longer than that reported by H.323 users.

In general, the majority reported that the technology was easy or not too difficult to become accustomed to, although three users reported that it "took a long time to settle" and balancing that, three also said it "felt natural". Almost all respondents reported that "long audio latency" led to some problems and a difficulty to interrupt others in a meaningful way. Many also commented on a need to speak more clearly

than would normally be the case. The Access Grid users placed slightly more emphasis on audio issues and problems than did the H.323 users. No one at all reported their view of the technology changing due to increased familiarity.

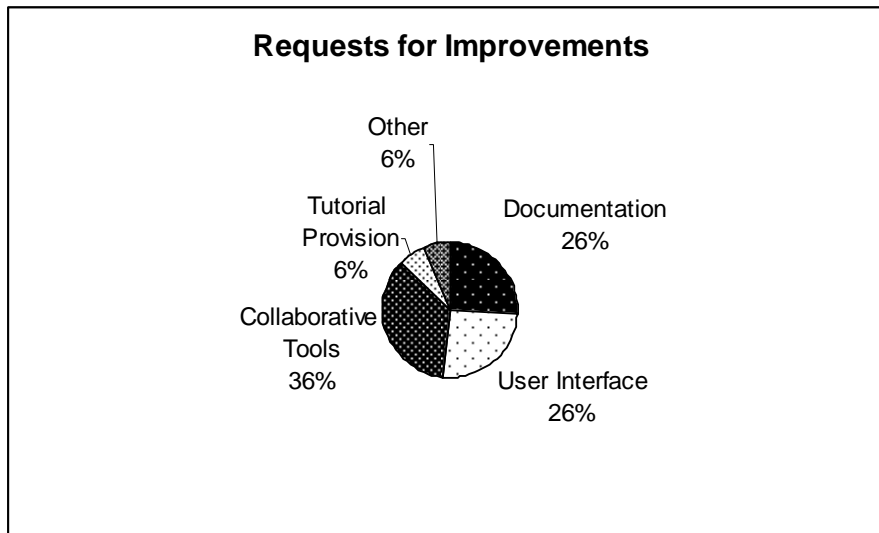
Opinions of the user interface were very mixed. Four respondents said it was "not intuitive", nine (the majority) said it was "acceptable", three "very intuitive" and the other three Access Grid users did not answer this question. It should be noted that there are a number of different user interfaces available for use that are known to have different levels of usability. There are some anecdotal reports that the research software (especially the earlier version – AG1) is generally considered to be less usable than commercial software available from inSORS. This may help explain the variation in the responses, but our sample size is too small to provide any real evidence to support or deny those anecdotal reports.

<b>Interface Usability</b>	<b>No Response</b>	<b>Not Intuitive</b>	<b>Acceptable</b>	<b>Very Intuitive</b>
Access Grid, version unspecified	3	2	4	0
Access Grid PIG	0	1	1	0
Access Grid 1	0	1	0	1
Access Grid 2	0	0	1	1
InSORS	0	0	3	1

When asked what most impressed them with the technology, many commented on the general audio/video quality and said that it was "better than ISDN" (this is perhaps surprising considering the negative comments mentioned earlier). Others commented on the ability to handle multi-site events well and liked the use of large screens in Access Grid studios. Several commented on savings in time and money by avoiding the necessity for travel. One noted the "amount of bandwidth it consumed" as the thing that most impressed!

When asked about what least impressed them, several important issues were raised. Many respondents commented that in general Access Grid studios were not yet "ready to be left unsupported" and many commented negatively about the general need to have to provide operator cover. One commented on the need for hand placement of video windows on screens. Several respondents commented about instability and reliability glitches. Some respondents have commented that the presence of a node that has bad audio quality has the ability to adversely affect audio quality for the whole session. Some commented that the current software is basically just a collection of pre-existing pieces of software with the implication of a lack of integration of the overall environment. Some negative comments were made about the provision of solid and reliable multicast provision in the UK that is deployed to reach all end users. The documentation available was rated as fair to good with only one user noting it as very good and one as poor.

The answers to the question "What aspects of this technology would you like to see improved?" eight respondents selected documentation, eight the user interface, eleven collaborative tools, two tutorial provision and two selected "other". Looking at the "other" answers, two answers referred to the need for better tools to present slides etc and improved support for remote windows. The final "other" answer commented that the user interface should be made more intuitive so that there was less need for users to have to consult documentation.



Based on responses, it appears that the issues most needing addressing are improved collaboration tools, including improved slide presentation tools and an improved user interface that looks less like pre-existing tools badly glued together.

#### 4.5.3 Opinions of H.320 and VRVS

The small number of answers addressing these technologies raised only one issue not covered above, namely the shortage of UK-based VRVS reflectors. It should be noted that another report in this series has recommended that the Access Grid Support Centre should host a VRVS reflector.

## 4.6 Section 4 – Overall views of ACE Technologies in General

### 4.6.1 Usage of ACE-related Tools and Technologies

This section commenced by asking the respondents whether or not they had used any tools and technologies from a fairly long list. The results are summarised in the table below.

Tool Name	Number	%	Tool Name	Number	%
Distributed Powerpoint	13	50%	VNC	14	54%
Debugview	0	0%	Webcasting	1	4%
Telephone Conferencing	7	27%	Blogs	1	4%
Wiki	7	27%	InSORS	5	19%
IGPix	3	12%	EQUIP	1	4%
ICENI	1	4%	CoAKTing	0	0%
Microsoft Messenger/Netmeeting/Chat	5	19%	AOL Instant Messenger	2	8%
IRC	5	19%	MUDS	5	19%
ICQ	2	8%	Other	4	15%

It is possible that some respondents who selected "Distributed PowerPoint" really meant they had used PowerPoint as a general component of a distributed session rather than the specific tool that carries that name. The use of VNC to gain control/view of the screen of a remote participant in a session appears to be quite common and valuable. Analysing the four answers of "Other" given above, shows that three are in essence equivalent to other items mentioned above, the other notes "Collaborative visualization tools – IRIS Explorer<sup>32</sup>".

We then asked whether the respondents had developed any collaborative tools of their own. One responded noting Massive-3, mentioned earlier, another commented on web interfaces to existing tools and another on distributed collaborative tools. Some respondents commented that they had produced modified interfaces to the existing multicast tools.

### 4.6.2 Specific Ideas for Future Funded UK R&D Projects in the ACE Area

The questionnaire had one full page question inviting respondents to put forward any ideas they had that could lead to future funded UK R&D effort in the area of ACEs. A wide range of responses were received with some respondents providing significant numbers of ideas, others offering none. A number of themes can be located running through the responses.

1. Improved inter-ACE features. Several users commented on the need for different ACE technologies to be able to inter-work. Real needs were identified for users of one technology to be able to interact in a meaningful manner with sites equipped with different technologies. One user commented on the need to develop collaboration tools that are independent of the ACE technology being used. Another user noted the need for studios to be equipped so as they are able to use multiple ACE technologies as being another solution to the same problem.
2. Improved robustness and stability in Access Grid tools.
3. Improved audio quality in both tools and installations.
4. Development and deployment of automated test tools.
5. Improved support for tools enabling desktop sharing and remote access to programs.
6. General improvement to collaboration tools.
7. Improved tools to enable collaborative visualization.
8. Improved documentation.
9. Various network related problems were noted by respondents. The need for better provision of multicast IP, improved network Quality of Service and general availability of high bandwidth connectivity being noted by several.
10. ACE access should be available integrated within web portals and others suggested more use of streaming webcasting.
11. Institution support was sometimes less than ideal, e.g. rooms made available for Access Grid studios were often too small.
12. An initiative to encourage the use of ACE technologies in teaching was suggested.

## **4.7 Section 5 – Technology Configurations**

The final section of the questionnaire attempted to capture details of the hardware and software deployed as part of ACE nodes in the UK. Respondents were asked to complete multiple copies of section five, one for each technology they had used.

### **4.7.1 Access Grid Configurations**

Twelve respondents reported having Access Grid studios, two reported use of personal Access Grid nodes (PIGs) and one reported a hybrid node. The nodes were of various ages, the earliest was reported as having been installed in June 2001 and the most recent being installed at the time of the response. In three cases the node had been installed by end users, in seven cases by a local technical support team and in four cases by a commercial installer, namely inSORS.

The nodes were based on a variety of operating systems: RedHat Linux versions 6.2, 7.3, 8 and 9; and Microsoft Windows NT, 2000, XP and XPPro. The Access Grid software used was AG1, AG2.1, Rat/Vic and inSORS.

Respondents were asked to tell us about the numbers of AV input and output devices in use. Sites reported different numbers of cameras in use, from one to ten; three or four were most common. Only one site reported having a document camera and one noted the availability of a digital whiteboard. The number of simultaneous video streams transmitted typically matched the number of cameras connected. Sites varied as to whether local display of video was via monitor or projector, the most common configuration being three projectors. Audio was typically captured via multiple microphones with most people reporting the use of Gentner/Clearone echo cancellers. Other cancellers mentioned included Audio Technica and Polyspan. In almost all cases, speakers were used to access incoming audio.

Some nodes were reported as only being used once per week, whereas at the other extreme, one was reported as being used 15 times a week. The average usage reported was 4.5 times per week. The number of users attending each session varied from one to ten people, the average being three. In most cases the node was bookable and available to researchers, the department and the institution with only a small number allowing access by students or the public.

When asked about difficulties faced when getting their Access Grid ACE commissioned, the answers given were as shown in the table below.

<b>Issue</b>	<b>Number</b>	<b>%</b>	<b>Issue</b>	<b>Number</b>	<b>%</b>
Persuading network administrators	3	16%	Persuading peers	1	5%
Network problems (e.g. multicast)	11	58%	Acoustics	3	16%
Background lighting	5	26%	Other	5	26%

We think it is very clear from this that network issues is by far the biggest difficulty facing people who wish to install Access Grid nodes. The main "Other" issues raised were the availability of suitable rooms and access to funding. Two of the "Other" replies were in essence yet more reports of network related problems. Overall, the users were split with six saying that installation had been difficult and seven saying that it was not.

In terms of on-going maintenance of Access Grid nodes, four end users reported that they were responsible; in nine cases a local technical support team was responsible and in just one case a respondent reported an outside contractor was responsible. Nine respondents reported that network resources associated with the node were monitored and five that they were not.

On the issue of node operators, seven reported that operators were in attendance or nearby with eight reporting that operators were not used to support user sessions.

#### 4.7.2 H.323/H.320 Configurations

Five respondents reported having H.323/H.320 studios; just one reported use of a personal H.323 node. The nodes were of various ages, the earliest was reported as having been installed in June 1999 and the most recent being installed in August 2002. In two cases the node had been installed by end users, in four cases by a local technical support team.

The nodes were in most cases proprietary with Polyspan, Tandberg and PictureTel being mentioned. Microsoft Windows 98 and 2000 were reported as being components of some nodes as was RedHat Linux 9.

Respondents were asked to tell us about the numbers of AV input and output devices in use. Sites reported a range of numbers of cameras being connected, varying from one to four, with one or two being the most common answers. Five sites reported having a document camera and two noted the availability of PC input. The number of simultaneous video streams transmitted was typically one, although one site reported the number as four even though they did not have that many cameras. Sites varied as to whether local display of video was via monitor or projector. Most sites had just one monitor or projector, although some reported two or three. Audio was less clearly described by respondents, most commenting that multiple microphones were used via echo cancellers within the main VC system. In all cases speakers were used to access incoming audio.

Some nodes were reported as only being used two or three times per week, whereas at the other extreme, two nodes were reported as being used 20 times a week. The number of users attending each session varied from a single person to eight people, the average being about four. In all cases the node was bookable and normally available to researchers, students, the department and the institution with only three reporting it as available to the public.

When asked about difficulties faced when getting the ACE commissioned, the answers given were as shown in the table below.

Issue	Number	Issue	Number
Persuading network administrators	0	Persuading peers	2
Network problems (e.g. multicast)	0	Acoustics	1
Background lighting	3	Other	0

We think it is very noticeable that "Network problems" was reported as zero in stark contrast to the answers given and reported earlier for Access Grid users. Overall, the users all reported that installation had not been difficult.

In terms of on-going maintenance of H.323 nodes, one end user reported they were responsible, and in six cases a local technical support team was responsible. Four respondents reported that network resources associated with the node were monitored but their answers in general indicated that this was at the "booking system" level rather than at the level of traffic on the wire.

On the issue of node operators, two reported that operators were in attendance or nearby with four reporting that operators were not used to support user sessions.

#### **4.8 Overall Conclusions from Survey**

We believe that some important issues have emerged from our analysis of the answers to the survey questionnaire. We briefly summarise these below. As noted earlier, our analysis is based on a small sample of only 26 responses and thus we do not attempt a formal statistical analysis.

1. There is a demand for improved tools to support data sharing and the collaborative operation of software and computer desktops within ACE sessions.
2. There is a demand for interoperability between different ACE technologies.
3. Access Grid is perceived as being less robust and stable than is required by the users.
4. Network difficulties are still reported as a major challenge for those installing Access Grid nodes while not being a problem for users of H.323. This in almost all cases comes down to the support of multicast IP, not only in the core JANET network, but right to the desks of end users.
5. The handling of multi-site conferences is currently less than ideal. With voice switched systems (common to H.323), users reported it was easy to forget quiet sites and quite hard to interrupt. While users liked the simultaneous display of multiple sites with Access Grid, they reported the problem of knowing who was speaking and problems in being able to interject. Improved "chair control" coupled with visual indications of the current talker (perhaps highlighting window borders) and technological assistance for "raising one's hand" could all assist in this area.
6. A possible, technically exciting, area for future R&D activity would be that of developing good support for distributed collaborative visualization systems.
7. The audio quality of some Access Grid nodes, typically the smaller nodes, is sometimes not as good as might be desired. Automated audio self testing systems might be another area for R&D activity.

## **4.9 VRVS Survey**

The VRVS support team recently solicited feedback from their user community via a web-based form. This survey<sup>33</sup> concentrated on the usability of the VRVS system and had 800 responses. The presentation of the results covers the following subjects: what users like best about VRVS, frequency of use, ease of use, relative importance of features, quality and reliability, and whether users intend to use VRVS in the future.

### **4.9.1 What users liked about VRVS**

According to the survey, users like:

- The availability of VRVS on multiple platforms (particularly Mac OS X)
- Ease of scheduling meetings
- That it works well for frequent users and is 'robust in mixed environments'
- Its ability to work transparently with Network Address Translation (NAT<sup>34</sup>) boxes, which provides a type of firewall
- That it is free to use.

### **4.9.2 Ease of use of VRVS**

Ease of use was split into the categories: application sharing, connecting cameras, connecting microphones, scheduling meetings and joining conferences.

- 28% found application sharing easy or very easy, 10% hard or very hard
- 58% found connecting a camera easy or very easy, 8% hard or very hard
- 71% found connecting a microphone easy or very easy, 7% hard or very hard
- 63% found scheduling a meeting easy or very easy, 3% hard or very hard
- 79% found joining a conference easy or very easy, 4% hard or very hard.

### **4.9.3 Importance of VRVS features**

96% of respondents said that the audio component was extremely or very important; 70% said that the video component was extremely or very important. The responses for application sharing and chat were evenly distributed across the scale from extremely important to not important at all.

### **4.9.4 Quality and Reliability**

For video quality, 61% were very or somewhat satisfied; 12% were somewhat or very dissatisfied. For audio quality, 68% were very or somewhat satisfied; 14% were somewhat or very dissatisfied. For overall reliability, 66% were very or somewhat satisfied; 15% were somewhat or very dissatisfied.

62% of respondents said that they would definitely use VRVS again, and 31% would probably use it again.

## 4.10 Access Grid in e-Social Science Survey

Another survey by the Fast Track project, which is producing teaching and learning materials on e-Science for the Social Science community, examined participants' views of a single Access Grid event. In January 2004, the Access Grid was introduced to a section of the social science community. It was used to deliver a session in a series of ESRC Research Methods events – *Exploring the tension between privacy and the social benefits of government databases*, a virtual discussion meeting, which was led by Professor George Duncan of Carnegie Mellon University. The meeting took place over Access Grid and was hosted by the University of Manchester, University of Southampton, Imperial College London and Pittsburgh Supercomputing Center (from where George Duncan presented).

Although this survey is based on a single Access Grid session, the results are nevertheless an interesting and illuminating insight into participants' experiences of the technology.

The full version of this survey is available at [http://www.ncess.org/docs/access\\_grid\\_survey\\_rpt.doc](http://www.ncess.org/docs/access_grid_survey_rpt.doc).

### 4.10.1 Respondents

There were 28 audience members in the session, all of whom completed feedback forms. Sixteen (57%) of these were in Manchester, seven (25%) were in Southampton and five (18%) were in London.

### 4.10.2 Audio Quality

Overall, most respondents seemed satisfied or better with the audio quality - almost everyone indicated that they could hear the primary participants very well. However, a less satisfactory score was achieved when respondents were asked how well they could hear other audience members, meaning that more care should perhaps be taken in microphone placement, ensuring that participants are aware of the need to speak into a microphone, or better quality microphones that have wider coverage.

### 4.10.3 Video Quality

Although responses were still largely positive, overall, respondents were less satisfied with the visual aspects of the session as opposed to the audio. There was also a difference in responses depending on the participants' site. This data suggests that there were problems with seeing remote participants, regardless of site. (Although one response showed that the Access Grid technology enabled the audience in London to have a better view of one of the speakers from 200 miles away than those who were seated only a few feet distant.)

### 4.10.4 Participant Interaction

People generally found it easier to interact with participants at their own site rather than at remote sites. The majority of respondents said that they behaved differently because the session was over Access Grid as opposed to face-to-face. Almost half of the respondents who gave reasons why they behaved differently said that this was because they weren't used to the technology or because they felt self-conscious.

#### 4.10.5 Impressions of Access Grid

100% of respondents replied that they would use it again for a seminar and 96% (all but one) would use it again for other purposes.

36% of respondents were most impressed by the fact that multiple sites were involved in the session and that all participants were able to be seen simultaneously with PowerPoint slides. 21% were most impressed by quality of the audio and 14% by image quality. Other notable responses included:

- "Close replication of a face to face seminar..."
- "Substantial improvement over videoconferencing"
- "It was possible to ignore the technology"
- "People seemed relaxed"

As to the opposite question "What *least* impressed you about the Access Grid technology in this session?", some generalisation of the responses was possible. 32% drew attention to technical hitches, which delayed the start of the meeting slightly. 25% of respondents were least impressed by image quality, mostly to do with picture update, latency and lag. 14% noted that it was difficult to see who was talking – "had to scan a range of images" one said. Other notable responses included:

- "A lack of...familiarity means we don't know how to behave – soon learnt"
- "Disability/access issues"
- "Individual visual contact not too good"

## **Appendix A - Useful Sources of Information**

The following are some of the sources of information used in the production of this report that may be useful to others.

- Workshop for Advanced Collaborative Environments (<http://www-unix.mcs.anl.gov/fl/flevents/wace/index.html>)
- Access Grid Retreats and Tutorials proceedings (<http://www-fp.mcs.anl.gov/ag/events.htm>)
- Workshop on the Technical Underpinnings of Collaboration (<http://scienceofcollaboratories.org/Workshops/WorkshopJuly192001/index.php?TechFinalSummary>)

## Appendix B - Unreferenced Collaborative Technologies

This Appendix is an incomplete list of collaborative technologies found during research for this report, but not specifically referenced in the text.

- **Access Grid on PDAs** (<http://www.evl.uic.edu/intro.php3>). Research into implementing Access Grid on PDAs. For more information, contact Jason Leigh ([spiff@evl.uic.edu](mailto:spiff@evl.uic.edu)).
- **ARTICIEL** (<http://www.teleinfo.uqam.ca/darwin/english/accueil.htm>). Tool to aid graphic artists to collaboratively build 3D characters.
- **CHEF** (<http://chefproject.org/index.htm>). The CompreHensive collaborative Framework (CHEF) initiative has as its goal the development of a flexible environment for supporting distance learning and collaborative work, and doing research on distance learning and collaborative work. CHEF is an on-line service that supports working communities; communities of scientific researchers, communities of teachers and students, people who work together in person as well as those who are geographically separated. CHEF is used to access computing facilities, to share resources, to communicate, to facilitate meetings, to work together. CHEF is accessed through the web. Many Portal Pages will be created in a CHEF site. Portal Pages are collections of tools configured into sets of layouts. Each user has a personal "workspace". Each group (workgroup, class, etc) has a shared "worksite". Both workspaces and worksites are portal pages.
- **Collaboratory for Multiscale Chemical Science (CMCS)** (<http://cmcs.org>). A data-centric collaboration environment that supports data provenance tracking, metadata extraction, data translation, etc. with collaborative tools such as chat, shared task lists, lightweight integration APIs, etc. CMCS uses Scientific Annotation Middleware (<http://www.scidac.org/SAM/>) and CHEF (<http://chefproject.org/index.htm>).
- **Confero** (<http://confero.alkit.se/>). An IP based real-time conferencing and collaboration software suite supporting audio/video teleconferencing, application sharing, text messaging, remote camera control, and multimedia streaming from servers.
- **Marratech Work Environment** (<http://www.marratech.co.uk/>). A collaboration/conferencing environment to help groups of people communicate, collaborate and manage information from their computers. It offers a secure environment where members can share video and audio as well as share information, pictures and MS Office documents.
- **ReDRess** (<http://redress.lancs.ac.uk/>). The main aim of the project is to raise awareness and accelerate the development of a computing and data infrastructure to support the increasingly national and global collaborations emerging in social science. Other aims of the project are: to stimulate the

uptake of e-Social Science methodologies and technologies in the social sciences; support the increasingly national and global collaborations emerging in many areas of social science. The project will also develop a web portal, which will be the main environment and mechanism for delivery of material to end users, utilising Sakai and Chef.

- **Sakai** (<http://www.sakaiproject.org/>). An enterprise services-based portal, a course management system with sophisticated assessment tools, a research support collaboration system, a workflow engine, and a tool portability profile. Used as standards for writing future tools that can extend this core set of educational applications.

## Appendix C – ACE Survey Questionnaire

### Purpose of this Survey

The term Advanced Collaborative Environment (ACE) is used to describe technologies that enable users to collaborate where they are remote from each other.

This survey questionnaire is intended to capture the views and experiences of users and operators of ACE technologies such as: Access Grid, VRVS, and H.323. We wish to capture views concerning the usability and management of such technologies and any specific improvements that may be suggested by you. The overall results of this survey will be used to inform UKERNA and the JCSR of possible future ACE Research and Development (R&D) projects that would be suitable for UK funding.

The questionnaire falls into five distinct sections that attempt to capture end user contact information, end user views and experiences and factual details of environments, together with views of installers and administrators of ACE environments.

Please complete separate copies of sections 3 and 5 for each technology that you have used within the last year.

Please complete as many questions as you can, and feel free to ask colleagues to help complete some sections if more appropriate.

### Section 1

The purpose of this section is to capture contact information and the geographical location of your institution.

---

**Name of Institution:**

---

**Town or City:**

---

**Department:**

---

**Contact Details**

---

**Name:**

---

**Email:**

---

**Phone:**

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**Fax:** \_\_\_\_\_

**Web Site:** \_\_\_\_\_

**Which of the following describes you:**

<b>Novice End User</b>	<input type="checkbox"/>	<b>Novice Technical Support</b>	<input type="checkbox"/>
<b>End User</b>	<input type="checkbox"/>	<b>Technical Support</b>	<input type="checkbox"/>
<b>Experienced End User</b>	<input type="checkbox"/>	<b>Expert Technical Support</b>	<input type="checkbox"/>

**Section 2**

The purpose of this section is to gather information relating to the Advanced Collaboration Environment (ACE) from end users. At the end of the section you will be given the opportunity to supply additional information you feel further describes your ACE.

**Q1. What types of collaborative sessions do you have, tick as many boxes as you feel is appropriate?**

Research	<input type="checkbox"/>
Teaching	<input type="checkbox"/>
Administration	<input type="checkbox"/>
Commercial Discussion	<input type="checkbox"/>
Management meetings	<input type="checkbox"/>
Project meetings	<input type="checkbox"/>
Informal discussions	<input type="checkbox"/>
Artistic events	<input type="checkbox"/>
Viewing seminars	<input type="checkbox"/>
Other	<input type="checkbox"/>

*If you answered Other, please provide details*

**Q2. Approximately how many times have you personally used each of the following ACE technologies in the last year:**

Access Grid	
VRVS	
H.323 (Video Conferencing over IP)	
H.320 (Video Conferencing over ISDN)	
Other	

*If you have entered data into Other, please specify the ACE technology used:*

### Section 3

Please complete a separate copy of the questions within this section (Q4 to Q12) for each ACE technology that you have used during the last year.

---

**Q3. Which ACE technology does this copy of your section 3 answers refer to:**

Access Grid	
VRVS	
H.323	
H.320	
Other	

**Q4. On average how long do the sessions last?**

hours

**Q5. When you or your team first started to use this ACE facility, how easy was it for you to interact with your colleagues at the remote site(s)?**

Very difficult	
Took a long time to settle	
Not too difficult	
Easy	
Felt natural	

**Q6. If you felt that you behaved differently than you would have behaved in a face-to-face meeting, please give details:**

**Q7. If your use of this ACE facility has become more frequent, have your views on the way you behave in meetings changed?**

**Q8. What is your opinion of this ACE's user interface?**

Not intuitive	
Acceptable	
Very intuitive	

**Q9. What impresses you most about your experience with this ACE technology?**

**Q10. What impresses you least about your experience with this ACE technology?**

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**Q11. How do you rate the content quality of documentation available for this ACE?**

Poor	
Fair	
Good	
Very Good	
Excellent	

**Q12. What aspects of this ACE would you like to see improved?**

Documentation	
User interface (expert/novice)	
Collaborative tools	
Tutorials	
Other	

*Please provide details.*

--

**Section 4**

Please complete this section once to give us some of your overall views on ACE technologies in general.

---

**Q13. Which of the following tools do you use?**

Distributed PowerPoint	<input type="checkbox"/>
VNC	<input type="checkbox"/>
DebugView	<input type="checkbox"/>
Webcasting	<input type="checkbox"/>
Telephone conferencing	<input type="checkbox"/>
Blogs	<input type="checkbox"/>
Wiki	<input type="checkbox"/>
InSORS	<input type="checkbox"/>
IGPix	<input type="checkbox"/>
EQUIP	<input type="checkbox"/>
ICENI	<input type="checkbox"/>
CoAKTing	<input type="checkbox"/>
Microsoft Messenger/Netmeeting/Chat	<input type="checkbox"/>
AOL Instant Messenger	<input type="checkbox"/>
IRC	<input type="checkbox"/>
MUDS	<input type="checkbox"/>
ICQ	<input type="checkbox"/>
Other	<input type="checkbox"/>

*If you ticked Other please provide details.*

**Q14. Please provide details of any collaborative tools you may have developed.**

**Q15. Please provide details of any modifications that you may have made to existing collaborative tools.**

**Q16. We are in a position to influence funding decisions on R&D projects to improve the experience for users and operators of these types of technology. What types of projects, or specific ideas, would you like to see in our recommendations?**

### **Section 5**

This section captures information relating to the equipment used by your ACE. Please complete a separate copy of the questions within this section (Q17 to Q36) for each ACE technology that you have used during the last year. Please provide as much detail as possible for each of the ACE nodes at your location. We also wish to capture views of operators, administrators and installers of ACE facilities.

**Q17. Please give a unique identifier/name for this node:**

**Q18. Which ACE technology do your answers in this section 5 refer to:**

Access Grid Studio	
Access Grid PIG ( <i>personal desktop AG node</i> )	
VRVS	
H.323 Studio	
H.323 Personal Node	
H.320 Studio	
H.320 Personal Node	
Other	

*If you have selected Other please give details?*

**Q19. Date of Installation:**

**Q20. Who installed this node?**

An End User	
The Local Technical Support Team	
A Commercial Installer	

*If you answered commercial please provide details of company (if possible):*

**Q21. Which Operating Systems are used by this node?**

Windows:		Version	
Linux:		Version	
Other:		Version	

*If you answered Other please provide details?*

**Q22. Which Version/Model/Brand of product or software does this node use?**

**Q23. Video Transmission:**

Number of Cameras	
-------------------	--

**Q24. Do you have any other types of video capture device attached to your ACE, such as: document cameras, microscopes etc. Please provide details:**

**Q25. How many video streams do you simultaneously transmit to other sites?**

**Q26. How is your incoming received video displayed to you?**

Number of monitors	
Number of projectors	

**Q27. How is your audio captured?**

Microphone model		How many	
Echo cancellation model			

**Q28. What method do you use for audio output?**

Speakers	
Headphones	
Both	

**Q29. How often is this Node used?**

**Q30. On average, how many participants attend the local site?**

**Q31. Is this ACE node book-able?**

*If you answered Yes, who can make a booking?*

Researchers	
Students	
Department	
Institution	
Public	
Other	

*If you answered Other, please provide details:*

**Q32. What kinds of, if any, difficulties did you have getting your ACE commissioned?**

Persuading network administrators	
Persuading peers	
Network problems (e.g. Multicast)	
Acoustics	
Background Lighting	
Other	

*Please provide details.*

**Q33. Who is responsible for maintaining your ACE?**

Users	
Systems Support	
Other	

*If you answered Other, please provide details:*

**Q34. Are the network resources used by your ACE monitored?**

Yes	
No	

*If you answered Yes, please provide details:*

**Q35. Was the installation of this ACE difficult?**

Yes	
No	

*If you answered Yes, please provide details:*

**Q36. Do you have dedicated node operators in addition to meeting attendees?**

Yes	
No	

*If you answered Yes, please provide details:*

**The End - Thank you Very Much for your assistance.**

## References

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<sup>1</sup> **Smart Tea Project** (<http://www.smarttea.org>). Smart Tea is about improving the information environment for chemists doing chemistry - within and beyond the lab. Smart Tea is about supporting chemists in the preparation, execution, analysis and dissemination of their experimental work.

<sup>2</sup> **Jabber** (<http://www.jabber.org>). A set of XML based protocols from the Extensible Messaging and Presence Protocol (XMPP) Internet Engineering Task Force working group. Jabber enables entities on the Internet to exchange messages, presence, and other structured information in close to real time. The first Jabber application is an instant messaging (IM) network that offers functionality similar to legacy IM services such as AIM, ICQ, MSN, and Yahoo.

<sup>3</sup> **VNC** (<http://www.realvnc.com/>). VNC (Virtual Network Computing) software makes it possible to view and fully-interact with one computer from any other computer or mobile device anywhere on the Internet. VNC software is cross-platform, allowing remote control between different types of computer. For ultimate simplicity, there is even a Java viewer, so that any desktop can be controlled remotely from within a browser without having to install software.

<sup>4</sup> **ISABEL** (<http://isabel.dit.upm.es/>). The ISABEL CSCW application is a group communication tool for the Internet, based on advanced videoconferencing features. Isabel allows efficient organisation of working procedures over the Internet in large enterprises or groups.

<sup>5</sup> **Mad-Flute** (<http://atm.tut.fi/mad/>). MAD/TUT is a project, which has implemented two protocols designed for reliable content delivery. MAD-FLUTE is an implementation of FLUTE - File Delivery over Unidirectional Transport (IETF draft). FLUTE is a protocol for the unidirectional delivery of files over the Internet, which is particularly suited to multicast networks.

<sup>6</sup> **6NET** (<http://www.6net.org>). A pan-European academic project focused on deployment of IPv6 technology.

<sup>7</sup> **ConferenceXP** (<http://www.conferencexp.net/community/>). Integrates recent advances in high-performance audio, video, and network technologies to seamlessly connect multiple distant participants in a rich immersive environment for distance conferencing, instruction, and collaboration. ConferenceXP provides an extensible foundation for interactive collaborative environments, and it serves as a research platform for designing and implementing distance conferencing and learning applications. For more information, contact Todd Needham (toddn@microsoft.com).

<sup>8</sup> **EQUIP** (<http://www.crg.cs.nott.ac.uk/~cmg/Equator/>). Data sharing platform. A number of data spaces exist that contain data items. Processes can add, update and delete data items. Information retrieved from the data space using *patterns*. EQUIP could also be used as the basis of an alternative, more extensible Access Grid. Could be useful for integrating specific instruments or applications. EQUIP needs to sit in the 'guts' of an application.

<sup>9</sup> **I-X Process Panels** (<http://www.aiai.ed.ac.uk/project/ix/ip2/>). Helps humans and computer systems to cooperate in the creation or modification of some product (e.g. a document, plan, design or physical entity). Intelligent 'to-do' list. When used in conjunction with other users' Panels, it's a workflow, reporting and messaging tool. Allows the coordination of activity between parties.

<sup>10</sup> **Croquet** (<http://www.opencroquet.org/>). A computer software architecture that focuses on deep collaboration between teams of users. Croquet is a complete development and delivery platform for doing real collaborative work and is an open, free, portable extension to the Squeak programming system, a modern variant of Smalltalk, in which there is no distinction between the user environment and the development environment. Any user has the ability to create and modify a "home world" and create links to any other such world. But in addition, any user, or group of users (assuming appropriate sharing privileges), can visit and work inside any other world on the net. Just as the World Wide Web has links between the web pages, Croquet allows fully dynamic connections between worlds via spatial portals. The key

differences are that Croquet is a fully dynamic environment, everything is a collaborative object, and Croquet is fully modifiable at all times. Croquet is immersive 3D and peer-to-peer. Demo at <http://murl.microsoft.com/LectureDetails.asp?1019>.

<sup>11</sup> **Admire Group** (<http://www.nlsde.buaa.edu.cn/admire/en/>). Rewritten the Mbone audio tool RAT. This new tool (CAT) is used in an integrated working environment that includes a whiteboard and web sharer. The whole environment is like a rewritten Access Grid, but it is still interoperable with this technology.

<sup>12</sup> **DV-Capable Access Grid** (<http://netmedia.kjist.ac.kr/agdv>). This system enables Access Grid to support Digital Video (DV) transmission, so that remote meeting participants can experience 30Mbps high quality video. The DV transport part is added to Access Grid toolkit 2.1.2.

<sup>13</sup> **UltraGrid** (<http://www.east.isi.edu/projects/UltraGrid/>). This NSF project aims to build a high quality video component to be used with the Access Grid, with a current focus on interactive high-rate High Definition Television (HDTV), but will look in the future at Digital Video (DV).

<sup>14</sup> **ICENI** (<http://www.lesc.ic.ac.uk/iceni/>). Among many other uses, ICENI can be used to remotely initiate other Access Grid nodes and could be used as a basis for an alternative, peer-to-peer Access Grid infrastructure that can incorporate a data sharing structure. Access Grid nodes are 'leashed' to each other (if one node changes venues, then so do all of them). ICENI can attach other nodes to multicast bridges and launch data sharing applications. ICENI is Grid middleware and X.509 certificates used for authentication/authorisation.

<sup>15</sup> **Shibboleth** (<http://shibboleth.internet2.edu/>). Shibboleth is developing architectures, policy structures, practical technologies, and an open source implementation to support inter-institutional sharing of web resources subject to access controls. In addition, Shibboleth will develop a policy framework that will allow inter-operation within the higher education community.

<sup>16</sup> **Wikis** (<http://c2.com/cgi/wiki>). Wikis are shared repositories into which can be uploaded files. They are presented as web pages that any user can edit and add their own web pages and links.

<sup>17</sup> **Chandler** ([http://www.osafoundation.org/OSAF\\_Our\\_Vision.htm](http://www.osafoundation.org/OSAF_Our_Vision.htm)). A Personal Information Manager (PIM) intended for use in everyday information and communication tasks. Chandler is intended to make it straightforward for users to share information with others. It is an open source personal information manager for e-mail, calendars, contacts, tasks, and general information management, as well as a platform for developing information management applications.

<sup>18</sup> **BuddySpace** (<http://kmi.open.ac.uk/projects/buddyspace/>). Provides a personal 'dashboard' or 'radar screen' so that the availability and 'interaction state' of colleagues within a team may be viewed (e.g. busy, low attention, ready to chat, etc.). Real-time updates are pushed to users; information aims to be non-intrusive; it's customisable; scaleable; interoperable - built upon Jabber ([www.jabber.org](http://www.jabber.org)), which provides gateways to other products, such as Yahoo!; it's cross-platform; it uses XML.

<sup>19</sup> **Compendium** (<http://www.aktors.org/coakting/>). Advanced agenda/minutes. Contains an intuitive visual map of issues, ideas and arguments. Maps are created in real time, providing a group working memory (and in subsequent meetings, a long term memory to recover what was discussed/agreed). Map contains icons and arrows. Icons can show questions, issues, ideas, arguments, decisions, and pointers to external resources (e.g. documents and websites).

<sup>20</sup> **Blogs** (introduction on [http://www.elearnspace.org/Articles/blogging\\_part\\_1.htm](http://www.elearnspace.org/Articles/blogging_part_1.htm)). Blogs (weB LOGs) are a way of instantly publishing web content from any device with a web browser. In general blogs have the entries in date order, with hyperlinks. Blogs can be 'subscribed' to so that users are notified when a new entry has been made. They can be linked together or content aggregated from multiple blogs. In practice, blogging involves typing the content into an on-line form. Aggregation is a very powerful aspect of blogging. Blogs use an existing 'news feed' technology called RSS (Rich or RDF Site Summary) that allows summaries of news item content to be aggregated and re-published.

<sup>21</sup> <http://www.fxpal.com/>

<sup>22</sup> **TeraVision** (<http://www.evl.uic.edu/cavern/optiputer/teravision.html>). "Networked digital projector". Real-time display distribution via a dedicated "VisionBox". Via a VGA output, the TeraVision box distributes a computer's display over the network using multicast at 20 frames per second, 1024x768 pixels, 24-bit colour.

<sup>23</sup> **NCAS Telepresenter** (<http://www.ncast.com/telepresenter.html>). The G2 model is a "graphics transport vehicle" and can webcast presentations. The M2 model can distribute audio and video as well as graphics. Approximate prices are US\$3000 for the G2 and US\$6000 for the M2 model.

<sup>24</sup> **ICWall** (<http://www.icwall.nl/icwall.html>). Tiled display including plasma screen and "smart whiteboard" output to the Access Grid.

<sup>25</sup> For more information, contact Jeff Eschbach ([eschbach@motorola.com](mailto:eschbach@motorola.com)).

<sup>26</sup> [http://www.atr.co.jp/index\\_e.html](http://www.atr.co.jp/index_e.html)

<sup>27</sup> Finn, K.E. Sellen, A.J. and Wilbur, S.B. (1997) *Video Mediated Communication* (Lawrence Erlbaum Associates)

<sup>28</sup> Heath, C.C. and Luff, P. (2000) *Technology in Action* (Cambridge University Press); Nardi, B.A., Schwartz, H., Kuchinski, A., Lechner, R. Witakker, S., and Sciabassi, R. (1993) *Turning Away from Talking Heads: the use of video-as-data in neurosurgery* (in Proceedings of InterChi 1993 pgs 327-334 4-29th April 1993, Amsterdam)

<sup>29</sup> For example, see <http://www.nwfusion.com/columnists/2001/00344023.html> and <http://www.acmqueue.com/modules.php?name=Content&pa=showpage&pid=90>

<sup>30</sup> <http://www.crg.cs.nott.ac.uk/research/systems/MASSIVE-3/>

<sup>31</sup> <http://www.centra.com/>

<sup>32</sup> [http://www.nag.co.uk/Welcome\\_IEC.html](http://www.nag.co.uk/Welcome_IEC.html)

<sup>33</sup> [http://www.vrvs.org/Documentation/News/VRVS\\_SurveyMarch2004.pdf](http://www.vrvs.org/Documentation/News/VRVS_SurveyMarch2004.pdf)

<sup>34</sup> See <http://www.webopedia.com/TERM/N/NAT.html> for a full definition.