

THE ACCESS GRID

Will it revolutionise online collaboration?

Anthony Relle (acr200@soton.ac.uk)

Multimedia Systems Conference 2003, Department of Electronics & Computer Science, University of Southampton, Southampton, Hampshire, SO17 1BJ, UK

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1 ABSTRACT

Currently audio/visual communication over the internet can vary between many standards such as H.323, NetMeeting, CU-SeeMe. Many of these standards cater for a low quality of service connection between videoconferencing participants with a single audio/video stream. To support events such as formal meetings in multiple locations with many different audio streams/cameras, a better videoconferencing system needs to be made. Research into the Access Grid is producing a high quality audio/visual communication network, where seamless formal events in multiple locations at once with many participants are a possibility. The Access Grid removes the responsibility of understanding the setup of the conferencing from the user, and places that on dedicated engineers of purposely constructed rooms for events.

2 INTRODUCTION

The Access Grid is an international development to allow for global online interaction, initially across the internet but ultimately across the Information Grid. The Access Grid aims to provide human interaction between many groups of people simultaneously, allowing for research, training, teaching, seminars and other group activities.

The Access Grid achieves this through the use of Access Grid nodes. These are dedicated rooms with the video and audio technology to provide a high quality multimedia experience, and can be used for both formal and informal meetings.

Though designed to be used on the Information Grid, currently this network is active over the internet, with working nodes in successful use now. The global Access Grid alliance website [1] currently lists 142 nodes located at international locations [2], of which 84 are based at academic institutions. This compares to 67 international sites [3] as of October 2001, a year before. The nodes can be seen to vary in location from US, UK, Japan, Germany, Canada, Brazil, Australia, and more, providing a very global coverage of this communications network.

3 THE ACCESS GRID

3.1 GRID NODES

An Access Grid node room is the centre of communication on the Access Grid. Every node has the ability to send data to any other node on the AG network. There is no complete specification for an Access Grid node room; they vary according to what room space was available when the node was being built. I have shown below an example of what a node room could look like.

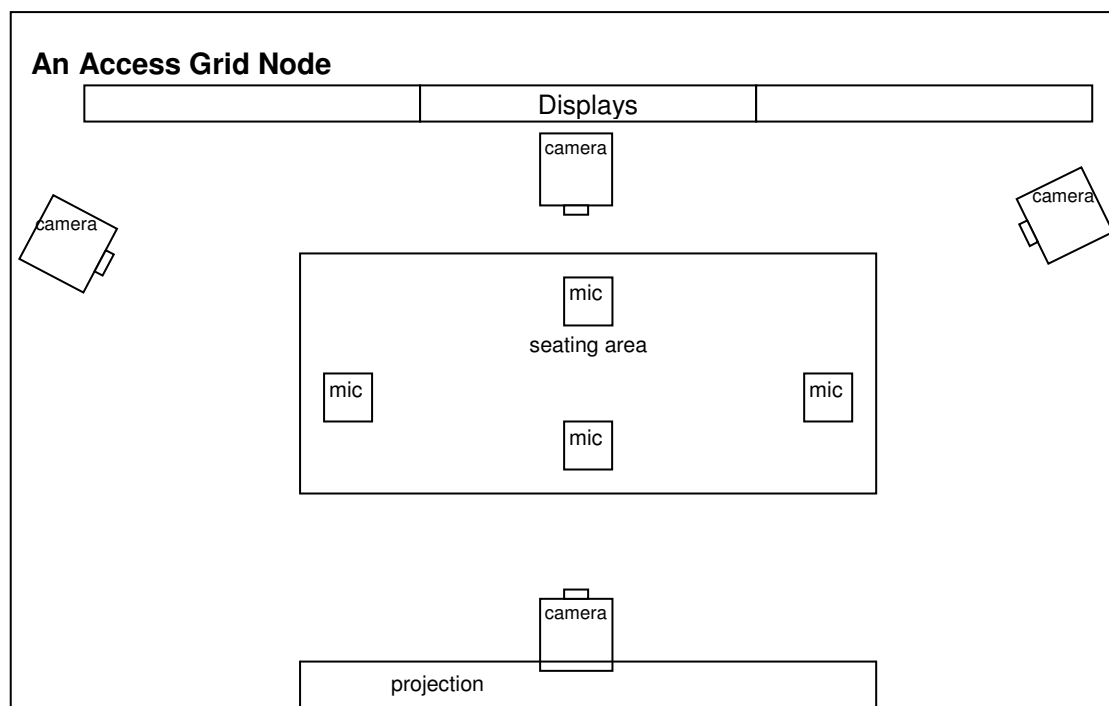


Figure 1. Example Access Grid node layout

Figure 1 is based on the "Access Grid-in-a-box Tutorial" [4] and demonstrates a simple example of how a node room could be set up. A three display setup is standard across all Access Grid nodes, the output of these are controlled by Grid Operators which are described in section 3.3. Rather than specify an exact room layout, the Grid-in-a-box tutorial states "being able to capture the image of all participants and enable interaction among them is essential to a successful AG experience."

For the end user, the Access Grid node is designed to allow them to communicate easily and effectively to other groups of people in other nodes, without having to

control, bring, or even understand any hardware themselves. This is achieved by both having a 'node' room dedicated just to this communication method, and also by Grid operators who control the setup of hardware, layout, lighting, display and more described in section 3.3.

A user or group participating in a meeting over the Access Grid can use this room without any hardware interaction required on their part. All that is needed is that they are sat in the field of view of the cameras. The display provides a view of other remote participants in the meeting. This is a completely user-friendly solution and allows people of all technical expertise to participate in Grid events.

3.2 HARDWARE

Providing a high-end visual and audio experience can be expensive, a typical 'small node' on the Access Grid can run into many thousands of pounds to build. In August 2001 the 'Access Grid Hardware Specification' was published [6]. This paper contained a list of hardware costs at the time in US dollars for setting up a small or large access grid node room, these are shown in Figure 2 and Figure 3 below.

| | |
|--|-----------------|
| Computing equipment | \$12,200 |
| Network equipment | \$750 |
| Other computing equipment (monitors, KVM switch) | \$1,800 |
| Small node audio configuration | \$6,500 |
| Video cameras (4 Sony EVI-D30) | \$5,200 |
| Projectors (3 Epson 710c) | \$16,000 |
| Total | \$42,450 |

Figure 2. Pricing summary for small node configuration.

| | |
|--|-----------------|
| Computing equipment | \$12,200 |
| Network equipment | \$750 |
| Other computing equipment (monitors, KVM switch) | \$1,800 |
| Large node audio configuration | \$11,000 |
| Video cameras (4 Sony EVI-D30) | \$5,200 |
| Projectors (3 Epson 710c) | \$16,000 |
| Total | \$46,950 |

Figure 3. Pricing summary for large node configuration.

The Hardware Specification also splits the computing equipment into further subcategories. Display computer, Video Capture computer, Audio Capture computer, and Control computer, all these are needed to provide this high-end audio/visual experience. The hardware specification also states equipment such as Echo Cancellation equipment in order to provide the best possible audio experience.

The tables Figure 2 and 3 demonstrate how high this cost can be. There is only 1 difference between the tables, for the difference in quantity of audio equipment. This reflects, as of August 2001 when the figures were created, that there were very high setup costs for a node room, but expanding the equipment to cater for almost double the amount of people was at minimal cost.

The small node audio configuration caters for 4 microphones, the larger for 7, allowing for a reasonably sized audience. The hardware specification recommends all participants are within 2-5 feet of a microphone. It also recommends using table-mounted/hanging microphones to help prevent users having to remember to wear portable microphones, or being replacing batteries in them. Also the cameras in the hardware list are recommended to be remote controlled pan/tilt cameras, for the convenience of altering angles by grid operators as events are happening.

All of the hardware needed is recommended for quality rather than cost, to achieve the best experience and having high quality audio and visual access to other nodes.

3.3 GRID OPERATORS

The Grid operators are the managers of the Access Grid nodes, controlling the hardware, what is seen by the participants, and what is sent to all other nodes taking part in the event. A grid event must be planned for in advance, dedicated operators are needed to setup the connections to other nodes. Video and audio streams must be monitored to ensure other nodes can see that participating node. A grid operator at each node is there to handle the entire technical side, preventing the need for

Access Grid node users to know anything about how the nodes are setup and having to understand anything to get the nodes are working.

For successful collaboration between grid operators at different nodes, the technique to communicate that has been adopted is by using a MOO [9]. MOO stands for "MUD, Object Orientated", while MUD stands for "Multi User Dungeon". The MOO is a text-based "back-channel" that can be used by all grid operators in nodes participating in an event. This communication technique allows for quick communication without requiring the grid operators to actually take over any video/audio links in the event should there be technical difficulties. As a backup to this a separate telephone conference call can also be used to get similar results.

It is also possible to use MOOs to handle how the event progresses rather than use it during link difficulties. Handling questions during events such as a lecture could be by asking questions by proxy. A user at a node can give a question to be forwarded by their local operator to the lecturer's grid operator. In this example the lecturers' grid operator can wait for the appropriate moment before asking the question, rather than the student be able to break into the lecturers presentation.

In another example such as a training session held over the MOO, it could be possible to use the grid operators to pass on a message saying an attendee wants to ask a question, rather than forwarding the question itself. In this case the grid operator could inform the host there is a question, and the host can allow for the question to be asked by the attendee.

As well as acting as a communicator, the dedicated grid operator controls everything that can be seen on the 3 screen display for users of the node. Every node has 4 different cameras, each has a specific purpose [4].

- View/shot of your Display Screen
- Close-up view of presenter
- View of audience area
- Close-up view of node operator or audience member who is speaking

The grid operator is the one responsible for ensuring each camera is covering the required position, and each operator must take these 4 camera views from each site to build their local display with the relevant videos.

3.4 ORGANISING EVENTS

One of the challenges with Access Grid nodes is to be able to prepare the nodes to all be ready for the event in advance. In order to cater for this there is an 'AGSchedule' online booking system [11], where nodes involved in events can be registered in use at that time in advance. This also reserves a room in the MOO for use of back-channel communications during the event (section 3.3).

The AGSchedule system also helps with co-ordination beforehand by allowing the sharing of multimedia content to be used in the event. Often formal meetings will have several presentations in applications such as Powerpoint. These presentation files can be shared beforehand using the AGSchedule system.

The guide “How to Produce an Access Grid Event: An Elementary Guide for Technical Users” [4] recommends rehearsals to achieve successful events. For informal events, where a low number of users are participating, only 1 rehearsal is recommended. For formal events that have a large audience and multiple speakers across many sites, multiple rehearsals are recommended.

3.5 MULTICAST

One issue with the Access Grid has been how to bring large groups together over the current medium of the internet. Currently the internet moves data around as *unicast* packets of data [7]. This means traffic is sent from one host to another through routers in the internet, as shown in Figure 4 below.

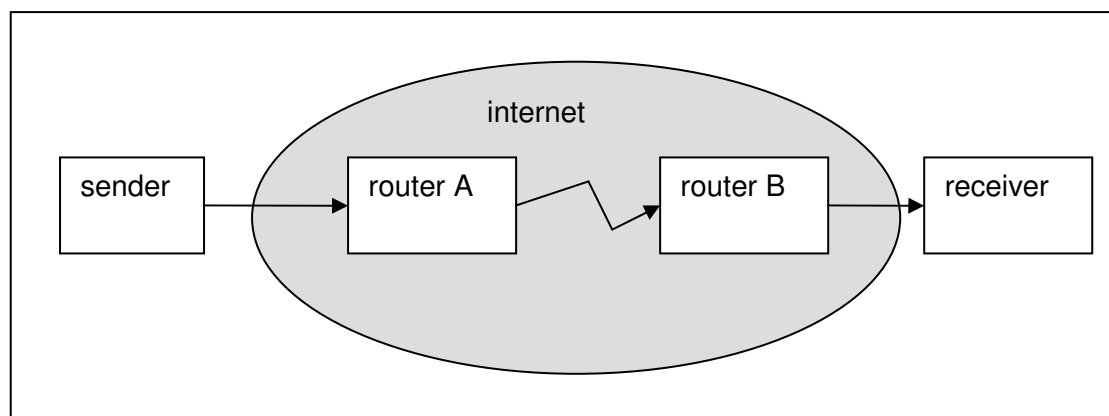


Figure 4. Unicast data flow example.

Communication on the Access Grid is based upon groups interacting with many other groups of people, which does not fit in the current model of the internet where data is sent from a source to a specific host, rather than sent to many hosts at once. To achieve interaction between many groups of people, each node must be able to send audio/visual data to each other node when participating in conferences with more than 2 nodes.

MBONE is a technology to allow multicasting through today’s internet, allowing data to be sent to several destinations at once by tunnelling this multicast data through the unicast internet [7]. This technique is used by the Access Grid as an essential part of data transfer between the nodes; it is what allows multiple groups to all be participating in a conference simultaneously.

MBONE works by having computers set up with the MBONE software/routers with hardware support on either side of the internet to handle the multicast traffic. These detect if there’s a multicast link in between and send multicast data if there is, else put the multicast data into several unicast packets to the correct destinations. This is shown in the below Figure 5.

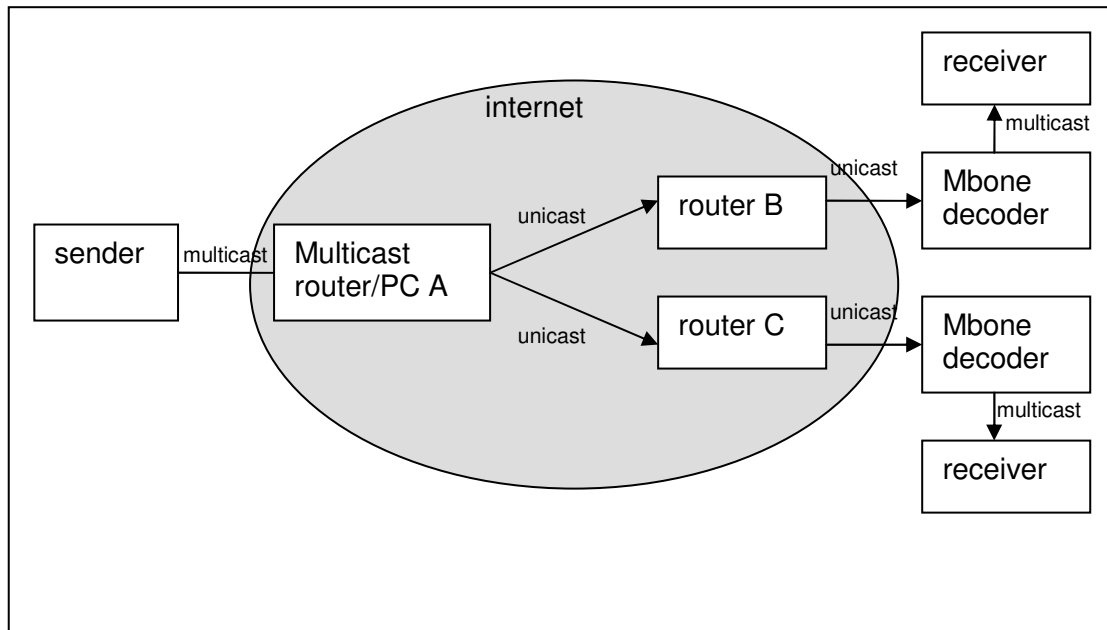


Figure 5. Multicast over unicast internet data flow example.

Figure 5 shows that even though the internet can only currently send data as unicast data, the multicast data can be tunneled through and sent to multiple recipients.

3.6 RECORDING EVENTS

It is possible to record the multicast streamed Access Grid events [12]. In order to use this software, there is a simple requirement that all machines that are streaming audio/video to the Access Grid must have their clocks synchronised to each other (such as through NTP clients installed on linux).

Once a stream is recorded in this manner, it can be played back over a lower bandwidth connection, such as a WAN or an ISDN connection. This could be a useful facility for use in recording events such as lectures, whereby it can be played back later over a relatively small bandwidth. This is achieved by “real-time translation of video streams stored in motion JPEG format to H.261 format”. This results in a perfect record of the event being stored, but being able to tune it down for lower bandwidth connections.

This video transformation [13] to lower bandwidth streams is one of the main ideas of bringing the use of the Access Grid to any user. It does not require a large expensive node room to view events. Not relying on expensive hardware would be extremely useful, for example, in use with remote teaching, where the cost of technology may be important.

3.7 PERSONAL INTERFACE

Having to rely on a node for use and grid operators to set you up may not be the most practical solution for an end user to use the Access Grid. In July 2002 the PIG (Personal Interface to the Access Grid) software package was released [10]. This allowed a single machine to access the Access Grid and other nodes without having a dedicated room and machines that run into the costs show on Figures 2 and 3 to buy.

The hardware setup for this single PC is still quite expensive. The suggested solution is as follows

- Dual P4-Xeon class processors, 1.5Ghz or faster
- 512MB DDR-RAM (more is better)
- Dual-head AGP video card, Matrox G400 or better recommended
- Single-head PCI video card (minimum)
- Total of 3 viewable screens, 2 supported by AGP (for a total resolution of 3072x768)
- Full-duplex audio support
- (2) Osprey 200 PCI Video Capture cards
- Personal Echo Cancellation device, similar to the Polycom SoundPointPC
- Two cameras, one oriented to provide a constant image of the user, a second variably oriented to display the workspace, as necessary for interaction/communication
- 100Mbit (minimum) multicast-capable network connection
- Microsoft Windows 2000 SP2 (with up-to-date hotfixes and patches applied)

Until the PIG all of the Access Grid nodes have been set up to be in dedicated rooms at set locations, serviced by engineers and with permanent hardware. The PIG single-machine fills the needs of individuals who want to use the Access Grid, and have access to hardware capable of fulfilling the requirements.

The PIG increases the scope of applications such as lectures behind held from an Access Grid node. Individual setups hosted elsewhere can use the PIG system to still be part of the Access Grid node without the inconvenience of travelling to a node room that could be some distance away. Though the video transformation from section 3.6 that caters for viewing only may be preferable to this for cost reasons.

4 CONCLUSION

The Access Grid provides a new way of video conferencing on a large scale by the use of purpose built rooms and operators dedicated to handle the technical side of the conferencing. Though designed for use on the Information Grid, it has currently been implemented successfully on the internet through the use of multicast bridging software between international locations. The Access Grid is currently providing high quality audio/visual videoconferencing between many distant locations, currently having on average of almost 10 events a week according to AGSchedule. Current events range from university tests to global group meetings, the usage can only increase as the technology gets more cheaper, more practical to install, and thereby more widely adopted.

Also the advent of the personal interface to the Access Grid has provided a solution that may be more convenient to users who do not wish to travel to/build node rooms and have sufficient access elsewhere. Recording Grid events can be useful for

historical value, and also for the distribution of recordings soon after an event rather than requiring a non-participating audience to be watching at the time of the event.

With all this the Access Grid gives a new high standard of audio/visual conferencing to offer a high quality experience allowing group collaboration over the internet with ease.

5 REFERENCES

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6 APPENDIX

6.1 INFORMATION GRID

The Information Grid is best described as distributed computing on an international scale. Still in its infancy, the aim is to build a global network, or 'grid', using new standards of communication between them. Being a new idea, and using the latest developments of technology, it is perfect for use by the Access Grid to provide global communications.