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1 INTRODUCTION

Our client commissioned 4-consulting Ltd to undertake a project to review various aspects of video conferencing in order to further inform the organisation on the feasibility and physical requirements for video conferencing.

Throughout the project we have been given considerable help and co-operation from our client's staff, and 4-consulting gratefully acknowledges their courtesy and contributions of ideas and information to the project team.

Eric Smith carried out the project.

We have now completed this brief review and have pleasure in setting out below our findings and conclusions

2 BACKGROUND TO THE PROJECT

Our client has a diverse membership spanning Scotland and would like to be able to use the technology they have available, if possible, to involve people from different geographical areas in their discussions and seminars and to be generally more inclusive.

2.1 The Brief

The objectives and programme of work agreed in January 2003. The project team was asked to:

- Review and report on the various technologies and software necessary to participate in a video-conference.
- Examine the possibility for our client to work with these technologies
- Inform our client's s technology administrator of the situation and
- To provide a brief report summarising the position.

It should be noted that the structure and underlying principle of this report was to ensure clarity whilst retaining simplicity. As a result, whilst the technical content is accurate, it has been expressed in its simplest (and usually briefest) form to ensure clarity.

This report deals specifically with "video conferencing over IP", ie over the internet, and only briefly addresses the use of "hard-wired" connections using ISDN (telephone) lines.

The concept of Audio conferencing using multi-party telephone conversations has been with us for some time. It would not appear to take a leap of imagination to extend this facility to include video.

However, at this time, the capacity and capability of hardware and software to accommodate the extra data to carry video signals introduces a number of issues, some of which have been addressed within this report.

The brief was also intended to cover the use of video conferencing when off-site. This would be in the case of a seminar being held in, for instance, a hotel.

3 THE WORK CARRIED OUT

As the researcher had already carried out some work in the past on this topic, it was possible to use this information and to carry it forward. This previous work was done for the University of Edinburgh (UoE) and their permission was obtained to use the original reports.

A substantial portion of this report is based upon the work and research carried out for UoE in 2002, and the results thereof.

Contact was made with a Microsoft Development Contractor and discussions undertaken regarding the possibilities, changes and potential enhancements in technologies involved.

The original reports were reviewed and new potential facilities briefly investigated. It was not within the remit of this project to carry out a full-scale research and development exercise. As a result, no testing was undertaken.

It should be noted that the nature of the technology is such that new developments are occurring almost daily and that the veracity of the findings of this report will time expire. It is anticipated that this report will be out of date/context by as early as the end of 2003.

The scope involved the equipment within the Glasgow office of our client and did not take into account any equipment in any other satellite offices. This includes the hardware, the software and the bandwidth available.

Within the clients Glasgow office, they use Microsoft Exchange Server 2000 with almost new (within six months) Dell computers running Microsoft 2000 O/S. Office 2002 runs on this platform and all of the equipment seen has sound cards and speakers.

The organisation uses BT as their ISP and has an ADSL connection. This provides speeds of up to 2000kb/s in download and 500kb/s upload. This is considered “state of art” within that which is commercially available.

One of the first activities undertaken was to take the clients representative to a local retailer (PC World) to identify the type of hardware and possible costs. This included looking at some of the cheaper end web cams and entry-level hardware set-ups. This proved an excellent familiarisation exercise. Unfortunately, there was no video demonstration available on-site at that time.

4 EXECUTIVE SUMMARY

- The concept of Audio conferencing using multi-party telephone conversations has been with us for some time. It would not appear to be a great leap of imagination to extend this facility to include video.

- Use of video will enhance the experience and interface between the members. It may be that fully interactive video may not be necessary.

- At this time, the capacity and capability of hardware and software to accommodate the extra data to carry video signals, introduces a number of issues.

- Our client has the necessary hardware for video conferencing on both Peer-to-peer and Multicasting formats.

- The organisation has the software to allow them to hold medium quality Peer-to-peer conferences at this time if it so wished.

- If it was required to multicast a video conference, it would be necessary to purchase some further software which would require configuration. Costs for this software may be in excess of £5000. (please see item 6.1 re costs.)

- The configuration of this software is relatively complex and possibly outwith the current competence capability of the organisation.

- This report was written assuming the use of the equipment available on-site in our clients' offices in Glasgow. In this case, there is an "always on", high bandwidth (ADSL) internet link and adequate computing power. In the event of using external resources, whilst the necessary equipment could probably be furnished using a high-end laptop, the main issue is likely to be available bandwidth, connectivity and cost.

- When bandwidth restrictions apply, it is usually possible to shut down unnecessary facilities in order to maximise performance.

5 THE BODY OF THE REPORT

In this section we describe our observations arising out of our review.

The report is split into a number of sections dealing with the discrete areas as follows:

- Hardware
- Software
- Bandwidth
- Issues

It is important to note that there are two levels of video conferencing. The first of these is peer-to-peer (or person to person). This is the simplest format and one that can be accomplished most easily, usually with the equipment provided on most entry-level retail computers

The second, more complex format is multi-casting. This is when there are more than two parties involved in the conference. In this case, intermediate technology is required to "re-transmit" the content to all parties.

In each of the sections below, both of these formats will be addressed.

Whilst the use of video during a conference will indeed enhance the experience and interaction between participants, It may be that there is no need for full action video.

There is some evidence to show that still pictures, or infrequently "refreshed" video shots can be very effective in enriching the experience. This effect could be achieved by ensuring that the video capture is minimised in order to maximise the use of the available bandwidth.

5.1 Section 1. - Hardware.

Essentially, the minimum requirement for video conferencing is

- a video camera (or web camera)
- a microphone either stand alone or incorporated with the camera
- a computer equipped with
    a. "reasonable" speed and memory
    b. a sound card and
    c. a video card
- some form of interface with the network used to carry the messages between parties. (this last will be dealt with in Section 3)

As indicated above, in the case of multi-casting, there is also a further requirement for an intermediate server to re-transmit and distribute the signals to each party in the conference. The cost and capacity of servers are relatively minor in comparison to the cost of the associated software, and therefore this issue is dealt with in the next (software) section.

Video cards, sound cards and microphones.

The standard onboard video cards and sound cards provided with most entry level hardware is of sufficient quality for Peer-to-peer conferencing and most internal multi-casting use. It is also likely to be satisfactory for the external environment. It would be sensible to carry out testing to confirm quality.

A very simple microphone is sufficient for Peer-to-peer video conferencing, however, should there be a multi-party at one end, or during multi-casting, it may be necessary to use a directional microphone or more expensive equipment to avoid feedback and ensure clarity of broadcast.

Cameras.

The equipment that our client has at their disposal in the Glasgow office is capable of supporting a medium quality Peer-to-peer conferencing facility with the addition of a simple camera. These cost of the order of £50 for a low quality one and can be sourced from a wide range of retail stores.

In order to improve the quality of the images being sent out, the existing digital camera, which is used for video diaries etc could be connected. This would provide a much better quality picture for the other party enabling the image to be expanded in size. If our client were to consider multi-casting then use of this camera would provide a better quality picture to the remote parties.

There are much better quality cameras on the market that are used by professional conferencing companies. These conform to specific standards, but as the price of this equipment can be in excess of £750 for the camera along, we have omitted these from this review. More information is available on this subject in section 6.

As indicated above, our client is equipped with ADSL provided by BT, which is the highest capacity Bandwidth currently available in the market place.

5.2 Section 2. – Software.

As is often the case with a technology issue, the problem often resides not in the hardware, but within the software.

For Peer-to-peer conferencing, the matter is very simple as Microsoft have created NetMeeting for this function. This is bundled within the Microsoft 2000 operating system and is available to Poverty Alliance on all of the machines that were reviewed.

There are a number of other Software and Applications providers who can provide solutions and these are dealt with below.

Software solutions

Microsoft NetMeeting

NetMeeting will allow for a small video picture, audio transfer, sharing of software applications, whiteboard (for drawing sketches) file transfer and a "chat" facility to send typed messages between parties.

In order to connect, it is necessary for both parties to be "on-line" and then for one to "dial" the IP address of the other into the software. The software also has a "phone book" facility to make this easier.

It should be noted that only those parties with a "relatively" fixed IP address can be held in the telephone book.

Note that IP addresses are allocated by the Internet Service Provider or ISP, whenever you connect to the internet. In the case of constant connections, such as ADSL or cable modems, this IP address normally stays the same.

However, if a party connects and disconnects to the Internet every session, then they will be allocated a new IP address for each session. This is referred to as "dynamic addressing" or DNS.

It is a relatively simple process to configure NetMeeting to allow Peer-to-peer conferencing and well within the capability of our client's staff.

It is not possible to use NetMeeting on its own, to multicast.

Note that it is possible to maximise performance by shutting off un-required features of the software.

Microsoft Exchange Conference Server

In order to multi-cast, it is necessary to use a server to re-broadcast, as has been stated before. This can be achieved by using Microsoft Conference Exchange Server 2000. This is a further piece of software, which sits on top of Exchange 2000 Server and allows for video conferencing over the network.

As our client currently use Exchange Server 2000, it should be possible to upgrade. (Provisional costs of up to £5000 have been indicated for this, as it may not be possible to upgrade Exchange 2000 Server, but this has not yet been confirmed.)

Once configured, this becomes a relatively simple interface to use. Users on the Internet, go to a web page and then log-onto a conference using a password and user name. Once logged on, a number of video screens are seen showing all of the parties involved in the conference.

There are a number of issues that restrict the number of conference attendees. The main one of these is the bandwidth availability both at the server, and also along the path to the server.

It is important to note that the Microsoft Developer contractor whose advice was sought regarding this software, indicated that the configuration of Conference Software is very complex and can take many days to arrange. It is likely that professional assistance would be required to configure the necessary web pages.

Further information on this software is provided in Section 6.

Further software solutions are available which, for cost reasons, have not been investigated. An example of this is a web site design solution from Dreamweaver.

DreamWeaver MX Flash Communications Server

This is what the advertising information says of this solution. The cost of this software is £3000 plus VAT for the Professional Edition, as there was no underlying research on the product, it was considered out of scope for the project.

“Unite communications and applications by adding streaming, multi-way audio, video, and live data to your websites and Rich Internet Applications. Built for streaming media, rich-media messaging, and real-time collaboration, Macromedia Flash Communication Server MX provides an easy, powerful, and open environment for developing groundbreaking communication functionality - and deploying it to the widest possible audience.

Develop the next generation of online communications. Create engaging pre-sales applications that integrate audio, video, text, chat, and enterprise data. Develop powerful corporate presentations with streaming video and synchronized multimedia content that are deployed seamlessly within the

context and branding of your site. Or build collaborative meeting applications that bring people together in real-time-connecting them to each other, to live data sources, and to back-end services for a significantly more compelling online experience. The Professional Edition, along with its corresponding Capacity Packs, offers the performance and scalability to meet your needs for installing workgroup or enterprise-level applications. The Professional Edition includes the ability to create virtual hosts, a feature specifically for large-scale deployments on multiple URLs."

As well as the software solutions above, there are a number of application service providers who have created possible solutions to this problem.

Application Service Providers

Centacom

This is a Talk and View product which provides a solution to high end video conferencing facilities, however, it requires some pricey hardware add-ons which would not be possible with a lap-top.

Centacom have promoted themselves as a Video Conferencing solution, but it is not considered appropriate for our client.

Intercall

Another application service provider who offer some of the discussed functionality. However, the video facilities are limited.

Genesys.

This is an attractive looking service which provides many of the facilities that would support an excellent video conference. The system uses a standard telephone connection for the audio feed, which would sustain quality. The disadvantage is that there is the additional cost of the extra telephone call.

SWYX

This is another web interface solution for video conferencing. There has been some research carried out under another project, unfortunately, the results will not be available within the timescale of this project, nor available for inclusion in this report.

iVisit.

iVisit is a web interface with free software downloads which allows Peer-to-peer conferencing over the Internet. It is reportedly easy to use and to configure (although the researcher did not manage to do so at the first try).

The advantage of this system is that it provides an alarm system (an indication if the people you wish to speak to are on-line)

This facility appears to provide peer-to-peer conferencing only. It is however, allegedly easily configured and also easy to use.

5.3 Section 3. – Bandwidth.

Bandwidth is the term used for the “pipe” that carries the data packets between the computers. These “pipes” are able to carry specific amounts of traffic.

There is also a limit as to the speed which data can be sent down the “pipes”. This will be controlled by the equipment that transmits the data through the pipe. In the case of an analogue signal, this is referred to as a modem.

Without getting too technical, in the case of an analogue connection, used on a standard telephone connection, normal modem speeds are nominally 56kbps (kilo bits per second). However, it is usual to achieve little more than 33kbps on a standard GPO line.

A further standard was developed to allow these speeds to be increased, but this has been largely overtaken by events and the development in the digital technology which is much faster.

Another telephone solution is provided by using ISDN lines. These have a capacity of 2*64kbps (128k) but can be run in parallel to create ISDN2 and ISDN3 can be used to provide higher multiples. It should be noted that whilst still very prevalent, this technology carries a cost penalty in that these lines are leased and must be paid for a period of time.

Cable modems, which are usually digital, can achieve speeds of between 250 and 1000kbps. (The author has a stream into his office of 1000kbps.) These are maximum quoted speeds, which will be affected by demand, itself is often dependent upon time of day etc.

Finally, there is XDL. This term refers to the various digital solutions currently emerging. These include synchronous (SDL) and asynchronous digital lines (ASDL). Speeds with XDL vary from 250kbps upload to 2000kbps download.

It is likely that these speeds will increase in the future. The advance in speeds appears to lag behind Moores Law, which defines the doubling of computer chip capacity for the same price every eighteen months. It is probably fair to say that there is no reason to suggest that data transfer rates will not continue to increase.

Video pictures require considerably more data than audio streams do. As a result, the bandwidth requirements are much higher.

When carrying data over the Internet, it is impossible to ensure the specific route the data is taking. As a result, whilst the bandwidth requirement will always be the same to carry the required number of “packets” of data, the route may have restrictions on the “pipes” through which it moves.

This will mean that the data may be delayed, or indeed may not even arrive. This results in the concept of bandwidth restrictions.

This report was written with the use of the equipment available on-site in our client office in Glasgow in mind. In this case, there is an “always on”, high bandwidth (ADSL) internet link and adequate computing power. In the event of off-site seminars or meetings, whilst the necessary equipment could probably be provided by using a high-end laptop, the main issue is likely to be available bandwidth, connectivity and cost.

Most hotels will be able to provide telephone access in a meeting room, whilst some are able to provide ISDN lines. All of this at a cost penalty. Few, at this time, will be able to provide the cheaper XDL solution although this is changing with time.

5.4 Section 4. – Issues.

This section deals with some of the issues associated with video conferencing as it impacts upon our client.

Peer-to-peer video conferencing should be possible with minimal configuration within the constraints of the equipment and software available to he Poverty Alliance at this time. This will provide an interim, simple solution.

The more professional multi-casting format is likely to have to wait for future advances in the technology and configuration of the necessary software (see below).

It should be noted that there is a “mirroring” effect that occurs in the use of this technology. This term is used to describe the fact that if one party has high quality equipment, software and bandwidth, it is the other party who gets the benefit of this. Similarly, if one party has a defect or fault, it is the other party who will suffer the adverse effects. As a result, should the picture deteriorate at one end, it is at the other site that investigation should start.

Also, as indicated above, whilst the organisation has “best in breed” connectivity, the equipment available in other parts of the organisation, may generate restrictions dependent upon the bandwidth capacity. This report did not extend to the equipment throughout the rest of the organisation.

Any attempt to hold a video conference off-site (in a hotel, say) would require investigation as to the availability and connectivity of bandwidth.

With the addition of Microsoft Conference Server, whilst the additional software may appear initially inexpensive, the additional configuration costs may prove to be a burden.

Much of the available software packages today offer a wide range of functions including:

- voice and image broadcast
- white-boarding (or shared sketch pad)
- instant messaging
- file transfer
- remote control of computer applications.

The more of these functions used in a conference, the greater the requirement for telecommunications bandwidth. Where this bandwidth is limited or cannot be provided, the poorer will be the quality of the image and voice transmission.

Videoconferencing software should comply with international technical standards including H323 and H325. In spite of these standards, there is a substantial history of incompatibility between “compliant” software applications. To avoid such problems, our client should seek to ensure that all computers involved in videoconferencing, use the same software.

6 TECHNICAL NOTES

The following are some more technical notes from various sources.

6.1 Microsoft Conference Server.

The following information relates to Microsoft Conference Server and has been sourced from a technical library.

Exchange 2000 Conferencing Server extends Exchange 2000 to provide data conferencing with application sharing and multicast video conferencing for organizations of all sizes. Exchange 2000 Conferencing Server must be deployed in conjunction with Exchange 2000 Server or Exchange 2000 Enterprise Server or deployed separately as long as there is at least one Exchange 2000 Server and one Microsoft Windows® 2000 Server in the domain

Exchange Conferencing Server 2000 .NET Servers (prices from Dabs) ex VAT £3,499.00, inc VAT £4,111.32

The vision for Exchange 2000 Conferencing Server is to enable "meetings without walls". Multipoint data conferencing enables two or more people to communicate and collaborate as a group over the Internet or corporate intranet in real-time. Exchange 2000 Conferencing Server provides a scalable and reliable platform for supporting the four key segments of data conferencing: application sharing, text discussion (chat), whiteboard capabilities, and file transfer.

Exchange 2000 Conferencing Server offers complete multi-party audio and video conferencing. Telephony API (TAPI) 3.0 accesses Windows 2000 features such as Quality of Service and IP-based multicast technology. IP-based multicast technology allows significantly more simultaneous users to participate in videoconferences.

Exchange Conferencing Server bridges H.323 clients (like NetMeeting) into multicast conferences with Windows 2000 clients. At the centre of Exchange 2000 Conferencing Server is the Conference Management Service. This component allows overall coordination of different conferencing technologies, tracking of scheduled conferences and administrator control of attendee access.

6.2 Further Information on Bandwidth.

The following are some technical notes from a report commissioned on behalf of the University of Edinburgh.

One of the advantages of IP Multicasting is bandwidth efficiency. However, because Internet clients need to participate in conferences by using the H.323 protocol, bandwidth is a major consideration for many customers. When you enable H.323 fallback, the audio codec used is G.711, which consumes roughly 70 kilobits per second (Kbps), while the video codec used is H.263, which consumes approximately 90 Kbps. Therefore, clients that are connecting to a conference will send an average of approximately 160 Kbps for each audio/video stream. This means that for every connection, you need approximately 160 times the amount of conference participants that are actively sending voice and video for a smooth conference. However, because of the inherent nature of the Internet, i.e. congestion, dropped packets, collisions, and so on, this amount of bandwidth does not guarantee that there will not be any problems.

Determining the required bandwidth for data conferencing is difficult because of the many variables involved, such as whether or not you will be chatting, using a white board, or sharing applications. In any event, compared to the bandwidth that is consumed by audio and video, data conferencing uses relatively little resources.

The following is an analysis of the various connectivity methods and how the resulting bandwidth affects audio and video performance.

Modem: 14.4 Kbps to 33.6 Kbps

Scenarios Supported: None.

Results: Jittery sound; dropped packets.

Workaround/Fix: Upgrade hardware and bandwidth.

Modem: 56 Kbps

Scenarios Supported: None (it may work fine with audio only between two people but this is not recommended).

Results: Jittery sound; dropped packets.

Workaround/Fix: Upgrade bandwidth or use point-to-point connectivity with NetMeeting instead of Exchange Conferencing Server (NetMeeting has a dynamic jitter control algorithm that scales better in low-bandwidth scenarios).

ISDN: 64 Kbps

Scenarios Supported: Audio with very little data sharing (no video, either sending and receiving).

Results: Intermittent and choppy audio may occur.

Workaround/Fix: Verify that the appropriate bandwidth setting is selected in NetMeeting (as always, an upgrade of bandwidth will increase performance).

ISDN: 128 Kbps

Scenarios Supported: Audio with very little video and data sharing.

Results: Slight jittery or choppy audio and delays in the video frames.

Workaround/Fix: Verify that the appropriate bandwidth setting is selected in NetMeeting (as always, an upgrade of bandwidth will increase performance).

DSL or Cable Modem

Scenarios Supported: Audio with very little video and data sharing.

Results: Same as ISDN with respect to the bandwidth.

Workaround/Fix: Verify that the appropriate bandwidth setting is selected in NetMeeting (as always, an upgrade of bandwidth will increase performance).

Methods for Controlling Bandwidth Usage

An administrator has several options for controlling the amount of bandwidth that is used in a conference. This section lists each of these methods.

- Selecting the codecs to be used. The codec of the resource that is used when the conference is scheduled defines the characteristics of the conference. For example, if you use G.711, each audio stream uses approximately 70 Kbps, whereas using GMS 6.11 reduces this to about 20 to 30 Kbps. For video, both H.262 and H.263 use approximately 90 Kbps. However, the H.263 codec has a smarter algorithm and uses slightly less network bandwidth.

- Reducing the Maximum number of conference participants setting for video resource.

- Defining audio-only resources.

- Setting default settings for audio/video to not send at join time.

- Implementing Quality of Service (QoS) policies. Microsoft Windows 2000 QoS includes enterprise and subnet policies that contain rules for your enterprise. You can set QoS policies to guarantee the amount of

available bandwidth to your organization, subnets, or individual users.

- Limiting videoconferences over WAN links with administrative scoping.
- Restricting the use of expensive resources.

Table indicating the effectiveness of each of the media

Access**	Video*	Desktop	Whiteboard	Audio*	File	Chat
None						
Wireless (28Kb)	***	***	***	? ***		
Modem (56Kb)				***		
Cable/ADSL (512Kb)						
Local LAN						

* We may be able to achieve multicasting of video and audio, if infrastructure (including ISP) supports it.

** In general, the functionality and usability of some of these 'mediums' is subjective and depends greatly on the actual bandwidth available.

*** Very poor quality