INFRASTRUCTURE ISSUES FOR INTERNET BROADCASTING TO HOME-BASED USERS

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Abstract

The use of computers in the home is continuing to grow and the integration of services between the television and the computer is blurring the definition of the two types of device and the services that they provide. This paper looks at the use of the Internet for broadcasting with particular reference to the issues behind the provision of relevant infrastructures, and appropriate software, access mechanisms, protocols and working practices. In addition it will look into the similarities and differences between the traditional broadcast medium and the use of the Internet for live events.

1.   INTRODUCTION

The use of the Internet to provide data streams from live events and from recorded sources with a similar appearance to television or radio output is termed Internet broadcasting, Webcasting or Netcasting. For the individual home-based user this provides a new source of information that is often predicted to become as popular as traditional terrestrial and satellite television broadcasts. There are, however a number of infrastructure issues that need to be addressed before the benefits of Netcasting can be fully realised for the individual user. The following sections look at these issues and also the related subjects of software packages, systems and working practices.

2.   INTERNET BROADCASTING AND TV

Terrestrial and satellite television both have established infrastructures that can deliver TV signals to nearly all the population in most industrialised countries. These traditional sources of television also have many other benefits. They are structured to cater for a large audience, are relatively low cost and frequently have facilities that allow large scale productions to be financed. In comparison, Internet broadcasting does not yet demonstrate any of the features of traditional TV, It is mainly an ad hoc facility that features one-off events or promotional videos from the web sites of film makers and others.

With the different charging structures that affect the use of the Internet and

TV there is likely to be a difference in the output of both these channels for a number of years and the niche that is expected of Internet broadcasting is presaged in the few pilot events that have taken place so far (Constable et al 1999). These are in areas that have limited popular appeal and/or obscurity and specific target audiences either locally or globally.

There are also two crucial differences between Netcasting and TV. Bandwidth is limited for the end-user on the Internet both by the need to use telephone connections and by the sharing of intermediate Internet links by a number of other users with no prioritising mechanism to share the limited bandwidth available. The use of compression (Watkinson 1995) does aid the situation but at present the combination of compression and the low bandwidth only allow small picture size and limited frame refresh rate on home-based users machines.

The other feature of Internet broadcasting of particular relevance to the home user is the blurring of the distinction between producer and consumer. With Internet broadcasting the possibility exists for the individual to produce the information that is broadcast which goes some way to enhance the prospect of the 'prosumer' as predicted in earlier works (Toffler 1980, Sloane 1996a).

In a business environment the use of video and television has long been accepted as playing a part in the various areas of business life from training to security (Sloane 1996b). The move to an Internet-based distribution of video information is also aided by the network infrastructures found within companies. This allows Netcasting to be a possibility within organisations where an Intranet is used or between separate parts of a distributed organisation using the Internet for transport of information.

2.1   The home user

For home-based users, either working in the home or taking part in leisure activities, the network infrastructures used by businesses are not available and Internet services generally come from an Internet service provider (ISP). This then requires an appropriate network infrastructure to be in place for the home-based user to be able to access the service as the originator intends. These infrastructures can take many forms and two events using different models are discussed in section 1.3.1 and the various models derived for Internet use are contained in section 1.3.2.

Previous work (Sloane 1994a, 1994b, 1994c) has looked at two-way communication and home users, but the use of Netcasting poses different problems for the providers of the service. To enable home-based users to receive an acceptable quality of service (QoS) the broadcaster and the relevant intermediaries need to provide the infrastructure required by the end-user, that is, the home-based viewer. There are no real user options in this situation the choice for the viewer is whether to view or not and the

quality of service will determine whether the viewer participates. The models outlined in section 1.3.2 go some way to ensuring that this QoS is achieved.

2.2   User software

There are a number of useful and usable software packages that can be used to broadcast video over the Internet. The events outlined in section 1.3.1 used two particular packages. The Celtica event[1] used Cu-SeeMe[2] for the video component whilst the OECD seminar (OECD 1997) used a more robust approach with the RealVideo[3] package throughout.

2.2.1   Cu-SeeMe

Cu-SeeMe was originally developed as an Internet video-conferencing tool for one-to-one and group video conferencing. It has since been developed into a commercial tool by White Pine [4] but is still available for free download in a cut-down version from the original site. The functionality has grown with the various versions that have been produced and it is now a useful tool although there are software components of web browsers that perform much of what CU-SeeMe can do. It does, though, come as a relatively small package that is runnable on less powerful platforms.

CU-SeeMe use reflectors (generally multi-user Unix machines)to distribute the video and audio signals to the various users connected. A single reflector would accept signals from the connected users and relay them to all the other connected users enabling them all to see and hear all participants in a specific conference. There can be a number of conferences on each reflector. There is also web-based information about events using CU-SeeMe on the White Pine web pages.

2.2.2   RealPlayer

The RealVideo and RealAudio software known as 'RealPlayer' and 'RealPlayer Plus' is a tool designed to permit the use of stream video/audio around the Internet. It uses buffering to achieve a reasonable approximation to live broadcasting although the frame rate and picture size are small when using low bandwidth links.

RealVideo also has a server which relays streams to users. A number of servers can be connected to the source of the video and used to distribute the signal over a wider area. The number of servers required will be related to the number of end users and the number of streams supported by each server.

RealPlayer can be launched from a browser which makes it amenable to use and there is also web support for events from the Real web site.

2.2.3   Servers

The widespread use of video over the Internet is dependent upon the existence of the reflectors or servers used to propagate the signals from an event to the audience on the Internet. To do this effectively requires multiple instances of co-operating reflectors for large events where many viewers may want to view at the same time. As an example an event in the UK could be watched in the other countries of the EU but there would probably need to be a reflector in each country for only a small number of participating viewers.

Reflectors that are used for this type of broadcasting need to be linked together. In CuSeeMe this is relatively straightforward since there is a reflector configuration that specifically allows ties to be made between reflectors. The original purpose of the feature was to permit wider video conferences but with selective barring on the linked reflectors this can allow video signals to reach the end users via a cascade of reflectors. RealVideo servers can be linked in much the same way.

3.   INFRASTRUCTURE ISSUES

As was outlined in section 2 there needs to be links between the reflectors or servers used for a broadcast. However, the links need to have some planned construction (an infrastructure) to enable the signals to reach the intended audience. The events outlined in section 3.1 give some idea of practical infrastructures that have been used and section 1.3.2 look at the infrastructure models with a more theoretical approach. With traditional TV broadcasts and satellite signals the problems of distribution have been solved with the positioning of TV masts, relays and satellites. This largely achieves the goal of full coverage for TV signals except in some remote areas.

The Internet is different in that the connected networks are already linked by hardware and communication links but the software and configuration links are not in place. They can, however, be positioned relatively easily and can be temporary or permanent. These Internet broadcasting infrastructures are crucial to the reception of the signal and are the only means by which individual users (especially home-based users can receive them.

3.1   Internet broadcast - example events

The use made of Cu-SeeMe during the Celtica broadcast was mainly as a video broadcast tool with a number of chained reflectors relaying the video stream around the world. The main event being relayed from Machynlleth, Wales via Aberystwyth to a reflector in Wolverhampton, England and then

to other reflectors in the UK, France, USA and Australia. This cascade enabled participants to view via their local reflector cutting down on the use of International connections. The seemingly ad-hoc arrangements for the broadcast were developed over a considerable time before the actual event with many hours of set-up and testing on the part of the various systems administrators that helped relay the event around the world. It was found that live broadcasting of test material helped but it was only possible to complete the full chain of reflectors on very few occasions before the event.

The OECD seminar in Turku used a simple broadcast infrastructure to propagate the video and audio signals. Since the signals were carried solely by EUnet, an ISP, the control over the infrastructure was greater than could be achieved in the previous example. The various reflectors (or RealVideo servers) all being part of the EUnet infrastructure.

The interesting contrast between these two approaches shows the extent to which some flexible configuration is possible on the Internet as it stands. The events were both able to be viewed by a wide audience but the EUnet event was mainly directed at a European audience whilst the Celtica event was distributed world wide. The infrastructure developed for the Celtica event was found to be difficult to maintain since the various reflectors had different audiences and the connections could be volatile. The OECD seminar appeared to run relatively smoothly but since there were fewer servers there were periods when it became difficult to connect to the event.

3.2   Infrastructure models

Future events will need support but there are many ways in which this can be provided. Some of these may be better for the long term interest of Internet broadcasting. This led to the development of models for the infrastructures that could be used for Internet broadcasting. These models are all dependent on differing levels of co-operation between the various intermediaries in the broadcast chain. In general the wider the audience that is expected, the greater the degree of co-operation required.

The following are the different models of co-operation that could be used for various types of Internet broadcasting:

Individual reflectors/servers.
In a company environment where there are enough user to reach a critical mass an individual reflector or server can be used to relay audio and video streams to a number of geographically separated users. This is less useful to the home-based user who is not connected to a company. For example, a freelance worker or a person enjoying a leisure pursuit may need to use such services but not have the necessary access to infrastructure development tools or systems. A typical system is shown in Figure 1.
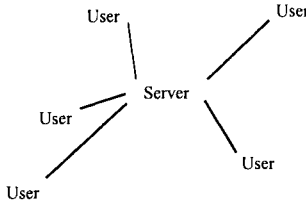
Figure 1. A single server/reflector

Network operators.

As in the Turku seminar case it is possible for a network operator to set-up a broadcast using a number of its own systems as reflectors. This allows all those users connected via the operators systems to have access to the event but does not broaden the Netcast to other groups. There is also the possibility of stream shortage if the broadcast is not relayed outside the operators systems.
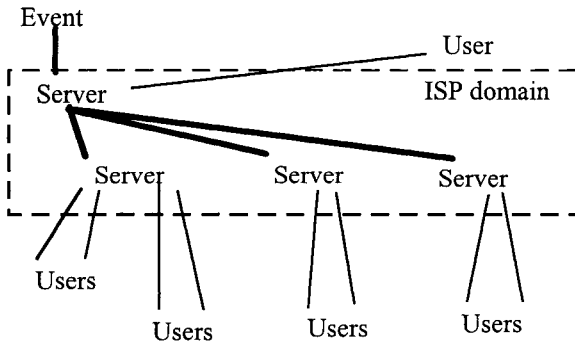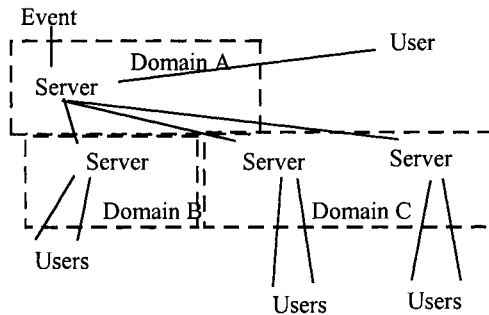

Figure 2. An ISP Netcasting set-up

Figure 3. Linked individual sites

Linked Individual sites.

This is problematic for viewers since the infrastructure is usually an ad hoc arrangement. This gives rise to unstable connections between broadcasts and repeated testing needs to be carried out to ensure that the infrastructure is intact. There is also the difficulty of promotion of the event and its promulgation to a wider audience. The individual sites can co-operate for the duration of the event or longer depending on the nature of the agreement between them although in disparate domains it is harder to maintain contact between servers unless a number of scheduled events are due to take place and the set-up and testing is done as a systems administration procedure. However, the nature of such ad-hoc arrangements is fraught with possible problems including the movement of personnel, the lack of time to do testing etc., the pressure on systems for other uses and the difficulty of communication for what is often a part-time interest.

Co-operation agreements.

A more ideal solution for wider dissemination to audiences is the use of long-term agreements between operators and individual sites to carry video streams on named reflectors. This would allow users a more accessible infrastructure which would not be subject to the change of individual site connections or the coverage restrictions of using the systems of a single network operator. It would also allow the individual operators to cover events in response to user requirements. In addition, a much more appropriate use of bandwidth would be possible as the user base would be more easily quantifiable. A typical infrastructure agreement would lead to links such as those shown in Figure 4.
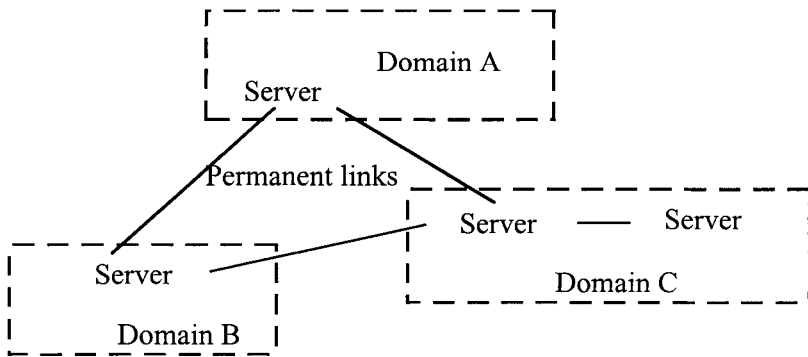

Figure 4. Co-operation agreements

The various infrastructure models outlined are all feasible methods of delivering Internet broadcasting. There are many ways in which the infrastructures can be implemented with variations on the basic structures. What is important is that the structure of the network must be suited to the needs of the audience and the performance, event or presentation being broadcast. The future of the Internet for broadcasting is still uncertain as

there are many problems to be overcome and many variables to consider, however, there is currently a place for small scale events to take place which can reach a global audience and these events need the infrastructure to facilitate their propagation.

3.3   Working practices

One area that also needs further consideration are the actual working practices used to conduct the event. Whilst the performance arts have different requirements and will not have strict guidelines governing content, the use of Internet broadcasting for business or academic purposes can benefit from the use of stricter controls.

As an example, it is relatively easy to broadcast an academic lecture or conference but attention must be paid to the usability of the content. A video of a projection screen may be usable but a better technical solution would be to directly feed the output from an overhead presentation (on computer) into the broadcast stream whilst retaining the audio stream. The video can then be switched back to a camera when the presentation is finished.

Other technical solutions to improving the content usability are possible but many will rely on the use of new methods and practices in the preparation and conduct of the broadcast. This may be seen as the technology influencing the content but is an inevitable consequence of the limited bandwidth available to end-users. It is little use being able to conduct a multimedia event with numerous media streams if the end result is not usable by the intended audience.

It is, therefore a problem that is currently determined by the technology available but is likely to be less restrictive in future when high-speed networks are more prevalent and more users have either high-speed modems, ISDN or higher speed connections.

3.4   Protocols and access

The use of current protocols (TCP, IP and UDP) over the Internet is one of the more restrictive features of present systems. Current Internet applications do not have a real time capability and most have used "work-around" solutions e.g. advanced buffering and bandwidth restriction. With newer protocol proposals such as RSVP and others (Lawton 1997) this restriction may be lifted.

In a local area network(LAN) such as within a business environment the bandwidth restriction may not pose too many problems on a broadcaster unless the LAN is heavily used. However, since the main concern of this paper is the home-based user the LAN restriction is not as great as that of the incoming data stream via modems. In both cases, heavily used LAN, and

home access via modem, the use of reservation protocols would ensure that the relevant amount of bandwidth was reserved for broadcast data. This may, of course, not always be possible to achieve, but should be an improvement over current systems.

3.5   Future use

It may be said that when a higher bandwidth infrastructure is in place the infrastructure problems will be resolved but there may not be a simple solution. Higher bandwidth inevitably costs more and the purchasers are the individual ISPs that provide the end-user service. Currently the purchasing of bandwidth is only keeping pace with the users' requirements (some are slightly ahead) but there are inter-ISP links that may not be upgraded so readily where agreements are needed between operators.

Even with higher bandwidths installed the possible explosion in use that is foreseen would fill many high capacity connections and render the quality of service less than desirable so leading to a renewed requirement for the type of broadcasting planning model outlined in this paper.

4.   SUMMARY

The use of broadcast data on the Internet is set to grow. There are many application areas that can benefit from easily accessible broadcast information. The growth of broadcasting will depend on many different criteria being met. One of these is the infrastructure that is used to deliver the broadcast to the user. These infrastructures are important in that they are outside the immediate control of the end-user, especially for home-base users, and need to be set up in the broad context of the Internet. This may not always be possible for various reasons, but if Internet broadcasting is to have a future for some events the infrastructures need to be put into place by the relevant providers.

NOTES

1   Details of the Celtica event are no longer available on the Web but are contained in Constable et al 1999.
2   The CU-SeeMe download ftp site is no longer available: please see Note 4 below.
3   The RealVideo web site is at http://www.real.com
4   The White Pine software web site is at http://www.wpine.com/

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