Bandwidth Delay:

Who cares? - We Do - Humans!

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Abstract

The issues of bandwidth availability and propagation delay as applied to (inter)networking are not, in themselves, particularly exciting. The authors are of the opinion however, that these issues attract great importance when applied to multimedia internet communications, particularly in the context of the increasing withdrawal of regional and rural services. These services, that have previously been provided on a 'face-to-face' basis, may be replaced at some stage by computer mediated communication. This paper presents a proposed research project that aims to investigate what levels of bandwidth availability and propagation delay can provide adequate levels of multimedia internet communications.

Introduction

In the last decade the use of computer networks has dramatically changed business communications. Traditional business communications methods are rapidly being replaced by their electronic counterparts. For most applications, real-time communication is not essential. However, in our research, which deals with real-time negotiation, breakdowns caused by propagation delay and congestion on intermediate subnets can severely effect the outcome of the negotiation and, in the worst case, cause total breakdown. This paper puts forward an experimental framework and details the motivation and rationale that supports it.

Scenario

Throughout Australia there has been in recent years a decline in services available in rural centres. More particularly in the Great Southern region of Western Australia, national banks have been closing down their service centres to the point where only
large rural centres such as Mount Barker and Albany will have physical banking services in the foreseeable future. These service centres that have been closed, have, in some cases, been profitable to both the bank in question, and the local community. The work of Beal and Ralston (1997) illustrates the dramatic and calamitous effect that closure of local services can have on the on-going economic sustainability of a rural community. Whilst the recent advent of `community banks' and the establishment of bank agencies in several Western Australian telecentres (Department of Commerce and Trade, 1999) goes some way toward alleviating these concerns in rural areas, a significant portion of the Australian rural population remains severely disadvantaged in the context of access to services.

To counter this withdrawal of these services, successive State governments and the banking sector have been promoting tele-banking and other electronically delivered services in the hope that most services can be replaced through the use of electronic media. However there are some serious issues which need to be addressed if these initiatives are to be successful. One of these issues is universal access to the Internet at a reasonable cost to the consumer. Through the government's telecentre initiative and a private state-wide ISP providing rural consumers with Internet access at city call costs, some headway has been made in this area. However, the telecommunications infrastructure in rural Australia may not be suitable to run these services.

To add to this problem we have concerns about the level of service that is being offered. Most tele or electronic banking services offer purely account enquires or facilities for transferring funds between accounts. Depositing funds is not an option and negotiating loans and overdrafts through this medium is not possible at this time, services which are of great importance in a rural context.
Our research is focusing on the area of loan negotiation using multimedia communications tools, including currently available tools such as the MBONE (multicast backbone) suite of tools, CU-SeeMe, and Microsoft's NetMeeting. The reason we have chosen these tools is to allow multiple participants at remote locations the opportunity to participate in negotiations simultaneously.

The MBONE tools use multicast technology to maximise efficient use of available bandwidth. The MBONE suite consists of a video screen, audio player and chat screen. CU-SeeMe and NetMeeting both allow for simultaneous use of text, audio and video communications. Toohey et al (1998) conducted a series of trials using these tools in communications with remote locations. They found that the quality of those communications was adversely affected during periods of peak Internet usage. It is intended in this research to build upon that work to, firstly, quantify the bandwidth available at any given time, and secondly, to discover at what bandwidth availability levels different modes of communication lose viability.

Research Questions

There are two distinct questions that need to be answered in this research to address the issues raised above.

When is the propagation delay to the remote site unacceptable for spontaneous negotiation using video or audio or a combination of both. The propagation delay is a function of the time it takes for the Internet packets to actually reach their destination.
Speed of the network links, distance and congestion have a combinatorial effect here. The effect of propagation delay is noted by long delays between communication. It has been noted for example, that communication systems in many rural areas of Australia do not have telephone lines capable of sustaining modem traffic thereby nullifying attempts to set up remote banking services for rural customers.

The second research question addresses the issue of whether there is adequate bandwidth available for the individual applications to run? Can we get enough data through the network to maintain spontaneous negotiations using video and sound? When there is insufficient bandwidth video will become jerky with infrequent updates and audio signals can break up and become unintelligible, leading to a reduction in quality of communication between the parties.

**Research Method**

The research method to be employed in this research involves two distinct yet intimately related (in this context) areas. The first area is that of communications quality, and the second is related to measuring network resource quality.

**Communications Quality**

There has been extensive experimentation with respect of communications quality using multi-media communications tools reported in the literature. The research of Minneman and Bly (1991), Apperley and Masoodian (1995) and Olsen et al (1995) for example, which was centred in the field of Computer Supported Collaborative Work (CSCW) and Human-Computer Interaction (HCI), indicated that audio-visual communication was preferred over the use of text-based communications alone by the participants in the communication. The researchers reported both an increased
perception of an increase in the quality of the communication by the users, and a measurable increase in the actual quality of the communication. However, we suggest that there must be some stage at which the limitations imposed by a poor communication channel will have a negative impact on both the participant perception, and the actual quality of the communication.

Initially, the researchers will simulate a series of realistic negotiation type scenarios making use of the multimedia communication tools mentioned earlier, possibly in a laboratory environment. These experiments will be conducted under differing network conditions, artificially imposed through the use of bandwidth 'chokes' and other methods. Quality of communications will be measured as a function of user satisfaction with the communication process, and correlated with the network conditions.

Later stages of the research will involve similar scenario-based experiments making use of the Internet over dial-up modem links. Similar measurements of communication quality will be made, again being correlated with the prevailing network conditions which will be evaluated as outlined below.

**Network Resource Quality**

The authors suggest that network resource quality is a function of both bandwidth availability and propagation delay. During the initial experiments both of these factors will be controlled for, however, during the later phases of the research, these will need to be measured.
Some initial testing of these parameters has already been conducted, and has involved the use of the Unix utility, ping. The ping manual says that "...Ping uses the ICMP protocol's mandatory ECHO_REQUEST datagram to elicit an ICMP ECHO_RESPONSE from a host or gateway...", in effect, measuring the time it takes for an Internet packet to travel from the local host to the remote host and return. This allows for a quantitative measurement of propagation delay. The researchers have been sending 100 pings to a remote host (the Multimedia Communications Group in Glasgow, Scotland) at hourly intervals and recording the minimum, average and maximum 'round-trip' timings. Some preliminary results are displayed below.

If these initial results are viewed in the light of the suggestion made by Toohey et.al. (1998, p119) that ...

"...performance deteriorates noticeably at the start of the work day in the United Kingdom, which coincides with (the) end of the work day in Western Australia ... Immediately prior (to this) ... over sessions lasting up to an hour,"
video quality was acceptable to all those participating, and audio was mostly of phone line quality.”

we can see that ping times are indeed longer during periods of deteriorating performance. The 'ping' utility is, of course, limited in its ability to actually measure bandwidth, as it sends packets of identical size to the destination interface. This can result in an overestimation of the bandwidth available.

To measure bandwidth availability the Unix utility 'bing' (bandwidth ping) will be used. "Bing determines the real throughput on a link by measuring ICMP echo requests roundtrip times for different packet sizes for each end of the link". (Bing manual)

Conclusion

This paper has presented a proposed research project that project will investigate at what levels of network resource quality various types of computer mediated multimedia communications become less viable. The authors suggest that this issue is of vital importance in the context of increasing losses of services in rural and regional areas, and further, that the attempted replacement of these services via electronic media is unlikely to succeed unless further improvements are made to the quality of telecommunication infrastructure in rural and regional Australia.

References


