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Bandwidth Usage of the Collaborative Tool: Microsoft NetMeeting V2.0

G.A. Coomber and W.D. Blair

DSTO-TR-0605

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ABSTRACT

This report examines the bandwidth usage of a collaborative tool, Microsoft NetMeeting. It shows that NetMeetings software configuration options can be used to sucessfully operate the product in the tactical environment at bandwidths as low as 32 kbps. It also provides information on how to setup a data conference to minimise the use of Wide Area Network bandwidth.

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Executive Summary

The ADF is making increased use of inexpensive commercial-off-the-shelf (COTS) software to provide electronic support to commanders. One area from which the ADF stands to gain immediate benefit is the use of COTS software to support distributed work practices. DSTO's Command Support System Group (CSSG) under the "Research On Collaborative Knowledge Systems" (ROCKS) task, ADF 97/061 has been investigating the suitability of commercial applications to support collaborative planning in a distributed headquarters environment. CSSG is considering the use of Microsoft NetMeeting to provide support for distributed meetings. This report investigates the ability of NetMeeting to operate successfully in a bandwidth constrained environment.

The report shows that NetMeetings audio and video conferencing features can be used effectively at bandwidth's as low as 32 kbps making the product viable for use over man portable satellite systems. It finds that the NetMeeting systems policy, which is an optional software component used by the system administrator to manage software configuration, successfully constrains average bandwidth consumption but does not guarantee that peaks in bandwidth demand will not exceed the available capacity. We also found that simple measures, such as ensuring that the video is always optimised for speed, drastically reduce bandwidth consumption with no impact on utility.

The report also examines the use of the T.120 conferencing standards on NetMeetings data conference facilities. We found that the sequence in which participants join a data conference has a major impact on the data conferencing bandwidth requirements. The report examines ways to ensure that data conferences are always set up to ensure the most efficient use of wide area network bandwidth.

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Contents

1. Introduction

Two innovations in the provision of electronic support to commanders provide stimuli for this report. Increasingly, commercial-off-the-shelf (COTS) products are being adopted without change for use in support of military command and control - including in the tactical arena. Secondly, the command support environment is attempting to introduce collaborative planning tools including distributed tools between headquarter locations. Accordingly, there is an increasing desire to field commercial collaborative tools, such as personal (workstation) video conferencing, shared whiteboards and shared applications.

DSTO's Command Support System Group (CSSG) has been developing prototype collaborative planning tools, which are increasingly being adapted for use in a distributed headquarters environment and between different headquarters. The current work named "Research On Collaborative Knowledge Systems" (ROCKS) is based on COTS products, specifically Lotus Notes. In adapting the original ROCKS from a system which operates on a single local area network (LAN) to one which operates between sites, CSSG is considering the integration of Microsoft NetMeeting. The choice of this software is further justified as the ROCKS development is integral to DSTO support to the experimental Deployable Joint Force Headquarters (experimental DJFHQ or exDep) based on HQ 1st Division which had independently decided on NetMeeting as a tool for collaborative meetings.

COTS products such as NetMeeting are often developed for LAN environments where bandwidth is relatively easy to provide, or for low rate telephone modem operation. The nature of the bandwidth demands of such software when used in a tactical military environment of shared, low bandwidth links has not been determined.

2. Aim

This report seeks to characterise the bandwidth usage of the collaborative tool: Microsoft NetMeeting V2.0.

3. Background

3.1 Operational Scenario

It is expected that tools such as NetMeeting will be used on the LAN provided within headquarters where bandwidth usage will not be a substantial problem. A more challenging scenario for its use will be between headquarters where communications over the wide area network (WAN) will be more limited. This will be particularly so for the DJFHQ where the link between the initially lodged headquarters and the yet to be deployed main body may be limited to 32 kbps over manportable satellite facilities. In such a case the tool will provide a critical link between the two elements during the conduct of initial planning of the deployment with one or perhaps two computers in the advance party linking back to staff in the old location (usually barracks).

DJFHQ staff have advised that even in such a limited capacity scenario, the links would interconnect internet protocol (IP) routers. Such an approach ensures that the capacity could be shared between multiple applications running at the deployed site as well as providing seamless interconnection into the wider Defence intranet.

3.2 NetMeeting Use of the Internet Protocols

While NetMeeting can operate directly between two hosts via serial line or dial-up modem, the operational scenario would indicate the major use will be over a shared IP network.

The internet protocols (more usually known as TCP/IP from Transmission Control Protocol/Internet Protocol), has been developed using a layered approach (see general data communications texts such as Tanenbaum [1] for a more complete description). The IP layer provides best effort service to get data packets from the originating host to the destination host. This provides the internetworking layer upon which the well known TCP layer provides reliable end to end connections. Less well known is the User Datagram protocol (UDP). This protocol operates at the same layer as TCP, however provides a best effort datagram service over IP. NetMeeting uses both TCP as well as UDP for interconnection services.

Since TCP provides a reliable end to end connection, this is the appropriate protocol for the exchange of data which must get through, regardless of time delay. NetMeeting thus employs TCP for the exchange of NetMeeting control messages and for sharing screen information such as shared whiteboard and shared applications.

UDP provides a best effort datagram service, and this is the appropriate protocol for the exchange of real time information where timeliness is more important than completeness of information. For applications such as NetMeeting's video and audio, loss of some data is not critical as there is a continuous flow of fresh information to follow any losses. The TCP mechanisms for reliability of transfer mean that the network delay experienced by the data can vary significantly as lost data is retransmitted. Such variation in network delay makes interactivity via video and audio difficult and so UDP is the preferred protocol for these applications.

Below the IP layer is the physical layer. In the case of the scenario considered, this is likely to be the Point to Point Protocol (PPP). Just as TCP or UDP adds overheads (headers/footers) to user data, which in turn is packaged by IP headers, PPP adds a protocol overhead. The impact of these overheads will be discussed in detail later in this report.

3.3 NetMeeting Use of International Telecommunications Union Standards

NetMeeting has adopted a number of International Telecommunications Union (ITU) standards within its architecture. The key motivation behind the use of such standards is to improve interoperability between NetMeeting and similar systems. The two key standards that impact on the bandwidth usage characteristics are ITU T.120 and ITU H.323. As stated in the NetMeeting Resource Kit [2]:

> The ITU T.120 standard is made up of a suite of communication and application protocols developed and approved by the international computer and telecommunications industries. These protocols enable developers to create compatible products and services for real-time, multipoint data connections and conferencing. T.120-based applications enable many users to participate in conferencing sessions over different types of networks and connections.
>
> Depending on the type of T.120 product, they can make connections, transmit and receive data, and collaborate using compatible data

conferencing features, such as application sharing, conferencing whiteboard, and file transfer. Microsoft and more than 100 other major companies support the development of products and services using the T.120 standard.

Significant to this study, T.120 impacts on the distribution of traffic between participants when a conference involves more than a point to point connection. This is discussed in more detail in Section 5.3 Impact of Conference Topology . T.120, because of its control nature and the need for guaranteed distribution of information employs TCP rather than UDP in IP networks.

The second standard has considerably more impact on the nature of NetMeeting traffic. NetMeeting has adopted the ITU H.320 family of standards for audio-visual conferencing. H.320 offers a range of optional voice and video coding standards but typically NetMeeting will opt for the low rate options - H.263 for video coding. The coding standards within H.320 have significant impact on bandwidth usage which, when understood, explains the nature of the bandwidth usage of audio and video conferencing.

Video coding is a process of digitising moving images and processing the digital data so that it can be reduced to a scale capable of being moved over the transmission media. The data rate can be reduced by two principal approaches - by taking advantage of redundancy of the information within a single frame (ie intraframe coding) and redundancy between frames (ie interframe coding). Significant areas of an image exhibit the same or similar pixel value (dot brightness) across the frame thus offering intraframe redundancy. More significantly, large portions of a frame will often be quite similar to portions of previous frames, thus offering interframe redundancy. Video conferencing standards (such as H.263) typically send periodic frames coded only in an intra fashion followed by a number of frames where the difference between the frame and a previous frame is coded (interframe coding). If an image is highly complex (i.e. with much detail), the intraframe coding generates a large number of bits, conversely flat images produce fewer. Similarly, video with little movement generates fewer bits in interframe coding than video with large activity.

The consequence of this is that the bit rate out of the coding process can be highly variable. A constant bit rate video device copes with this variability by buffering the output of the raw coder. The high bit rate periods tend to fill the buffer, while the low bit rate periods tend to empty the buffer. The buffer cannot be too big otherwise excessive coding delay (ie time taken for the coded representation to be generated and sent to the receiver) will disturb interactivity. If the buffer becomes too full, the coder can only resort to reducing quality of the coded representation to reduce the bit rate. Consequently, the visual quality of a constant bit rate video coder system is variable.

In contrast to a constant bit rate coder, the NetMeeting implementation of H.263, especially when used on a large, variable capacity media such as a local area network, is not constrained to be constant bit rate. As a consequence its demands on the communications system will burst up and down depending on the nature of the video being coded. Any user control over bandwidth usage of NetMeeting will control the average capacity used, but this may not impact on the peak demands of the system.

3.4 NetMeeting Facilities

NetMeeting is a collaborative meeting support tool which has a limited conferencing capability allowing two users at a time to exchange audio and video. NetMeeting also provides the ability for several users to share a whiteboard and/or Windows applications, eg Microsoft Word or, across a network. In any NetMeeting conference

several or all users may be sharing applications but only two of the participants may be using the video conferencing features at any point. NetMeeting does, however, provide facilities to switch video conferencing between participants, i.e. broadcast of the video from one to many users is not supported. To achieve multiple sessions, multiple meetings are required.

3.5 NetMeeting Use of System Policies to Restrict Bandwidth Usage

System policies are an optional feature of the Windows 95 and Windows NT operating systems. They give systems administrators the ability to standardise and control access to operating system and application configuration settings.

The NetMeeting Resource Kit [2], which is available as an optional download from the Microsoft web site, contains a system policy which allows the systems administrator to set default values and restrict user access to a comprehensive range of NetMeeting options. During our testing the system policy was installed and the policy option "Set limit for audio/video throughput" was tested. This option gives the systems administrator the ability to set an average bandwidth consumption rate for audio and video traffic on a specific computer. It is important to note that this option does not set a hard limit for throughput, rather it is an average rate for audio and video. Setting this option has no limiting effect on data traffic, eg file transfer or whiteboard traffic.

The NetMeeting Resource Kit [2] Chapter 10 "Controlling Bandwidth with NetMeeting System Policies" gives an overview of the actual mechanisms used to limit the audio/video bandwidth.

4. Test Set up

4.1 Configuration One

The configuration for the initial one-to-one tests consisted of the following equipment:

- Two IBM Thinkpad 760XD Pentium 150 MMX fitted with Compro D-Cam Digital cameras and PCMCIA 10/100Mb/s Zircom CE3 ethernet adaptor running at 10Mb/s.
- Two Sparcstation 5s (Burke and Canb) fitted with FORE Systems ATM adaptors acting as network gateways.
- One 10Mb/s shared ethernet hub.

The ATM cards fitted to the network gateways provided a Classical IP over ATM connection which was used to simulate a WAN. The bandwidth of the WAN was modified during experiments to represent both LAN rates and WAN values which the ADF would reasonably expect to encounter in a deployed environment.

4.2 Variables Tested With Configuration One

The following software settings where used during testing. A brief description of each setting is included in Table 1 below. Full details on NetMeeting options may be obtained from the NetMeeting Resource Kit [2].

Table 1. NetMeeting Options

Option	Settings used during testing	Description
NetMeeting - audio	On or Off	Controls the sending of audio.
NetMeeting - video	On or Off	Controls the sending of video.
NetMeeting - video quality	Speed or Quality	Sliding scale which optimises the video transmission for speed of delivery or quality of the image. During testing optimisation was for either full speed or full quality.
NetMeeting System Policy Option - "Set limit for audio/video throughput"	None, 256kbps, 32kbps, 28kbps	Sets the average bit rate for audio and video.
Gateway Operating System - WAN bandwidth	10Mb/s, 256kbps, 32kbps	Used to set simulated WAN connection rate.

This combinations of controls lead to a matrix of test options described in table 2.

Table 2. Test Plan for Configuration One

		No Network Constraint (10 Mb/s)	256 k Network	32 k Network
LAN Rates	video high quality	5	5A	5B
	video fast	6	6A	6B
32 k limit by profile	video high quality	7	7A	7B
	video fast	8	8A	8B
28 k limit by profile	video high quality			7C
	video fast			

The actual WAN bandwidth available to NetMeeting during testing was slightly less that the settings shown in Tables 1 and 2. This is because the use of Classical IP over ATM introduces a small additional framing overhead of 8 bytes per IP packet. As this overhead is relatively small it was not taken into consideration when assigning bandwidth values to the WAN connection.

4.3 Configuration Two

The configuration used to test the effect of conference topology on bandwidth was:

- Three IBM Thinkpad 760XDPentium 150 MMX fitted with Compro D-Cam Digital cameras and PCMCIA 10/100Mbp/s Zircom CE3 ethernet adaptor running at 10Mb/s.
- One Sparcstation 5 used to run the network monitoring software.
- One 10Mb/s shared ethernet hub.

4.4 Monitoring Software

The monitoring, processing and analysis of the NetMeeting experiments was carried out in a three stage process using software appropriate for each stage.

The Unix *snoop* utility was used to capture the details of packets exchanged between the NetMeeting processes. The *snoop* program promiscuously monitors packets and records for each packet, time of arrival, type of packet (TCP, UDP etc), TCP/UDP port number and payload length. The output of the program can be to the screen or, more typically to a special *snoop* format file for later off-line analysis. The program allows the user to filter to consider traffic only from a particular source, destination, port number or packet type. For this stage, *snoop* was monitoring all traffic from the system under test. More detailed filtering was conducted in the next stage.

A DSTO developed program *snoop_bps* took a text file generated from *snoop* for processing. *Snoop_bps* collated the output of *snoop* into activity in each second of time. The payloads were totalled to determine the effective user bit rate being offered each second. A second calculation was made to determine the bit rate being offered to the network. IP, TCP or UDP headers for each were considered. In addition, it was assumed that the packets would be transmitted over the wide area as PPP and appropriate header overheads were factored in. The output of this program was a text file suitable for input into the analysis phase.

4.5 Data Analysis

The analysis phase was conducted using Excel spreadsheets. For each test *Snoop_bps* was used to produce a set of files for the sending and the receiving ends of the link. Each set was composed of a file containing the TCP, audio and video traffic. All six of these files were loaded into a single spreadsheet. This data was then used to generate two types of graph. The first is an area graph showing the distribution of information by its type ie TCP, audio, video. The second is a simple line graph showing the total number of bits per second (bps) transmitted and optionally the total bps received. It is important to note that all graphs in this report are not drawn to the same scale, to assist the reader all X axes are labelled in hours:minutes:seconds.

In addition to the graphs, the average bandwidth and peak bandwidth usage in bps was calculated. The average bandwidth is based on audio and video traffic only and did not include any TCP traffic. Both average and peak bandwidth were always calculated for the period of time that both audio and video was being transmitted. An approximation of the amount of information lost during periods when the application was offering more traffic than the network could transport was also calculated.

5. Test Results

5.1 Introduction to Results

The NetMeeting Resource Kit [2] identifies a range of factors which will influence bandwidth consumption; among these are the choice of hardware (camera and CPU type), and the choice of operating system (Windows 95 vs Windows NT). It is therefore important for the reader to note that results obtained during testing are specific to the hardware/software configuration tested.

The amount of movement in the video is also an important factor which affects bandwidth consumption. During our testing approximately one third of the test cameras field of view was unintentionally obstructed by the back of the laptop, thus the amount of movement in our picture was reduced. In addition we were positioned so that there was little or no movement behind the subject. It would be reasonable to assume that if the product was deployed in a different environment such as a busy command centre the product would use more bandwidth.

5.2 UDP and IP Protocol Overhead

As discussed earlier in section 3.3, NetMeeting utilises the IP suite. The majority of traffic generated by NetMeeting is UDP, i.e. video and audio data contained in a UDP datagram which is in turn encapsulated by an IP packet. For the purposes of our discussion on protocol overheads we shall ignore the TCP traffic as the volume generated is small when compared to the volume of UDP traffic, see Figure 1.

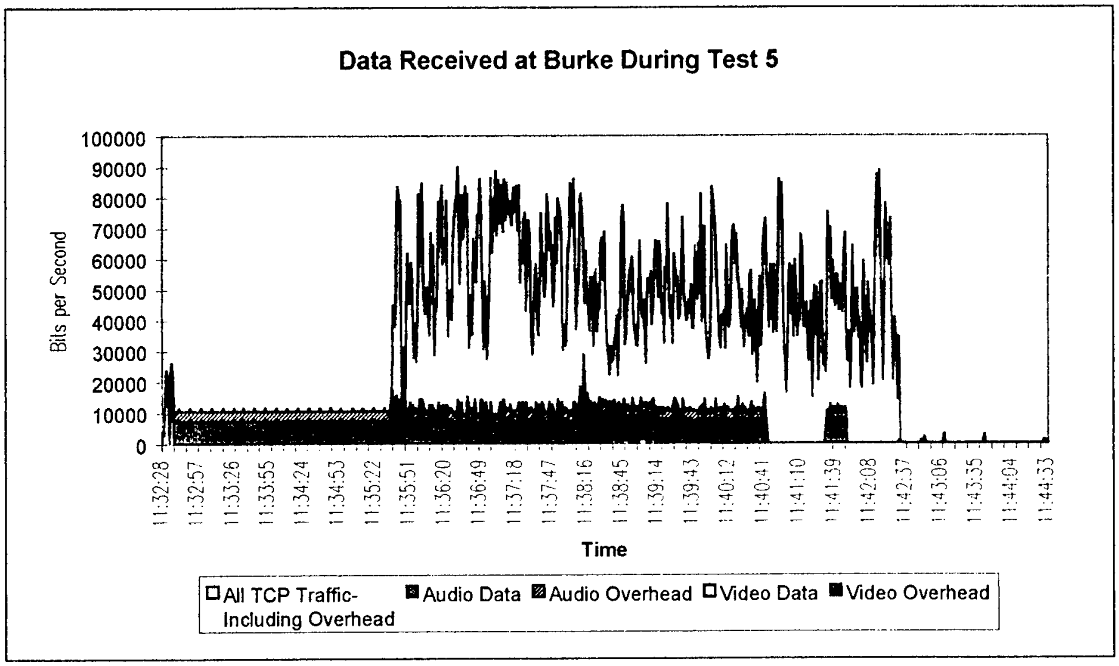


Figure 1

As can be seen from Figure 1 the overhead for audio traffic is quite noticeable and remains constant, whilst at this scale the overhead for video traffic is undetectable. This result is to be expected as audio traffic is composed of many small UDP packets whilst the video traffic is sent in fewer larger UDP packets. Figure 2 is a two minute sample taken from the same data starting at 11:34:38.

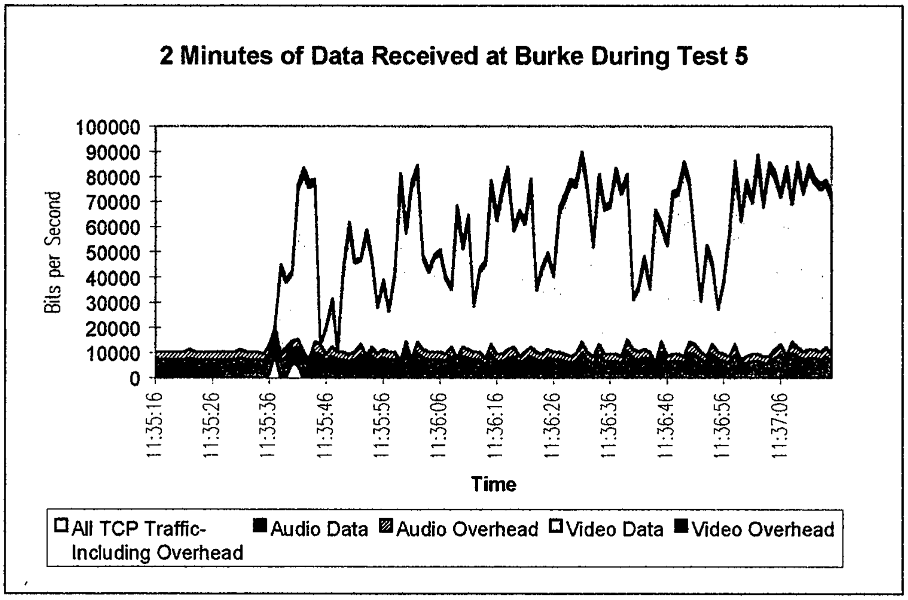


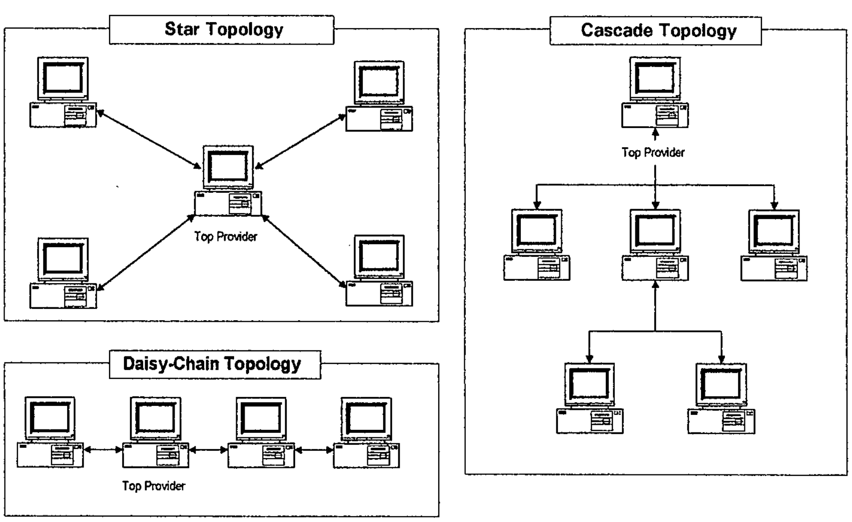
Figure 2

Throughout the remainder of this report we will only consider the gross data amount which includes the TCP/UDP and IP protocol overheads.

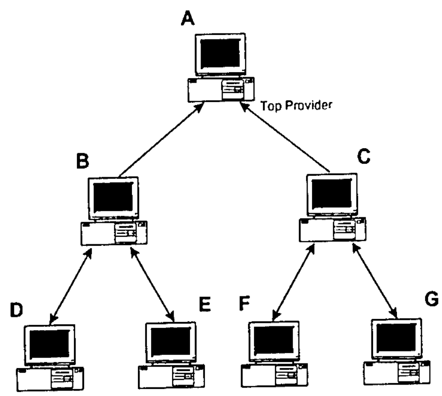
5.3 Impact of Conference Topology

The following extract from the NetMeeting 2.0 Resource Kit [2] gives an overview of the role of conference topologies in NetMeeting:

> The T.120 architecture supports several topologies that define how users connect to a conference and transmit data during the conference. The following diagram illustrates three common topologies: star, daisy-chain, and cascaded. These topologies represent the types of connections typical of NetMeeting 2.0 conferences.



The first node to place a conference call always becomes the top provider or controlling node, under the T.120 architecture this node is then responsible for coordinating and synchronising the conference. The following extract from the NetMeeting 2.0 Resource Kit [2] describes how the topology is formed:

> Data flows according to the conference topology, which is determined by how each connection in the conference is established ("who calls who"). For example, in the diagram, the following order of calls establishes the conference topology:
>
> - A (top provider) initiates calls to B and C.
> - Then, B calls D and E (or D and E each call B).
> - C calls F and G (or F and G each call C).
>
> 
>
>
> There is only one top provider in a conference. After the top provider (A) is established, that computer remains the top provider throughout the conference. Note that two conferences cannot be joined together. Therefore, if C called F and G first, it would not be possible for them to join the conference with A, B, D, and E.
>
> During data conferencing, if B shared an application with the other conference participants, data would flow simultaneously to the adjoining connections (A, D, and E). Then, data would continue to flow outward to the remaining connections. Also, any two connections within the conference can initiate audio and video conferencing. NetMeeting enables audio and video switching, so that participants can switch the pair sharing audio and video.
>
> If B hangs up or is removed from the conference, D and E are also removed. D and E may remain conferenced together, though, if they were connected with audio and video in the original session. D and E would not have data conferencing, however, because this function is removed when B hangs up.

We make two observations from this information, firstly that the transfer of audio and video information between two nodes is point to point and not affected by the conference topology. We tested this using configuration two with three computers on the same network segment, *snoop* was used to collect and analyse the data. We found that regardless of the conference topology, audio and video information always flowed point to point.

The second observation is that in a low bandwidth environment the conference topology will have a significant effect on data transfer. For example if we had two

sites connected by a WAN connection, say Canberra and Brisbane with two users at each site that wished to share a map via the whiteboard, we could establish a connection by the following sequence:

User A at Brisbane calls user B at Brisbane. Later, users C and D in Canberra join the call by calling user A in Brisbane. We can see from Figure 3 that this topology will result in inefficient use of the WAN bandwidth as any changes made to the map by user D will first be sent to user A and then back across the WAN to user C.

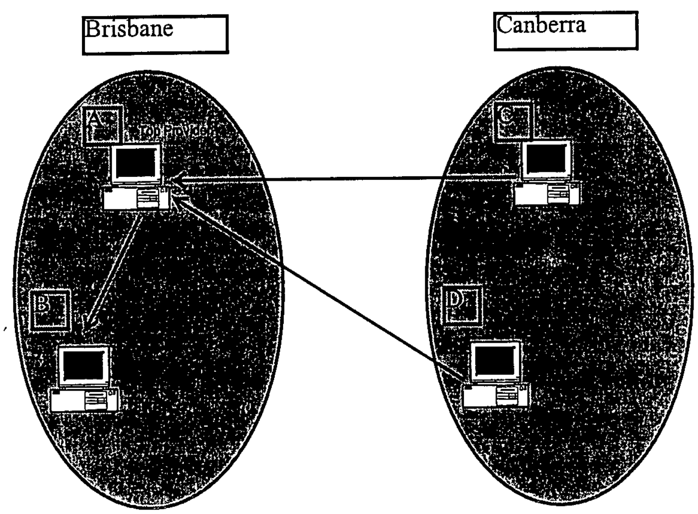


Figure 3

A simple rule can be established to ensure that WAN bandwidth is used efficiently, if you wish to data conference with people at a remote site you must first check to see if anyone at your site is already in the conference you wish to join, if they are you call them if not call the person you wish to speak to at the remote site. By following this rule the WAN bandwidth consumption will always be minimised.

5.4 Summary of Results

Detailed results of the trials are at Appendix One. Key points to draw from the trials are:

- Bandwidth requirements from the audio connection in NetMeeting is constant at about 10.5 kbps.
- Bandwidth requirement from the video connection in NetMeeting is substantially greater and very peaky.
- When unconstrained, NetMeeting capacity requirements average about 50 -60 kbps but peak around 120 - 130 kbps.
- Routers routinely provide buffers to overcome short periods of congestion. Large buffers prevent losses - especially welcome for TCP connections, but will cause large delays, and delay variation, for real time communications such as voice and video.
- The NetMeeting policy control provides good controls over the average capacity consumed by NetMeeting, but does not constrain peak requirements which can overwhelm the link capacity.

- Providing the system manager allows, NetMeeting offers a user control to set video quality to "Fastest Video"; this substantially reduces the capacity requirements of NetMeeting with little reduction in picture quality.

6. Conclusions

NetMeetings audio and video conferencing features can be used successfully at network rates as low as 32 kbps. By taking simple steps such as always setting video quality to fastest, users can dramatically decrease the bandwidth that NetMeeting utilises.

The different aspects of NetMeeting communications call for differing qualities of service (e.g. voice and video seek low delay and low delay variation) but this is not normally supported on an IP network. Some support is becoming available with advanced routers.

When using the data conferencing features of NetMeeting the manner in which a NetMeeting conference call is set up has an appreciable effect on bandwidth utilisation. Users with a poor understanding of how different conference topologies affect bandwidth could inadvertently double the required WAN bandwidth.

7. References

[1] A. S. Tanenbaum, *Computer Networks,* Third Edition, New Jersey: Prentice Hall International.

[2] Microsoft NetMeeting Resource Kit. (Available at: http://www.microsoft.com/netmeeting/)

Appendix A: Detailed Results

1.1 Introduction

The combinations of controls lead to a matrix of test options described in table 3.

Table 3. Test Plan for Configuration One

		No Network Constraint (10 Mb/s)	256kbps Network	32kbps Network
LAN Rates	video high quality	5	5A	5B
	video fast	6	6A	6B
32 k limit by profile	video high quality	7	7A	7B
	video fast	8	8A	8B
28 k limit by profile	video high quality			7C
	video fast			

1.2 Test 5 Series

The results from tests 5 are shown at Figures 4 and 5. The configuration for this test was high quality video, no system policy constraints and a 10Mb/s WAN connection. The results show two characteristics which are typical of NetMeeting traffic. Firstly audio traffic is more consistent in bandwidth demand than video traffic as can be seen from Figure 4 which shows the distribution of traffic sent during test 5 by traffic type. We can also see from this graph that the peaky nature of the overall traffic is being predominantly caused by the video traffic, this is not surprising given NetMeetings use of H.320 standards.

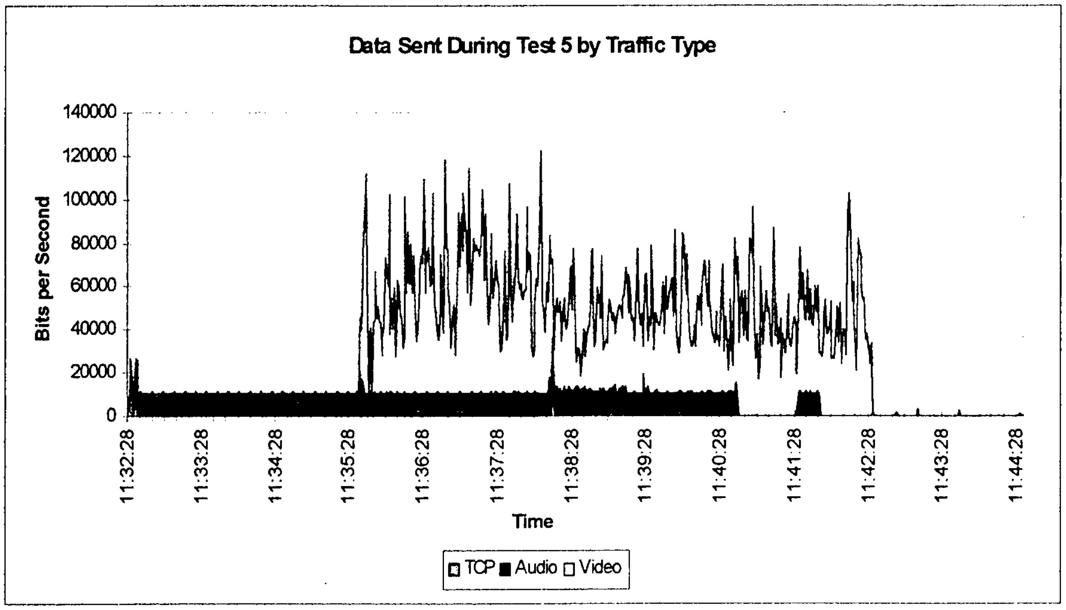


Figure 4

Figure 5 shows a comparison of the data sent and received during test 5. We can see from this graph that the volume of traffic arriving at Burke, the receiving end, is almost identical to the traffic departing Canb. It does however appear that some data is being lost during the highest traffic peaks. It is more likely that the apparent loses during the peaks are due to network latency, i.e. large packets sent in one second being received in the next second.

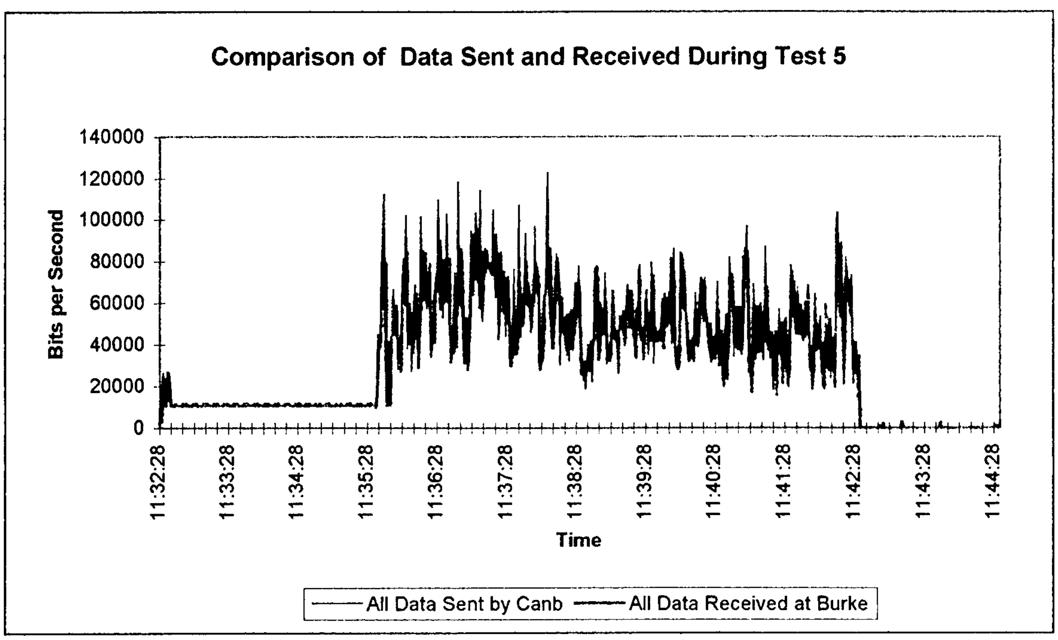


Figure 5

The average bandwidth consumption for NetMeeting when both audio and video traffic were being sent during test 5 was 54753 bps and the peak bandwidth was 122672 bps. Figure 6 shows the results from test 5a. The configuration for test 5a was almost identical to that for test 5 except that the WAN connections bandwidth was limited to 256kbps. The average bandwidth consumption when sending audio and video traffic was 58090 bps and the peak bandwidth was 118768 bps. As we would expect these figures are similar to the results from test 5. We can conclude from these figures that even with audio and video options in their most network intensive mode the product does not consume more that 140kbps of bandwidth in a point to point video conference.

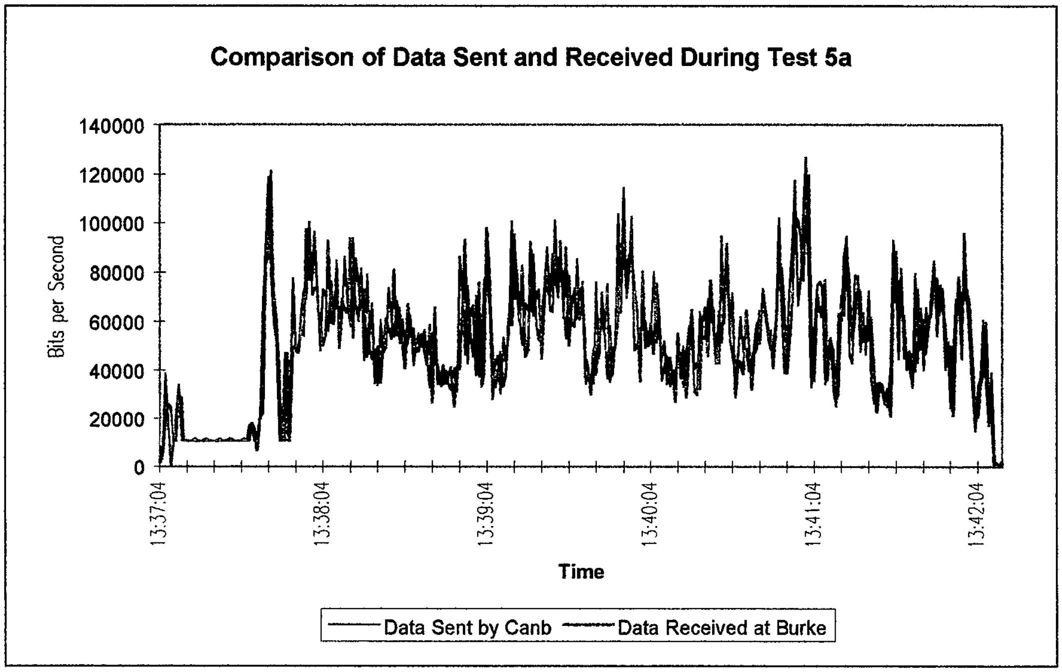


Figure 6

Test 5b is also identical to test 5 & 5a except that the WAN connections bandwidth is limited to 32kbps. In Figure 7 we can see quite clearly the effect of the constrained WAN bandwidth, when the Canb end is sending audio only, all traffic is getting through. However as soon as video is turned on at 14:19:33 the traffic offered jumps well above the available bandwidth and information loss occurs. The average traffic offered whilst both audio and video are on was 131016 bps and the average load received at Burke for the same period was 48279 bps. The information loss for the period was 49%.

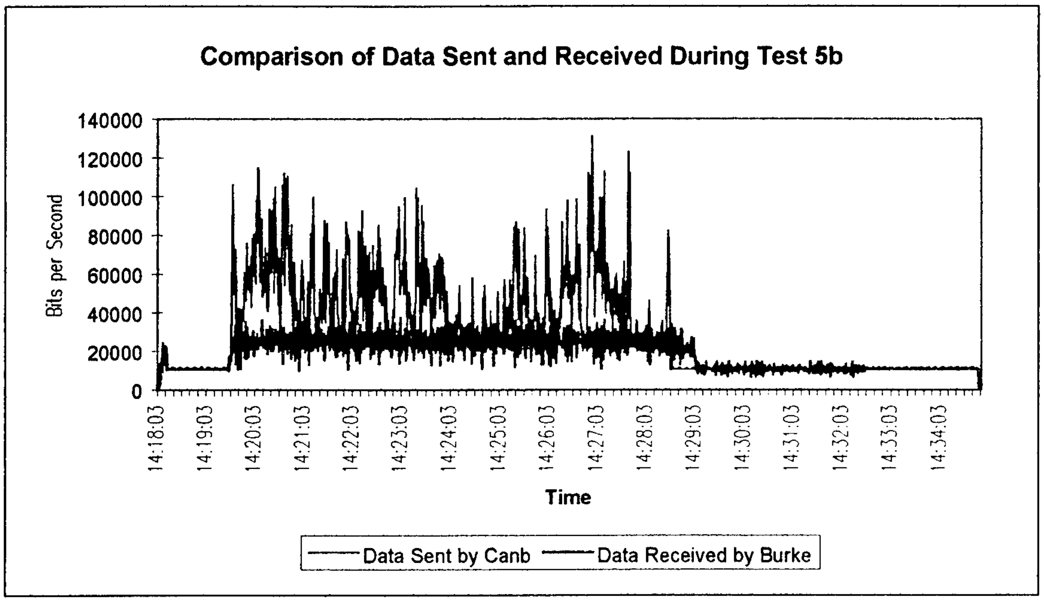


Figure 7

Figure 7 also shows the buffering provided by the routers in the network, we can see from the graph that Canb stoped sending video at 14:28:33 and that Burke continued to receive more data than Canb was offering for another 40 seconds, for approximately the next 3 minutes the traffic received remains unstable before settling down to the familiar audio pattern at 14:32:03. The presence of the buffer resulted in an apparent latency of about 20 seconds when both video and audio were being sent.

It is hardly surprising given the results obtained during this test that the video conferencing features of NetMeeting where unusable. Video quality was so bad that you could just identify the presence of a person's head and audio was extremely difficulty to understand. This test is a graphic illustration of the fact that NetMeeting does not automatically adjust its settings to suit the bandwidth available.

1.3 Test 6 Series

Figure 8 shows the results from test 6. The configuration for this test was fast video, no system policy constraints and a 10Mb/s WAN connection. The results indicate that using the user control to change the video quality to "Fastest Video" has a dramatic effect on bandwidth consumption. The average bandwidth consumption when both audio and video traffic are being sent during test 6 is 15943 bps. This figure is much smaller than the 53820 bps average we obtained for test 5 where the video quality was high. The peak bandwidth generated by the sender for test 6 was 36576 bps compared to 122672 bps for test 5. Test 6 also appears to be more stable in terms of output than test 5, in test 6 a peak in video traffic occurs approximately every 20 seconds. The quality of the picture received was subjectively little changed from the "Highest Quality" video opted for previously.

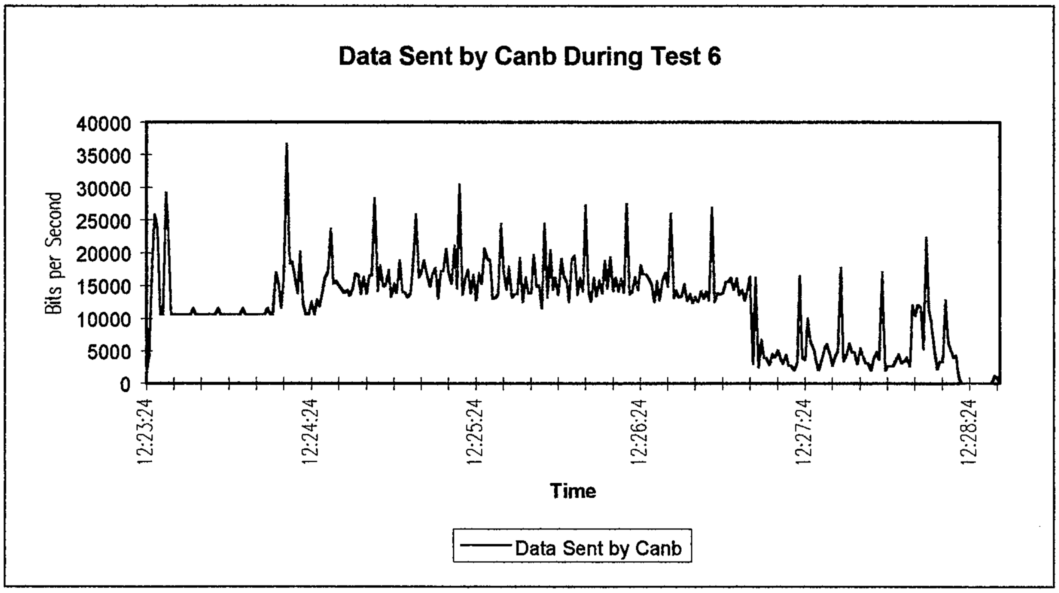


Figure 8

Figure 9 shows the results for test 6b. The configuration for this test was identical to test 6 except that the WAN connection was limited to 32kbps. Given the low average traffic and small traffic peaks of test 6 it is not surprising that test 6b has produced very similar results. The average bandwidth generated when both audio and video traffic is being sent during test 6b is 15731 bps and the peak bandwidth generated by the sender is 33296 bps. The overall quality of video and audio was quite good during this test.

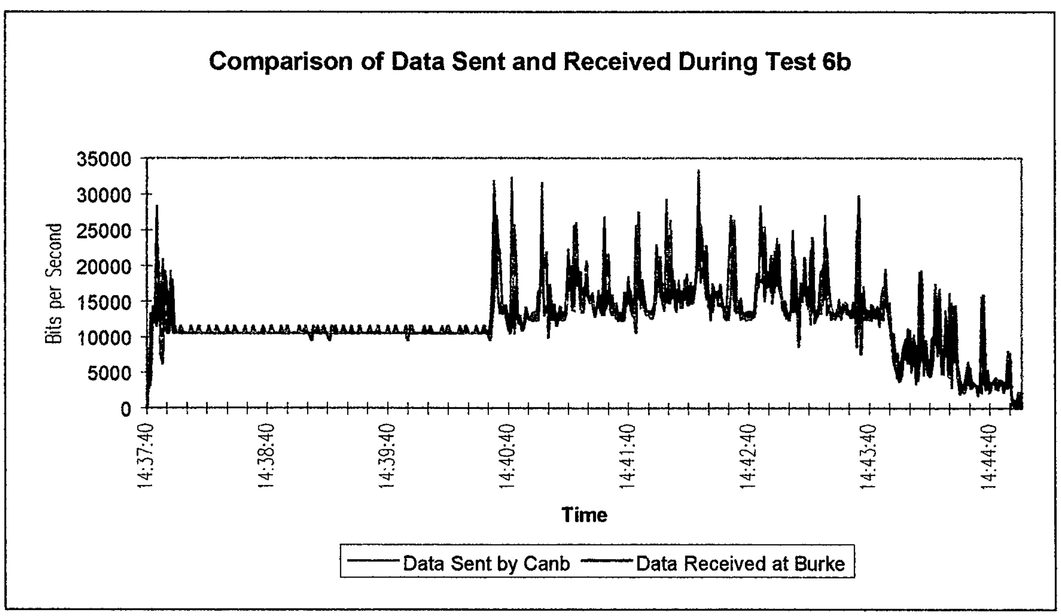


Figure 9

1.4 Test 7 Series

The results for test 7 are shown at figure 10. The configuration for this test was high quality video, 32kbps system policy constraint and a 10Mb/s WAN connection. Comparing the results from this test with test 5 we find that setting the system policy to constrain output to 32kbps has reduced the average bandwidth consumption when both audio and video traffic is being sent from the test 5 value of 53820 bps to 31879 bps.

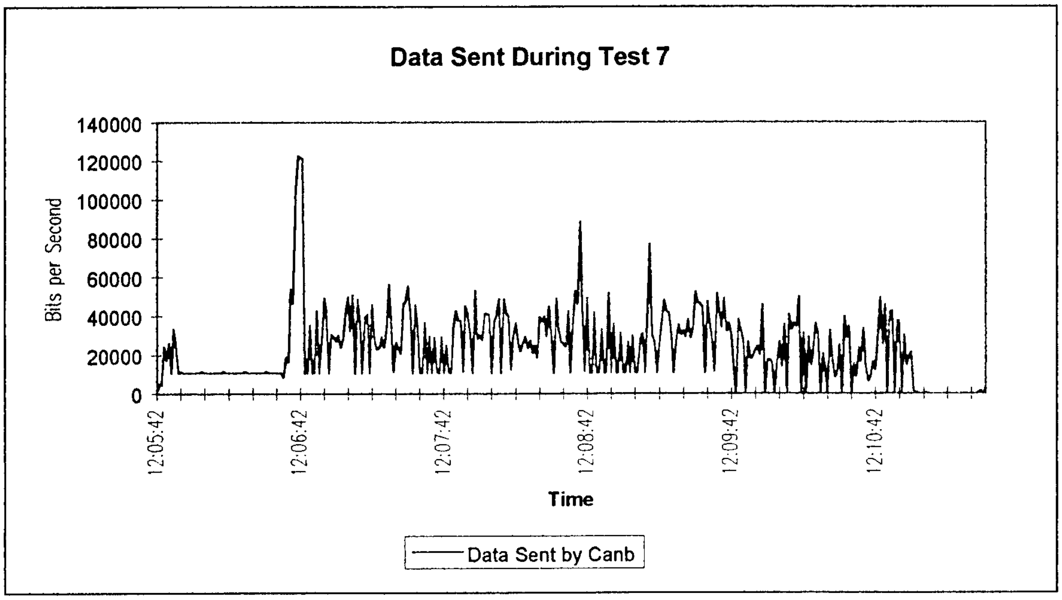


Figure 10

We can see from figure 10 that the traffic is constantly peaking above the 32kbps average value set by the system policy. Whilst this has no appreciable effect in test 7, because traffic is not constrained by the WAN connection, it does have an effect in test 7b when the WAN is constrained to 32kbps as shown in Figure 11. This diagram and Figure 12, which is a two minute slice of data sent by Canb broken down by traffic type, show that the video traffic is being sent in bursts. Returning again to figure 11 we see that the information received at Burke is much smoother hovering around 25kbps this is due to network buffering occurring at the Canb gateway.

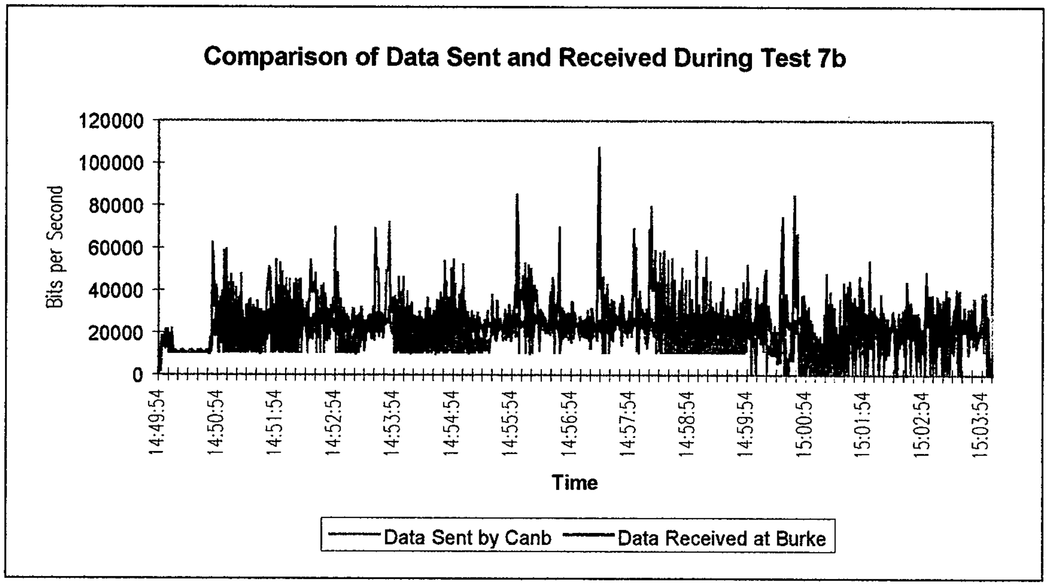


Figure 11

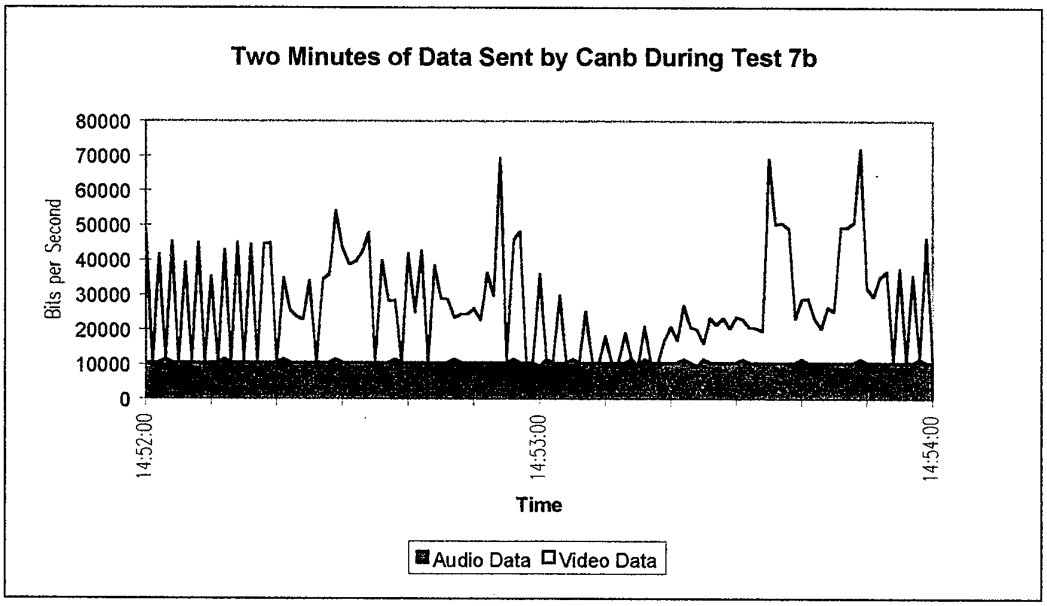


Figure 12

1.5 Test 8 Series

Figure 13 shows the results for Test 8. The configuration for this test was fast video, 32kbps system policy constraint and a 10Mb/s WAN connection. As we would expect the results for this test are similar to those for test 6 as even without a profile constraint NetMeeting used less than 32kbps when optimised for fast video.

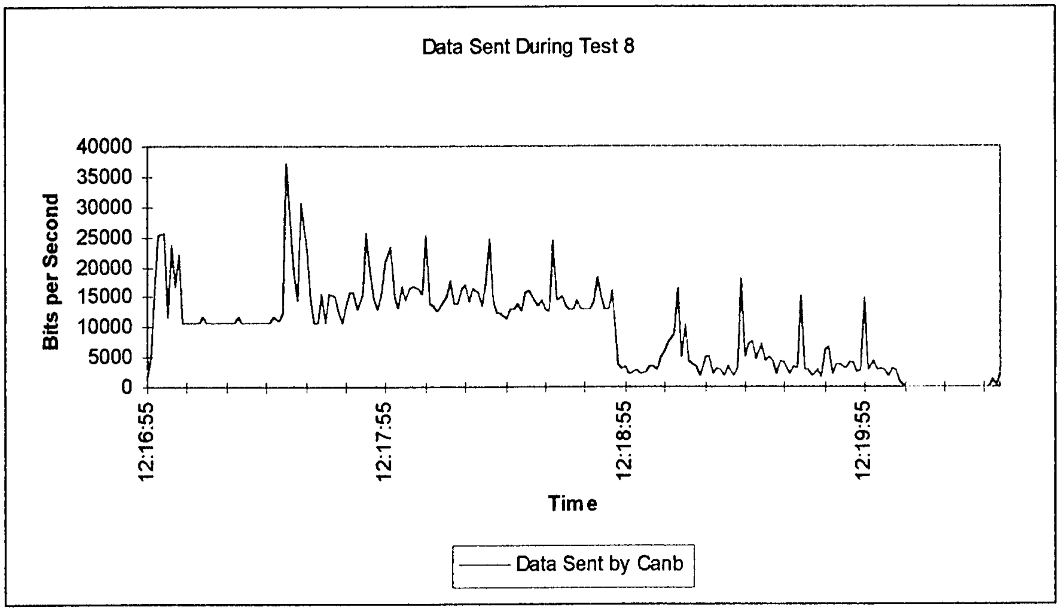


Figure 13

Figure 14 shows the results for test 8b. The configuration for this test was fast video, 32kbps system policy constraint and a 32kbps WAN connection. We can see from the diagram that the traffic is well behaved and there is little or no information loss occurring.

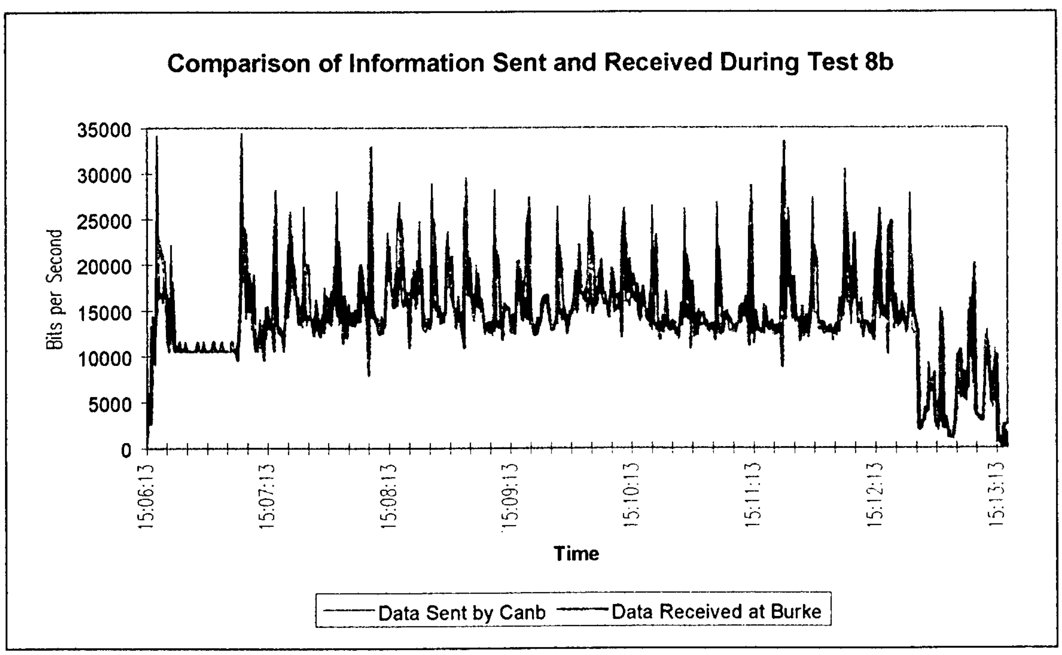


Figure 14

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Bandwidth Usage of the Collaborative Tool: Microsoft NetMeeting V2.0.

G.A. Coomber and W.D. Blair

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19. ABSTRACT

This report examines the bandwidth usage of a collaborative tool, Microsoft NetMeeting. It shows that NetMeetings software configuration options can be used to sucessfully operate the product in the tactical environment at bandwidths as low as 32 kbps. It also provides information on how to setup a data conference to minimise the use of Wide Area Network bandwidth.

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