

MBONE WEBCAST: NETWORK SETUP AND DATA COLLECTION

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Abstract

In this paper, we describe the webcast implementation details and data collection during a multicast session of a technical conference held in Vancouver in Summer 2001. Audio and video signals were multicast using Internet Multicast Backbone (MBone) multimedia conferencing tools. The signals were transmitted to the MBone network using DVMRP tunneling through an ADSL line to the BCnet gigabit-capacity point of presence. Genuine traffic traces were collected during the multicast session and were later used to analyze the impact of traffic on network performance.

Key Words

Multimedia conferencing, multicast, MBone, tunneling, traffic collection.

1. Introduction

In Summer 2001, we organized the multicast session of the Open Forum workshop held at the Joint 9th International Fuzzy Systems Association World Congress and the 20th North American Fuzzy Information Processing Society International Conference (IFSA/NAFIPS 2001) held in Vancouver on July 25-28, 2001. In this paper, we describe the implementation details and data collection that was performed during the multicast session. We first provide an overview of the Internet Multicast Backbone (MBone) multimedia application tools. We then describe details of the MBone multicast sessions and the webcast setup at the IFSA/NAFIPS 2001 conference [1].

1.1 Multimedia conferencing using MBone

The MBone is the multicast-capable backbone of the Internet. It is a virtual network built on top of the Internet. It shares the same physical media with the Internet, while using a parallel system of multicast enabled routers connected via high-bandwidth *tunnels*. Even though the MBone was originally envisioned as an experimental network, it currently consists of more than 4,200 multicast routers [2].

Before users can participate in an MBone session, they need to launch the multicast Session Directory tool (`sdr`) to set up and join the multicast session [3]. Once a session has been announced to other users on `sdr`, they may join the particular session. Each session contains the following advertisement: session title, session description, details about media types used (audio, video, whiteboard, and/or text editor), and the time and date when the session will take place.

After joining the session, the `sdr` automatically launches the application tool corresponding to the media type that is selected for participation in the multicast event. If `sdr` is not available, multicast addresses, port numbers, and TTL values must be announced through e-mail, phone, or posting on a web page. In this case, the appropriate tools can be invoked manually via the command:

```
name -t ttl address/port,
```

where `name` corresponds to the tool name (`rat`, `vic`, `wbd`, or `nre`), `ttl` corresponds to the Time to Live (TTL) value, and `address/port` corresponds to the multicast address and the port number. The variable `port` is a User Datagram Protocol (UDP) number, unique to the broadcast session. It is automatically assigned by the `sdr` together with the multicast address. The TTL value determines how far multicast packets can travel across the Internet. The higher the TTL is, the further the destination that packet can reach. Standard values for TTL are: 15 for a local area network, 63 for a region, and 127 for the world.

Robust Audio Tool (`rat`) provides access to audio data. Videoconferencing Tool (`vic`) provides access to video data, `wbd` displays a whiteboard, while `nre` opens the Network Text Editor. The MBone tools that we used were developed at University College London [3].

1.2 Multicasting

Multicasting is a way of efficiently sending data packets across the Internet from a host computer to a set of hosts that belong to different sub-networks. It is used for applications such as videoconferencing, corporate communications, or distance learning, where many

destination hosts choose to receive data from a single source. The source host sends data to a specific multicast IP address called a *multicast group*. Multicast groups are identified by a Class D IP address in the range from 224.0.0.0 to 239.255.255.255 [4]. In unicast or broadcast transmissions, copies of a packet are made and sent to multiple destinations. The multicast source sends a packet only once, and, thus, makes the multicast transmission more efficient [5].

Multicast aware MBone routers use multicast routing protocols to deliver packets across the Internet to dispersed sub-networks whose member hosts belong to a specific multicast group. A multicast routing protocol is responsible for building the multicast distribution trees and for forwarding the multicast traffic. The most frequently used multicast routing protocols are the Distance Vector Multicast Routing Protocol (DVMRP) [6], Protocol Independent Multicast (PIM) [7], and Internet Group Management Protocol (IGMP) [4].

For various reasons, many IP routers on the Internet do not support multicast routing. Some organizations do not support multicast to avoid security problems. Furthermore, some local area networks have multicast traffic disabled to avoid unnecessary traffic that may cause performance degradation. This blocking of multicast traffic across networks prohibits the use of the MBone in such environments.

Tunneling is a scheme used for forwarding multicast packets among the islands of MBone sub-networks (multicast domains) through IP routers that do not support multicast. This is achieved by encapsulating the IP multicast datagrams into unicast IP packets and by addressing them to the routers that support multicast routing. Multicast enabled routers use the DVMRP protocol that provides connectionless datagram delivery to multicast group members [8]. Multicast routing capabilities are usually implemented on UNIX workstations running the *mrouterd* program [9].

2. The MBone test session at SFU

We first performed an MBone test session in the Communication Networks Laboratory (CNL) at Simon Fraser University (SFU).

In order to establish an MBone multicast session, it is essential that all routers between two end points have enabled multicast functionality. Neither the Centre for Systems Science network (CSSnet) nor the Academic Computing Services network (ACSnet) at SFU support multicast routing outside their respective domains. This implies that it is not possible to establish an MBone session between a machine in the CSSnet (or the ACSnet) and the outside world. One approach to establishing MBone sessions originating from the SFU campus is *tunneling*: i.e., creating a tunnel from a source machine to

the BCnet point of presence and, then, multicasting from there to the Internet MBone. The source machine needs to have an appropriate video capture board, video camera, an audio input, and the MBone tools to create the MBone feed. It also requires a DVMRP tunnel to the machine (named *jade.bc.net*) in the BCnet.

The DVMRP tunnel, which tunnels IGMP in IP, needs to be established between the two end points. The tunnel's end points may be two workstations running the Unix operating system and the *mrouterd* program. The *mrouterd* program is loaded with the standard installation of FreeBSD. In our tests, we used two FreeBSD PCs, one at each end of the tunnel.

To test the setup on the SFU campus, a machine at the tunnel termination in Harbour Centre (BCnet POP) was required. The test plan was to setup the DVMRP tunnel from the CNL laboratory, over the campus links, to the BCnet and then to the MBone. Upon successful completion of the test, moving the equipment to the conference site and connecting it to the ADSL modem would reduce the available bandwidth, but would not produce any operational difference.

The idea was to have the PC with MBone tools on a local network sending the multicast traffic via the DVMRP tunnel to a machine on the remote network that terminated the tunnel and routed the multicast locally. This was needed to ensure that the local multicast did not travel through the local router. In order to verify that the multicast could be received, a third machine should be used as an MBone client on the remote network where the tunnel terminates.

Hence, to ensure the multicast was operational, we decided to use the machine in the ACSnet to establish the tunnel to the machine in the CSSnet, and use a third machine (also on the CSSnet) with a video camera and an MBone client. Upon completion of this initial test within the CNL laboratory, we connected to the BCnet GigaPOP and performed a test transmission to the MBone. We were interested in finding out if MBone users outside the BCnet could join our MBone session.

Users on a remote network cannot join MBone sessions when the unicast and multicast routes differ. Therefore, we needed to test the tunneling of the SFU (ACSnet) IP address via a foreign network. In the initial test at SFU the foreign network was CSSnet, while during the live MBone webcast at the conference site, the foreign network was the Telus network accessed via the ADSL link.

2.1 Network setup

The test session network setup in the CNL laboratory at SFU is shown in Figure 1.

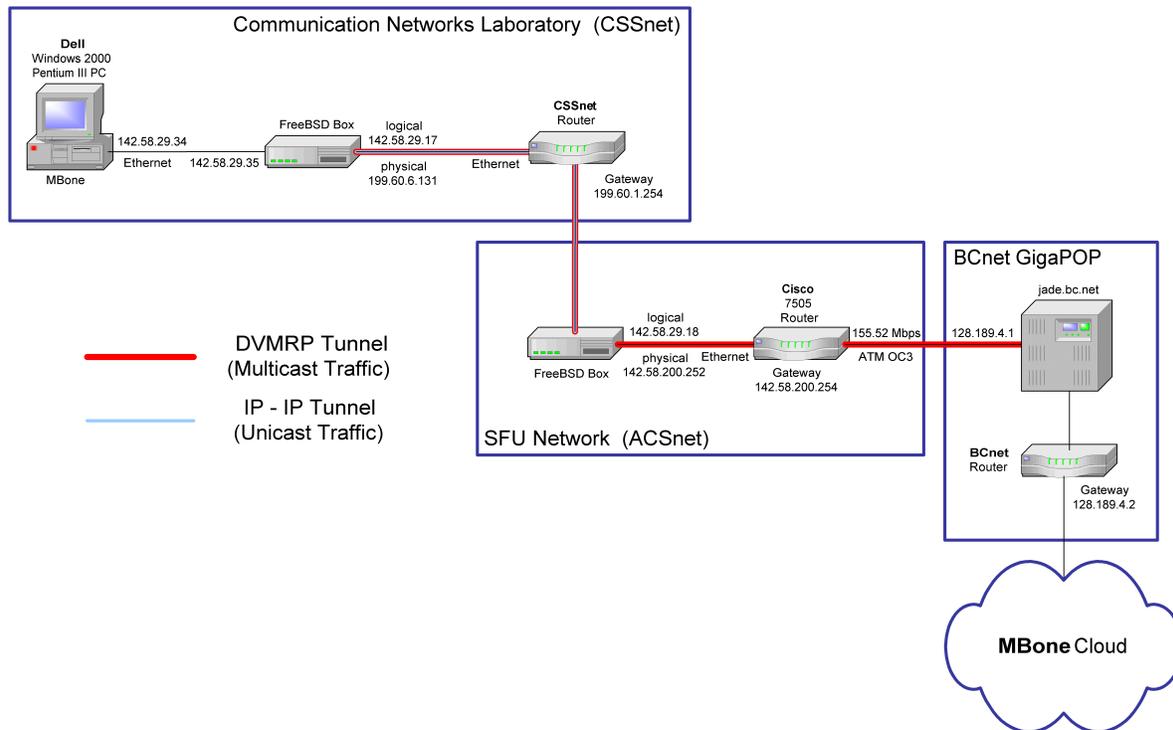


Figure 1: Network setup for the MBone test session in the Communication Networks Laboratory at SFU.

The FreeBSD PC had two network interfaces, one marked ADSL (connected to the CSSnet) and one marked MBone to which the MBone machine was attached.

The Internet protocol (TCP/IP) settings on the FreeBSD machine used for testing at SFU were:

```
IP Address: 199.60.6.131
Subnet Mask: 255.255.240.0
Default Gateway: 199.60.1.254
DNS Server: 199.60.1.1
```

The Internet protocol (TCP/IP) settings on the MBone machine were:

```
IP Address: 142.58.29.34
Subnet Mask: 255.255.255.248
Default Gateway: 142.58.29.35
DNS Server: 199.60.1.1
```

The static route for the 142.58.50.0 network was directed to 199.60.1.254 in order for the tunnel traffic to reach the ACSnet. The `/etc/rc.local` file for the test session at SFU was:

```
gifconfig gif0 inet 199.60.6.131 142.58.50.1
route add -net 142.58.50.0 199.60.1.254 \
255.255.255.0
mouted
```

The DVMRP tunnel was configured in the `/etc/mouted.conf` file, as:

```
tunnel 142.58.29.35 128.189.4.1
```

The dual port FreeBSD box in the CNL laboratory (connected to the CSSnet) acted as a router, an *mouted* host, and a tunnel starting point, all at once. One interface provided the IP address 142.58.29.17 and accepted the multicast traffic coming from the attached MBone machine. The second interface was connected to the CSSnet and it routed multicast traffic to the ACSnet. The CSSnet FreeBSD machine created an IP in IP tunnel to 142.58.200.252, and an *mouted* DVMRP tunnel to jade.bc.net (in the BCnet) with the IP address 128.189.4.1. The second FreeBSD machine was located in the ACSnet. Its role was to terminate the IP in IP tunnel and forward the multicast traffic to the BCnet GigaPOP.

2.2 The MBone test session setup

The MBone test session from CNL laboratory at SFU was entitled: "Test from SFU". The details of the media used are:

	PROTOCOL	FORMAT	ADDRESS/PORT	TTL
AUDIO	rtp	pcm	224.2.218.26/20856	127
VIDEO	rtp	h.261	224.2.173.55/64872	127

In the test session announcement, the recommended MBone conferencing tools were *rat* for audio and *vic* for video signals. *rat* and *vic* should be started using *sdr*.

3. The MBone multicast session of the Open Forum workshop at IFSA/NAFIPS 2001

We organized the live webcast MBone session of the Open Forum workshop held at the IFSA/NAFIPS 2001 conference in Vancouver on July 25-28, 2001. We describe here the network setup and the collection of the genuine audio and video traffic traces during the multicast session.

The webcast session network setup is shown in Figure 2. The dual port FreeBSD machine at the IFSA/NAFIPS 2001 conference site performed the routing between the 142.58.29.32/29 interface and the 142.58.29.16/29 interface. The MBone machine (mbone1.ensc.sfu.ca with IP address 142.58.29.34) was connected to the FreeBSD machine on the interface 142.58.29.35. 142.58.29.17 was the default route for the FreeBSD machine at the conference site and the tunnel's starting point. *mrouterd* on the same FreeBSD machine created a DVMRP tunnel to jade.bc.net (the MBone machine at the BCnet GigaPOP). This machine (jade.bc.net) had an additional DVMRP tunnel to the commodity MBone.

The IP in IP tunnel routed the traffic arriving at the physical interface of the FreeBSD box to the ADSL line, and from the Telus network to the machine 142.58.50.1 on the ACSnet at SFU. The FreeBSD PC in the ACSnet had a connection to an Ethernet port on the SFU Cisco

7505 router that was connected to the BCnet via an OC3 ATM network. That router was the termination point of the IP in IP tunnel. The purpose of this tunnel was to hide the Telus ADSL link from the unicast routing path, so that the multicast route from jade.bc.net would match the unicast route from the MBone machine (142.58.29.34) at the conference site.

3.1 Network setup

The `/etc/rc.conf` file for the IFSA/NAFIPS 2001 webcast session at the conference site was:

```
# -- sysinstall generated deltas -- #
# Enable network daemons for user convenience.
# This file now contains just the overrides from
/etc/defaults/rc.conf
# please make all changes to this file.
gateway_enable="YES"
# defaultrouter="142.58.29.17"
hostname="mbone1.ensc.sfu.ca"
ifconfig_gif0="inet 142.58.29.18 netmask
255.255.255.248 142.58.29.17"
ifconfig_xl0="DHCP"
ifconfig_rl0="inet 142.58.29.35 netmask
255.255.255.248"
inetd_enable="NO"
kern_securelevel="2"
kern_securelevel_enable="YES"
nfs_server_enable="NO"
portmap_enable="NO"
sendmail_enable="NO"
sshd_enable="YES"
```

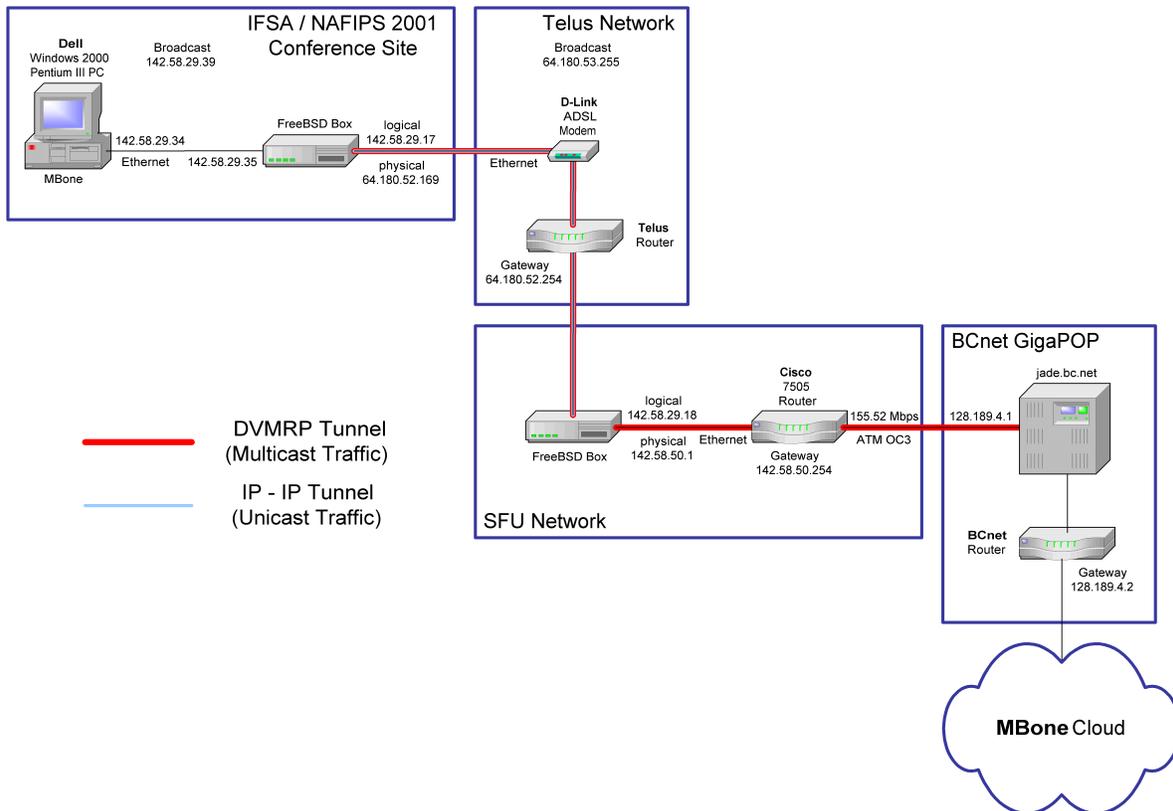


Figure 2: Network setup for the MBone webcast session at the IFSA/NAFIPS 2001 conference.

The default router line was commented in order to allow DHCP to set the default route to the Telus network via ADSL.

The FreeBSD machine was booted while it was connected to the ADSL modem in order to accept the addresses assigned by the DHCP server. The assigned IP addresses were:

```
IP address: 64.180.52.169
Subnet Mask: 255.255.254.0
Default Gateway: 64.180.52.254
```

The routing table was obtained using the command `netstat -rn`:

```
Destination      Gateway          Flags    Netif
default          64.180.52.254  UGSc    xl0
64.180.52/23    link #1         UC      gif0
127.0.0.1       127.0.0.1      UH      lo
142.58.29.32/29 link #2         UC      rl0
```

The routing table provided information about the assigned IP address (64.180.52.169), default gateway (64.180.52.254), and subnet mask (255.255.254.0) that were needed to configure the `rc.local` file. The IP address of the Telus default gateway (64.180.52.254) was deleted, and the IP address of the local gateway (142.58.29.17) was added. The static route for the 142.58.50.0 network was directed to 64.180.52.254, so that the tunnel traffic could reach the ACSnet.

The `/etc/rc.local` file for the IFSA/NAFIPS 2001 webcast session was:

```
route delete default 64.180.52.254
route add default 142.58.29.17
gifconfig gif0 inet 64.180.52.169 142.58.50.1
route add -net 142.58.50.0 64.180.52.254 \
255.255.255.0
route add -net 142.58.103.0 64.180.52.254 \
255.255.255.0
mouted
```

The DVMRP tunnel was configured in the `/etc/mrouted.conf` file, as:

```
tunnel 142.58.29.35 128.189.4.1
```

The default router line in the `/etc/rc.conf` file was uncommented to force a new default route (142.58.29.17), which is the tunnel's starting point. We also changed the tunnel addresses in the `/etc/rc.local` file to match the IP addresses obtained from the routing table.

On the other side of the IP in IP tunnel, analogous changes had to be implemented in the ACSnet FreeBSD machine. (The details of the setup are not available because they were implemented locally by the ACSnet system administrators.)

During the webcast session network setup at the conference site, shown in Figure 2, the local FreeBSD machine (with IP address 64.180.52.169) created an IP in IP tunnel to 142.58.50.1, and an *mrouted* DVMRP tunnel to jade.bc.net (BCnet) with the IP address 128.189.4.1.

3.2 The MBone live session setup

The MBone webcast session from the conference was entitled: "IFSA/NAFIPS 2001 Open Forum session". The details of the media used are:

	PROTOCOL	FORMAT	ADDRESS/PORT	TTL
AUDIO	rtp	pcm	224.2.160.30/20038	127
VIDEO	rtp	h.261	224.2.152.112/65504	127

In the webcast session announcement, the recommended MBone conferencing tools were `rat` for audio and `vic` for video signals. The `rat` and `vic` tools should be started using `sdr`. If `sdr` was not available, the audio and video tools could be started manually with the commands:

```
rat -t 127 224.2.160.30/20038
vic -t 127 224.2.152.112/65504
```

The `sdr`, `rat`, and `vic` MBone tools setup, before the live MBone webcast session at the IFSA/NAFIPS 2001 conference had started, is shown in Figure 3.

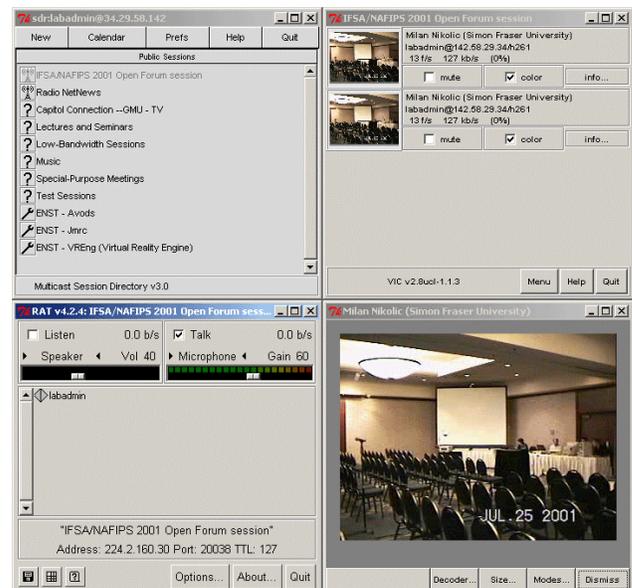


Figure 3: The `sdr`, `rat`, and `vic` MBone application tools setup for the live session at the IFSA/NAFIPS 2001 Open Forum workshop chaired by Prof. Lotfi Zadeh.

The audio/video and measurement equipment setup used for the live MBone webcast session is shown in Figure 4.

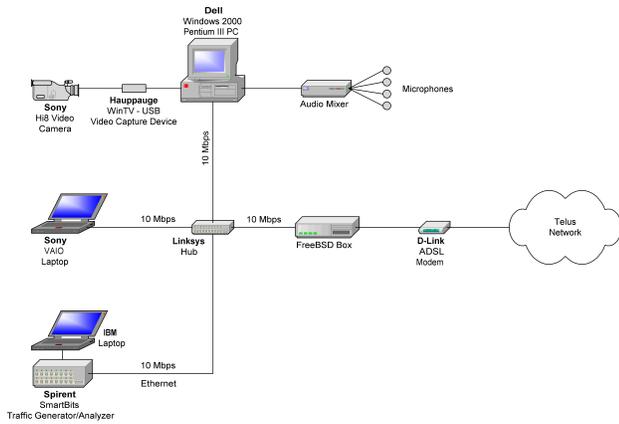


Figure 4: The audio/video and measurement equipment setup for the live MBone webcast session.

The video signal was captured with a Sony Hi8 video camera and converted to a digital signal by Hauppauge WinTV - USB video capture. Audio signals were captured with four PZM microphones and an audio mixer. Traffic traces were captured using *tcpdump* on two laptop PCs, using the command:

```
tcpdump -w -n <file_name>
```

in the LINUX environment. From the original data (sample):

```
13:23:52.743908 142.58.29.34.1043 > \
                224.2.152.112.65504: udp 993
13:23:52.744331 142.58.29.34.1043 > \
                224.2.152.112.65504: udp 551
13:23:53.212855 142.58.29.34.20038 > \
                224.2.160.30.20038: udp 96
13:23:53.229241 142.58.29.34.20038 > \
                224.2.160.30.20038: udp 96
13:23:53.251362 142.58.29.34.20038 > \
                224.2.160.30.20038: udp 96
13:23:53.260655 142.58.29.34.1043 > \
                224.2.152.112.65504: udp 1000
13:23:53.277100 142.58.29.34.20038 > \
                224.2.160.30.20038: udp 96,
```

we extracted the traffic trace with inter-arrival times [sec] and packet sizes [bytes] (sample):

```
0.001652 993
0.000423 551
0.468524 96
0.016386 96
0.022121 96
0.009293 1000
0.016445 96.
```

The collected traffic traces were later used for trace-driven simulations and the analysis of traffic impact on network performance.

The video-recorded webcast was processed using Adobe Premiere 6.0. The archived webcast has been posted on the IFSA/NAFIPS web page and it is available in the Real Player and Windows Media Player formats [10].

4. Conclusions

We performed several test multicasts to the Internet Multicast Backbone (MBone) and organized the multicast session of the Open Forum workshop held at the IFSA/NAFIPS 2001 conference. The MBone is a virtual network built on top of the Internet, which comprises multicast enabled routers connected with virtual links called tunnels. The connection to the MBone network was established using DVMRP tunneling through the ADSL link (provided by Telus) to the BCnet GigaPOP, via the SFU campus network. Audio and video signals from the session were sent to the MBone using the *sdr*, *rat*, and *vic* MBone multimedia conferencing tools. Genuine traffic traces were collected during the multicast and were later used to analyze the impact of traffic on network performance. The archived webcast has been posted on the IFSA/NAFIPS web page and it is available in the Real Player and Windows Media Player formats.

5. Acknowledgement

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