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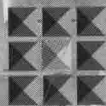
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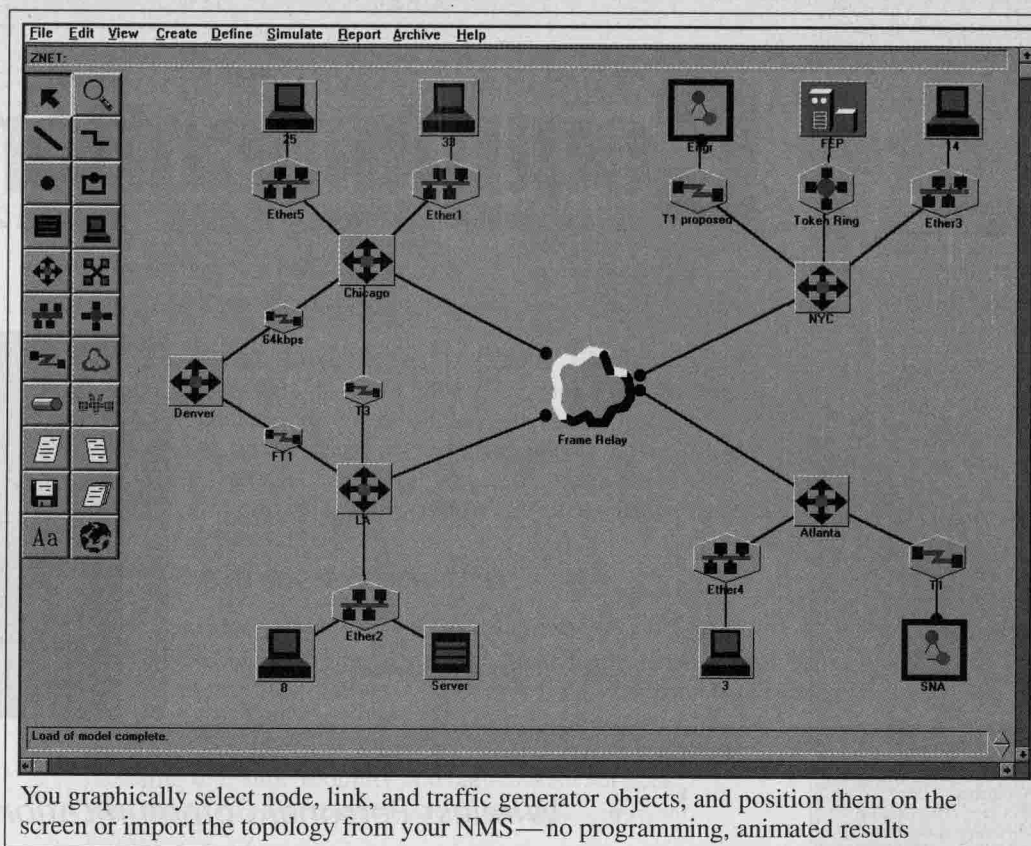
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IEEE Communications Magazine

January 1995 Vol. 33 No. 1

MAGAZINE

■ THIS ISSUE

is a current portrait of wireless personal communications around the globe.

Cover Illustration: Image Bank



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- 42 Propagation Measurements and Models for Wireless Communications Channels**
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BRIEF TOPICS IN COMMUNICATIONS

The Internet Multicast from ITS: How it was Done and Implications for the Future

Luis F. M. de Moraes and Stephen B. Weinstein

Many sessions at the International Telecommunications Symposium (ITS) in Rio de Janeiro, Brazil, in August 1994, were multicast through the Internet as live audio and pictures to viewers in the U.S. and elsewhere. The Multicast Backbone (MBONE) frequently carries meetings of the Internet community and special events such as space shuttle launchings. It is beginning to be used for workshops and other professional gatherings. Making one of its major conferences available through MBONE was a first for the Communications Society and a cooperative effort by many people that relied on the generous loan of equipment and staff members by a number of companies. A special satellite data connection extended MBONE from the United States to Brazil. We report here on how it was done and what it means for the Communications Society.

MBONE

MBONE, a virtual network layered on portions of the existing physical Internet [1,2] is composed of islands (such as multicast LANs like Ethernet), joined by virtual point-to-point links called "tunnels" (Fig. 1). The tunnel endpoints are typically workstation-class machines with operating system support for IP multicast and running the "mrouted" multicast routing daemon (always-running background process). IP multicast packets are encapsulated for transmission through tunnels, so that they

look like normal unicast packets to intervening routers and subnets. IP multicast addressing is an Internet standard (RFC 1112) [3] developed by Steve Deering of Xerox PARC and now supported by numerous workstation vendors. The real-time protocol (RTP) used for transmission of audio, video, and whiteboard media is due largely to Steve Casner, chair of the Internet Working Group in this area.

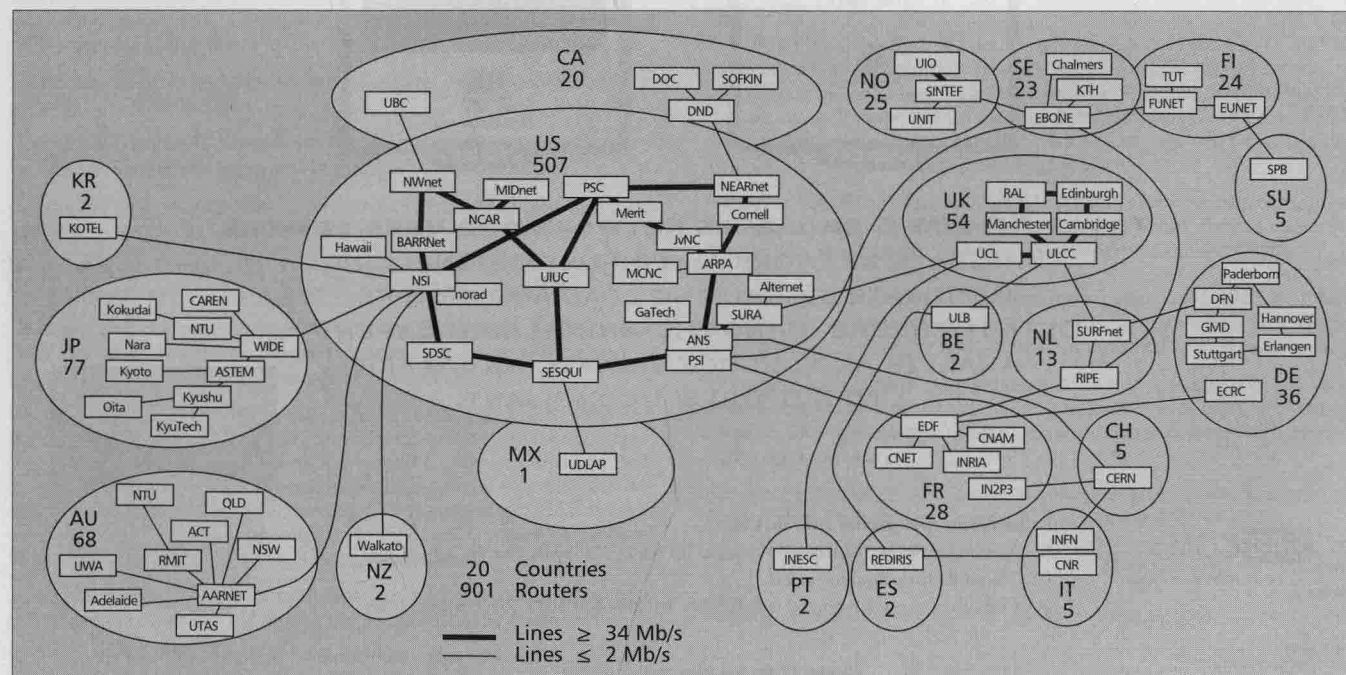
A participating workstation should have audio coding hardware plus software for compression to 32-Kb/s ADPCM, 13-Kb/s GSM, or 4.8 Kb/s LPC. The software for packet audio (vat) and video (nv), and the user interface software, is available by anonymous ftp [4]. No special hardware is required to receive the slow-frame-rate video prevalent on MBONE since decoding and display is done in software. The data rate is typically 25-150 Kb/s. Originating video requires a camera and a frame grabber card. A whiteboard function (wb), supporting display of Postscript documents as well as ASCII text, is also available.

Many of the audio and video transmissions over MBONE are advertised in sd, the session directory tool (accessed through the user interface). Session creators register the session with sd which assigns an address. This address and the session information appear on the screens of workstations running sd. The audio and video programs can be invoked with the right parameters by clicking a button in sd.

Why Do It?

This multicast, designed by us and our colleagues at the Federal University of Rio and NEC's Princeton C&C Laboratory, had several motivations. One was to further the globalization of the Communications Society by illustrating how a national society such as the Brazilian Telecommunications Society and the Communications Society can jointly sponsor a conference that has a truly international accessibility. In the future, it could become common for a Communications Society member to purchase a remote registration for a distant conference or workshop, listen to and view sessions of his or her choice, and ask questions while being seen and heard by people at the meeting location and those attending remotely.

This will be an enhancement of services offered by the Communications Society that many of us believe will increase the value of membership and the impact of our activities. It will give us additional freedom in locating conferences and could provide more stability in conference finances. Although this initial experiment was free, and the quality of the service may not be good enough to charge for in the immediate future, the Society expects that in a few years it will begin collecting registration fees for remote electronic participation. This is itself part of a larger, still developing plan to convert as many as possible of the Society's activities from



■ Figure 1. Major MBONE routers and links (courtesy of Steve Casner).

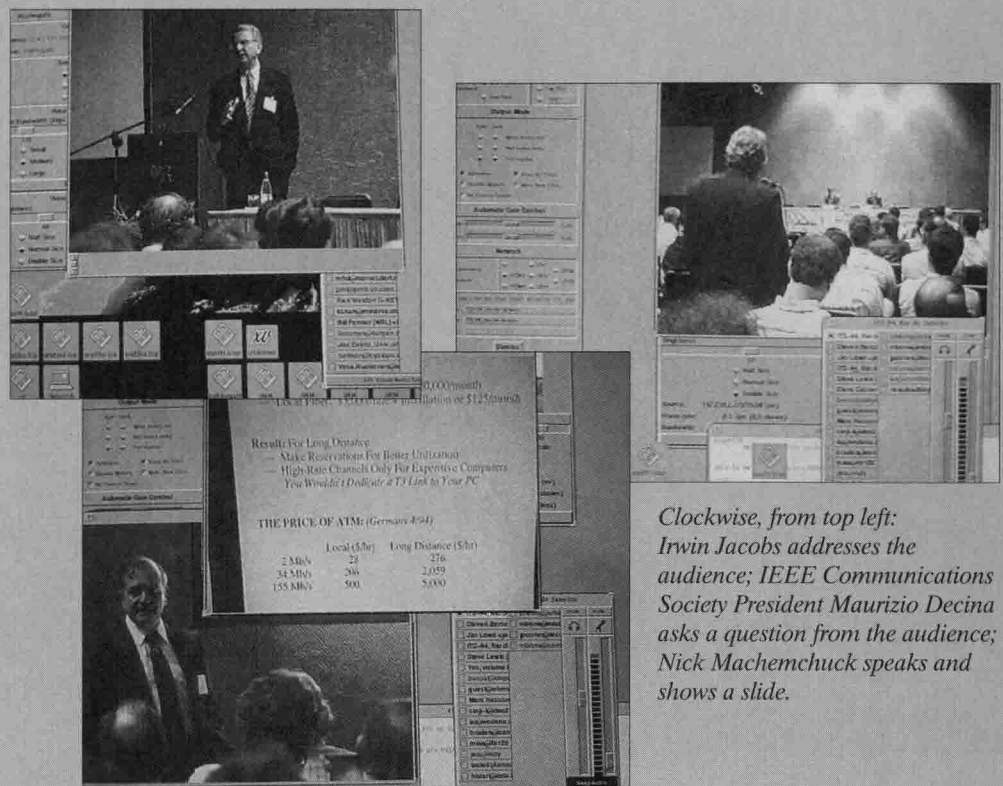
paper-based to computer and communications-based.

A secondary motivation was to experiment with a particular service system, the Internet MBONE network, that represents a different world view from the telephone industry that many of us come from. The Internet pioneered the concept of a best-effort service offering little if any quality of service guarantee, but provided cheaply and ubiquitously. Although intended for store and forward data traffic, not media streams, this service concept may also have some relevance for real-time traffic. We complain about the two-frames-per-second video and the sometimes clipped and broken audio, but there is a learning value in deploying and experimenting with a best effort real-time service. With the experience gained in Rio the Communications Society can begin to define a member service of acceptable quality, that may still be relatively inexpensive

and open to experimentation and innovation. It may be decades before it is possible to offer all-day "toll quality" remote conference participation at an acceptable price, but in two or three years MBONE may evolve into a service offering acceptable quality at an affordable price.

The time difference between originating and viewing locations will always be an obstacle and it remains to be seen how much the sociology of meetings will change to partially accommodate it. Almost all of the viewers of the ITS 94 multicast were in the United States, within a very few time zones from Rio de Janeiro. Can conference formats be redefined to reduce the impact of the time difference? Perhaps question periods will not follow immediately on live presentations but be delayed by half a day so that members of the audience in other parts of the world will have had a chance to view delayed multicasts and submit questions. There are other technical and behavioral questions that also require "just trying it," such as the importance of better quality visual aids, which could be realized by use of Postscript files on the MBONE whiteboard. It was so hard getting the basic audio/video elements in place that the Rio experiment did not have a chance to get into these questions. But the experiment stimulated thinking about the real human problems of globalization through electronic processes.

Multicast Screens from ITS '94



Clockwise, from top left: Irwin Jacobs addresses the audience; IEEE Communications Society President Maurizio Decina asks a question from the audience; Nick Machemchuck speaks and shows a slide.

Putting Together the Connection

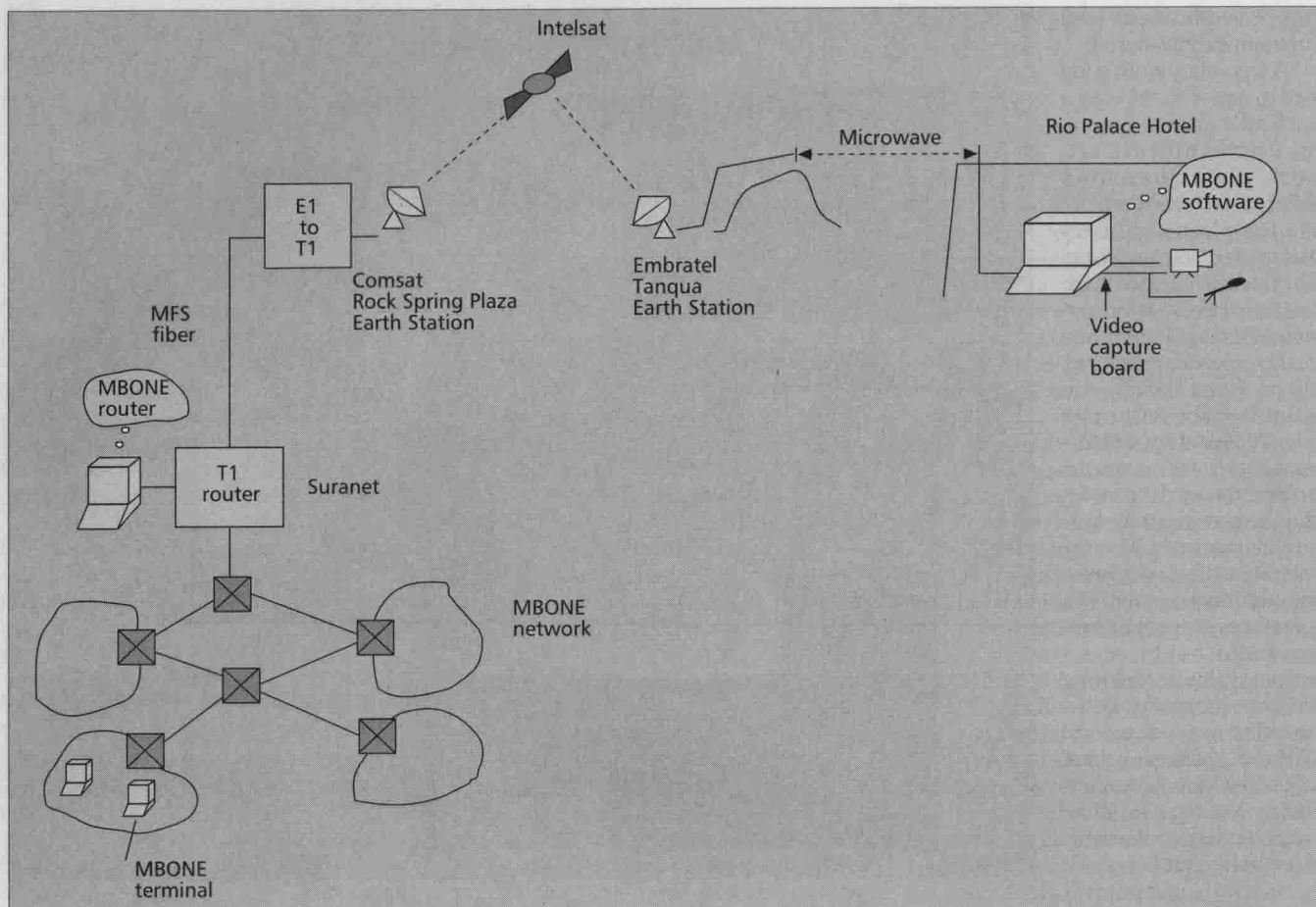
After getting the right software and media hardware components, our main concern was the data connection from the conference site at the Rio Palace Hotel to an MBONE router in the Internet backbone. The existing 64Kb/s Internet connection from Brazil to the Internet backbone in the U.S. was inadequate for this experiment. So the Communications Society and the Brazilian Telecommunications Society, co-sponsors of ITS 94, solicited the participation of a number of companies and institutions in setting up a special satellite data connection. We gratefully acknowledge the contributions of equipment and facilities made by Anadigicom Corporation, COMSAT World Systems, Embratel, the Federal University of Rio de Janeiro, INTELSAT, Metropolitan Fiber Systems, NEC USA Inc., Sun Microsystems, and SURANet. The USC/Information Sciences Institute and Rede Rio/FAPERJ contributed additional expertise and support.

Figure 2 shows the essential systems components. Workstations functioned as Internet hosts and as media processors (using the software described earlier) at the two ends, which were a conference room in the Rio Palace hotel and the facilities of SURANet, an Internet access provider

in College Park, Maryland. Professional audio/visual assistance was arranged in Rio, including a camera operator, which helped obtain the best audio/visual quality possible in the MBONE context. The workstation in College Park also served as an MBONE multicast router.

A microwave link carried the digital compressed audio/video signals from the workstation at the Rio Palace Hotel to an antenna at the top of Corcovado, where the famous statue of Christ is located, and from there by terrestrial cable to Embratel's Tangua C-band earth station. The signal, bursting to several hundred Kb/s, was imbedded in an E1 (2.048Mbps) transmission frame (a European CEPT standard) and sent via an Intelsat digital satellite service to the U.S. It was received by a 4.5-meter antenna at COMSAT's headquarters in Bethesda, MD.

Then came the difficult part, conversion of the E1 frame to a T1 (1.544Mbps) frame used in transmission systems in the U.S. Despite a decades-long coexistence of these two standards, the configuration of the conversion equipment can be confusing, especially if the traffic does not conform to standard 64Kb/s telephone channels. Not all 64Kb/s tributaries in an E1 frame can be accommodated in a T1 frame, and there are different assignments of tributary channels to time slots. Several days were consumed in determining that misconfiguration of this



■ Figure 2. The data communication system extending MBONE to Rio de Janeiro.

conversion equipment was the source of data transmission problems and in making the fix. It was necessary to have fully compatible data test sets at the two ends of the circuit, a requirement we were lucky to be able to meet.

Finally, nearing the end of the first regular day of the conference, the T1 signal sent by fiber network from the U.S. earth station was received error-free at the Internet access point. We were on the MBONE network and were very happy to see, in the next couple of days that about 60 listeners signed on to our conference. Comments received back were helpful in improving camera work, mainly by minimizing any change or motion. As in most media productions, careful attention to production details is critical to the success of MBONE multicasts.

The Communications Society as a Testbed

All in all, the experiment was a considerable success. Transmission was reliable once the conversion problem was solved and we were fortunate that there were few competing conferences to contend for Internet resources on the days we were active. We learned that there could be a significant audience for a conference like this one, that careful use of media

improved subjective received quality, and that the fact that parties unknown to a speaker could be watching might have an influence on a speaker's style and willingness to make provocative remarks.

Setting up the experimental multicast was more difficult than it should have been and usually will be. Many countries, including Brazil, either already have or are planning early deployment of high-speed Internet connections. José Roberto Boisson de Marca, General Chair of ITS '94 and VP-International Affairs of the Communications Society, said, "We are happy that ITS was the conference and Brazil the host country for an experiment that will help give the idea of International Information Infrastructure real meaning." Maurizio Decina noted, "Our Society has been internationalizing and this experiment, which took a lot of cooperative effort by people in Brazil and the U.S. shows how communications infrastructure can make a big difference."

There is no organization more appropriate than the Communications Society to use itself as an international testbed for electronic communications and processes for the benefit of a professional community. The MBONE multicast from

Rio de Janeiro reflected a new, more aggressive and proactive role of our Society in pressing the development and use of advanced information networking technology and realizing an International Information Infrastructure.

Acknowledgments

Thanks to Vivek Bansal of NEC's Princeton C&C Laboratory, who played a central role in the experiment, and Steve Casner of the USC Information Sciences Institute.

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- [4] MBONE software is available by anonymous ftp from [ftp://parc.ftp.xerox.com/pub/net-research/](http://parc.ftp.xerox.com/pub/net-research/).

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