Chaining CU-SeeMe Reflectors: The SBRC'96 Experiment

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Abstract: This paper reports the experiment involving a live transmission–video and audio–of some events of the XIV Brazilian Symposium of Computer Networks. This was the first live transmission of this kind using the Brazilian Internet backbone. We chose to use CU-SeeMe software–client and reflector–which made it possible to build a reflector chain, especially designed to broadcast the transmission throughout Brazil.

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Resumo

Este artigo relata o experimento envolvendo a transmissão ao vivo–vídeo e áudio–de alguns eventos do XIV Simpósio Brasileiro de Redes de Computadores. Pela primeira vez este tipo de transmissão foi realizada usando somente a malha da Internet no Brasil. O software escolhido foi o CU-SeeMe–cliente e refletor–que permitiu a criação de uma cadeia de refletores, especialmente projetada para a difusão da transmissão pelo Brasil.
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Abstract

This paper reports the experiment involving a live transmission–video and audio–of some events of the XIV Brazilian Symposium of Computer Networks. This was the first live transmission of this kind using the Brazilian Internet backbone. We chose to use CU-SeeMe software–client and reflector–which made it possible to build a reflector chain, especially designed to broadcast the transmission throughout Brazil.
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1. Introduction

The XIV Brazilian Symposium of Computer Networks (SBRC'96) took place in Fortaleza in the northeastean state of Ceará, during May 1996. We were invited to transmit live video–grayscale–and audio via the Brazilian Internet backbone (internet.br) for the very first time.

We chose to use CU-SeeMe software because it was freeware, worked with low end machines and it had a server software named CU-SeeMe Reflector that could be used for multicast conferencing.

Although we have previously been part of a few reflector chains, this was our first opportunity to create–and to manage–the design of one.

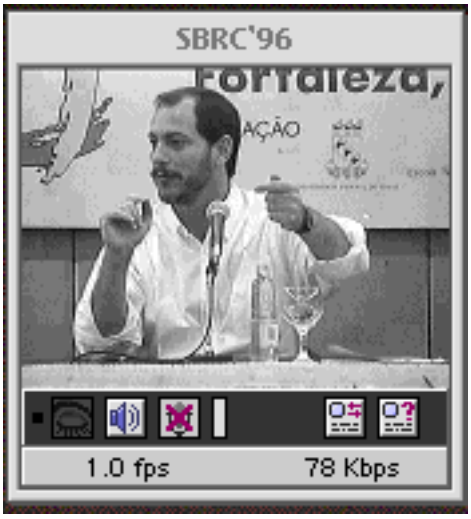


Figure 1: CU-SeeMe Window

The paper is organized as follows. The second section introduces the CU-SeeMe's client and reflector. The third section deals with the reflector chain design. There we talk about team work, the experiment's logistics and we present a brief data analysis of traffic generated by the experiment. The fourth section is about Rio Internet TV–the oldest public reflector in Brazil. Finally the conclusion and future work are presented.

2. Videoconference

Videoconferencing has been around for quite a while, but unfortunately, far away from the few resources reachable to Mr. Average. It has been available to mega corporations that could afford tens of thousands of dollars in expensive equipment and proprietary high bandwith networks.

Fortunately the situation is changing as pointed out by Rober Rustici, author of CU-SeeMe: Internet Video-Conferencing the Authorized Guide (Rustici 96).

> *Dropping prices of PCs and their increasing processing power spurred the development of many PC-based videoconferencing systems. When you combine videoconferencing systems offered by high-end room systems, telecommunications companies, and PC hardware and software vendors, the choices for some people are endless. Even though the number of suppliers has increased, the overall cost of installing a complete videoconferencing system has not gone down as dramatically. Developing the network infrastructure for both room and desktop videoconferencing systems remains costly. This is where CU-SeeMe is the perfect solution.*
>
> *CU-SeeMe's global communications network is the Internet. Organizations and individuals don't have to reinvest in a separate network just for videoconferencing. CU-SeeMe capitalizes on both the Internet's existing capabilities and the PC being used in work and play. The relative cost to upgrade the computer's software and hardware to use CU-SeeMe achieves the important goal of adding a minimal incremental cost.*

For the reader that is interested in desktop videoconferencing products, we recommend the on-line reference source named DT5: Desktop Video Conferencing Product Survey, which is available at <http://www3.ncsu.edu/dox/video/survey.html>. For an exhaustive Videoconferencing FAQ go to <http://www.bitscout.com/faqtoc.htm>. There is a wealth of information regarding enabling technologies for desktop videoconferencing in Leigh Anne Rettinger's masters thesis (Rettingers 95) available at <http://www2.ncsu.edu/eos/service/ece/project/succeed_info/larettin/thesis/>. A substantial part of chapter 2 of her thesis (the one concerned with the enabling technologies for desktop videoconferencing) can be found in Portuguese at <http://www.inf.puc-rio.br/~refletor/st/indice.html>. Finally there is a lot of information concerning this topic in sundry newsgroups like comp.dcom.videoconf, comp.speech, comp.multimedia, misc.education.multimedia, rec.video.desktop, comp.compression, comp.compression.research, alt.education.distance, and comp.groupware.

2.1 The CU-SeeMe Client

CU-SeeMe development began in 1992 at the Cornell University's Information Technology Organization. Initially written for the Macintosh, today it also runs on the PC platform. CU-SeeMe requires at least a 14.4 baud data rate, preferably 28.8–or higher. At these rates one will receive video, but the audio portion will be lost (Sattler 95).

In its early versions, it displayed 4-bit grayscale windows at either 320x240 or half that diameter, 160x120. It provided a one-one connection or, by use of a reflector, a one-many, several-to-several, or several-to-many conference, where each participant could decide whether to be a sender, a receiver, or both.

Currently White Pine is CU-SeeMe's master licensee. It developed a product called Enhanced CU-SeeMe which uses color and has improved codecs for image and sound.

CU-SeeMe client works in the following way. A video camera captures the image and sends it to the computer video board where it is digitized–this is changing

with the introduction of digital video cameras like the QuickCam which dispenses the use of a video board. Then the client encodes the image in a proprietary coded video format called CUSM. At the other end, a computer running the CU-SeeMe client decodes the CUSM video and displays it on the screen. The sequence is shown in figure 2.

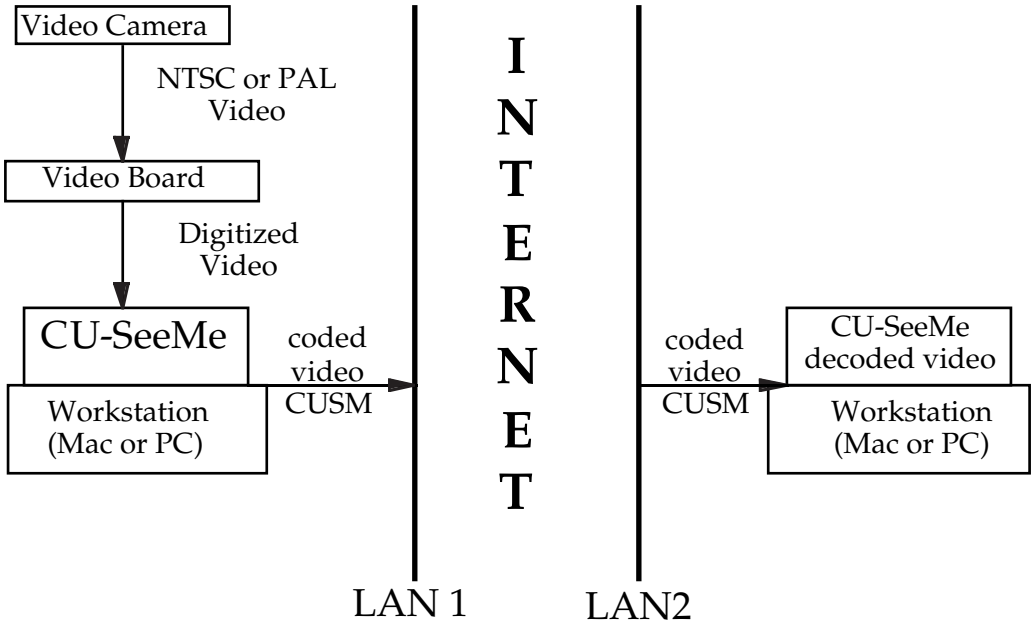


Figure 2: Sending and receiving video between CU-SeeMe clients

Regarding the relationship between frames per second (fps) and Kbps, CU-SeeMe has been optimised for minimum changes in picture from frame to frame. The greater the changes, the more data which must be transmitted to describe those changes and the lower the fps rate. Of course, a powerful processor is always a helping hand.

2.2 The CU-SeeMe Reflector

The CU-SeeMe reflector is a software that works as an audio and video server, where all the clients connected to it receive everybody's else video and audio according to their preferences.

At the time of SBRC'96, there were only Unix versions of the software. Currently there are reflector versions for most PC operating systems like Windows NT and Windows 95.

Connecting reflectors is possible as shown in figure 3 below. Note that reflectors accept connections from Unix workstations running mbone tools like nv and vat.

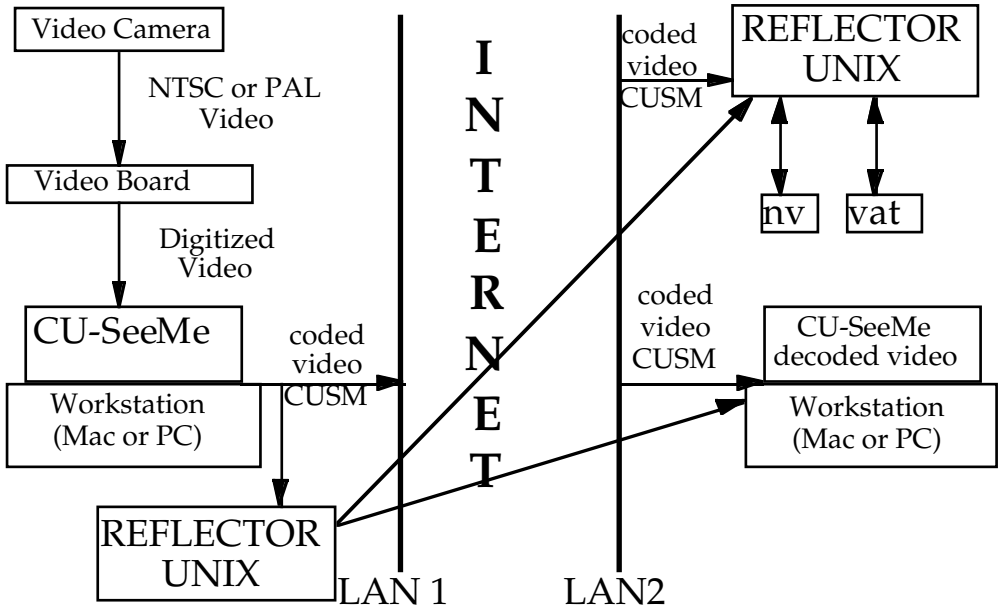


Figure 3: Sending and receiving video using CU-SeeMe clients and CU-SeeMe reflectors

3. Digital Communication Design

In order to preserve internet.br's bandwith we decided to build a reflector chain so users could connect to the reflector closest to them. So, let us imagine, if you are in Rio de Janeiro, you are supposed to connect to one of the reflectors in Rio, and not to the reflector at Fortaleza–although there are no restrictions to doing so.

That was not the first time we participated in a chain of reflectors. We have experienced it in the following events:

- Earth Day - Cornell US (Apr95);
- Everything Cyberdelic Tour - US (Oct95);
- Computers Fair - Limeira SP Brazil (Nov95);
- Networld+Interop96 - Las Vegas US (Mar96).

The novelty was that for the first time we were creating its design.

3.1 Chaining Reflectors

The symposium organizers decided that they only wanted to send video and audio to the rest of the network. They did not want to receive any audio or video, because they thought it could disturb the talks that were being transmitted. This design of digital communication is very similar to what regular TV does–broadcasting.

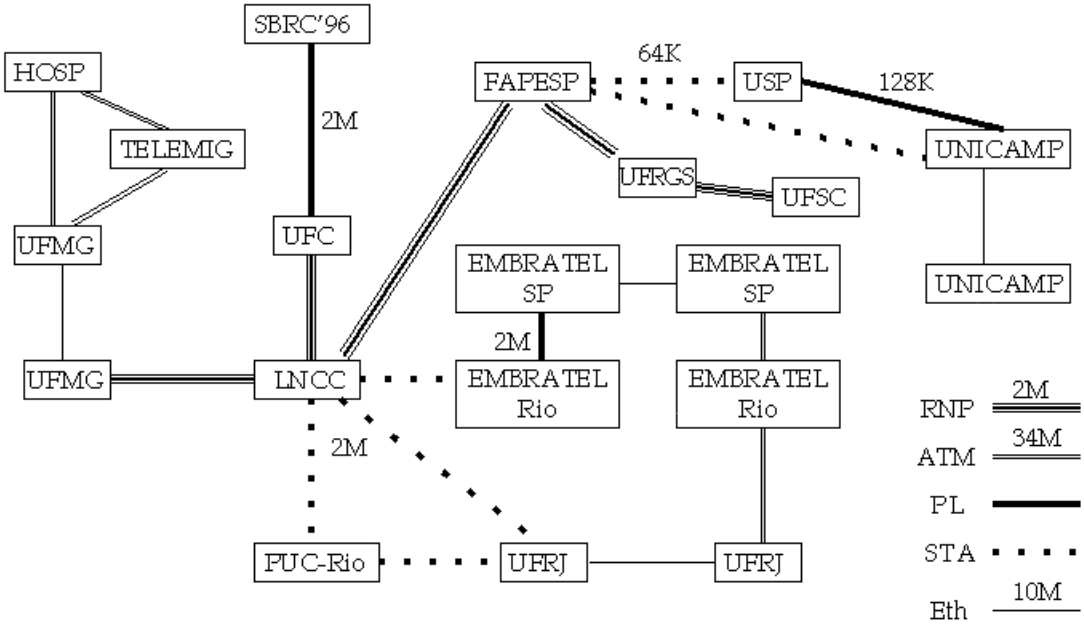


Figure 4: The National Research Network Topology (RNP)

The first step we took to build the chain was to study internet.br's computer network topology provided by RNP–National Research Network. As can be seen in figure 4 above, most of the networks had 2MBps bandwiths, which was good enough to conduct the experiment without bringing internet.br to a halt. It is important to notice that part of the experiment was conducted through ATM networks without incurring in any problems.

The second step was to define the chain itself as shown in figure 5 below. The SBRC'96 block is the CU-SeeMe client running at the hotel which generated the symposium's audio and video. The first reflector of the chain was supposed to be the UFC (Federal University of Ceará) one, but due to technical problems we opted to use the LNCC (National Laboratory for Cientific Computing) one as the main reflector.

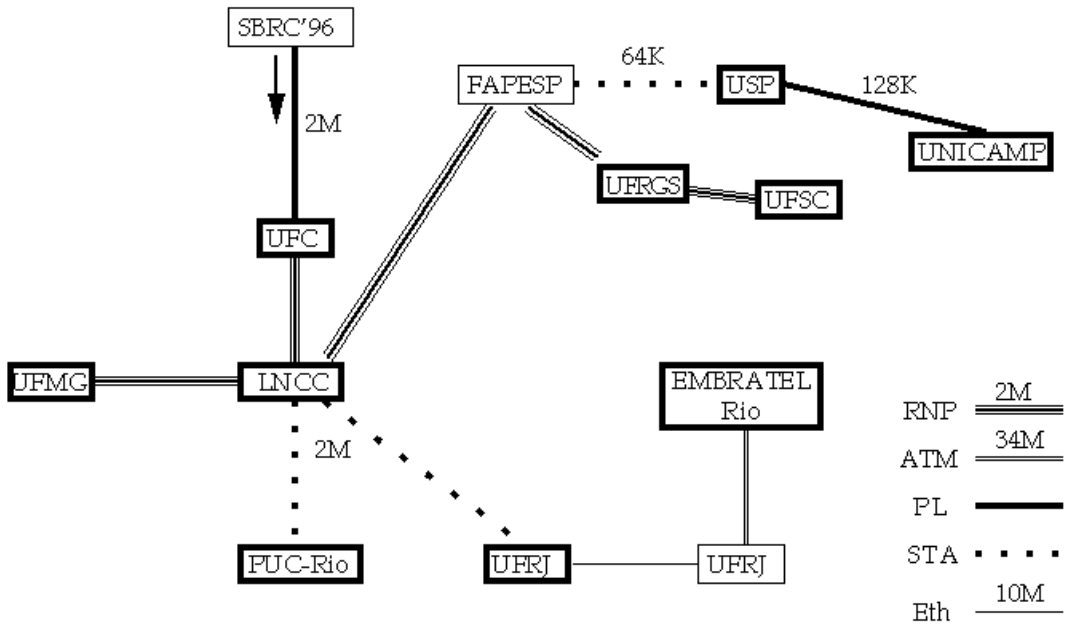


Figure 5: Chained Reflectors at SBRC'96

The chained reflectors IP addresses were: PUC-Rio (Rio Internet TV):139.82.17.17, LNCC:200.159.255.10; UFRJ:146.164.53.76; EMBRATEL-

Rio:200.20.215.41; USP:143.107.231.203; UNICAMP:146.106.30.65; UFC:200.19.177.4; UFRGS:200.132.0.21; UFMG:150.164.7.22. Unfortunately, due to many different problems, only a few reflectors were up and running during the complete duration of the experiment.

3.2 Team Work

There were four teams involved in the experiment. Apart from the first team that was responsible for the video and audio capture, all of them used 2Mbps connections with the Internet.

The first team comprised the camera crew. They used two professional cameras hooked to a Videonics–Digital Video X1 (4 channels)–and four microphones controlled by a Soundboard Panasonic M3000 45DB (8 channels).

The second team received a s-video out connector from the video board which went into the s-video plug-in of a PowerMac 7100AV (24MB RAM) running an early version of a CU-SeeMe client. The second team also had a Flexcam from Videolabs for testing and communication with the third team which was based in Rio. After trying for a while to connect the RCA jacket to the PowerMac sound-in port–the PowerMac has a proprietary amplified plug–the decision was taken to capture the sound straight from the first team's loudspeakers on a TV set. It worked very well indeed.

The third team in Rio (PUC-Rio) had a PowerMacintosh 8100AV (36MB) connected to a Flexcam from Videolabs. This team's mission was to coordinate all the configuration required for the chaining.

The fourth team in Porto Alegre (UFRGS) had a PC 486 DX2 and its mission was to monitor the transmission and check the overload that the transmission was placing on internet.br's networks.

3.3 The Logistics of the Experiment

The sessions chosen to be transmitted ran for four nights usually from 7PM to 10PM. The CU-SeeMe client at the symposium's hotel was configured to maximize transmission and to minimize reception–remember that the organizers wanted a one way transmission–during the transmissions. All the communication between Rio (third team) and the hotel (second team) during the transmission was done using Unix talk.

In the afternoon both teams reconfigured their CU-SeeMe clients for normal videoconference sessions–Rio lowered its reception rate and raised its transmission and the hotel crew did vice-versa.

A couple of hours before the beginning of the first session we fell into a panic station situation: The first reflector on the chain was not fowarding the received streams to the second reflector and therefore to the rest of chain. We spent the next hour trying all sorts of configurations variants, till, by pure luck, we realized that the chains's first reflector also needed a CU-SeeMe client connected to it–a little push. Shame on you documentation!

We asked a few people, that we knew beforehand would be watching the transmission from various parts of the country, to answer a short questionaire. Most of them expressed amazement regarding the audio quality but complained about the shattered images (figure 6). This phenomenon happens whent the client is renewing the window's image but part of the previous image is still there. This problem arises due to CU-SeeMe's video encoding algorithm–designed for talking heads–that subdivides the video frame 8x8 pixel squares, and a square is selected for transmission if it differs sufficiently from the version of it that was transmitted most recently (Dorcey 95).

Figure 6: Shattered Image

The camera crew was instructed to avoid panning and zooming. The special effects generated at the digital video board were fine.

We also asked the presenters to move as little as possible–but we knew that that was humanly impossible-while talking to the audience. One of the presenters ran from one end of the stage to the other during his talk making his the worst transmission imagewise–however, his audio was all right. Internet's traffic was (is) also partially responsible for shattered images though we could do nothing about that.

3.4 Traffic Pattern

During the videoconference the traffic was monitored to allow us investigate what would be its impact on the RNP. Measurements where done at random in each router used to traffic forward from its generation at conference site to some of the chainned reflectors.

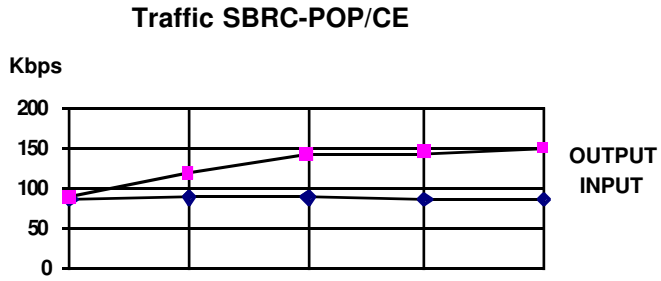


Figure 7: Traffic during the preparation of the transmission

The first segment was the connection between the SBRC site and the RNP-POP (Point-of-Presence) in that state (Ceará). As it is possible to see from the first graphic (figure 7 above), the amount of Kbps entering the conference router was about 100 Kbps. That traffic was related to a local CU-SeeMe client used to receive image and voice from the remote operator that was on charge of reflectors management at PUC-Rio. The outgoing traffic was around 100 Kbps in the beggining and later grew up to about 150 Kbps. The cause was an extra CU-SeeMe client being used to generate image at the conference site in the demo area. During the videoconference there was very low extra traffic as it can be the second graphic.

During the second videoconference, data was gathered before and during the transmission (figure 8 below) to check hypothesis about low traffic being generated at conference site and it was in fact lower than 10 Kbps. The incomming traffic was kept low at that measures because the incomming traffic was limited once it was not

needed real time moving image from remote operator. We was using mainly the chat window for communication and a bare image from the operator at management center was enough to give the feeling of having the hability to reach her if needed.

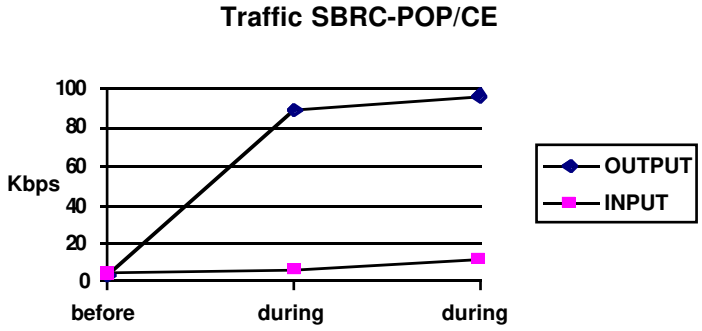


Figure 8: Traffic during transmission

We also took some data from other routers in the path of the videoconference chain (figure 9).

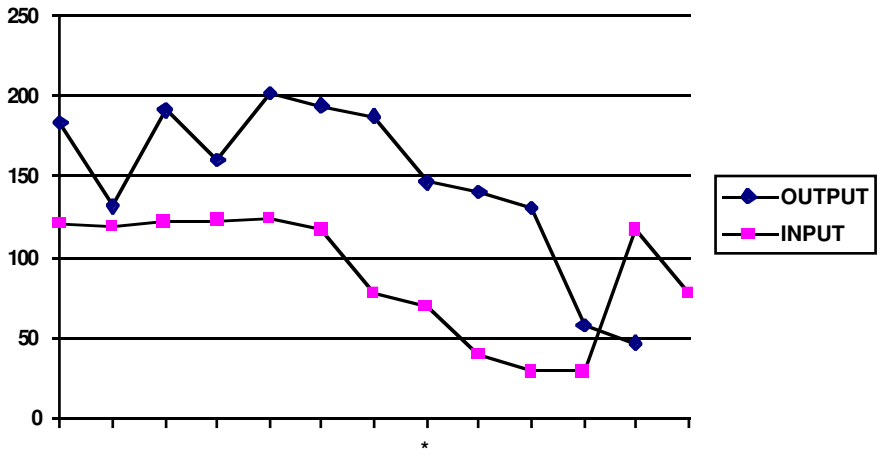


Figure 9: Data from other routers in the path

4. Rio Internet TV Reflector

Rio Internet TV reflector at PUC-Rio is the oldest public reflector in Brazil. It started its operations in early 94 and since SBRC'96, it is connected through the unicast directive to the reflector managed by the Computer Network Group at UFRGS–it does not matter from the user's point of view if he or she is connected to PUC-Rio (139.82.17.17) or to UFRGS (200.132.0.21). This arrangement–full interactivity–is different from the symposium's set up where the organizers's option was for a broadcast type of transmission.

Rio Internet TV is a mature reflector receiving over one hundred different visitors a day. It has been cited in popular magazines and newspapers (Ediouro 96, Mandarim 96 & Informática *etc* 96) and has a companion web site (http:www.inf.puc-rio.br/~refletor) which is a major source of information for the Brazilian CU-SeeMe community–there is also general information about videoconference. There, one will find all the information needed to download and to use CU-SeeMe software, reflector and accessories, and also be aware of who is currently connected to the reflector.

Rio Internet TV reflector is listed worldwide and as mentioned above, it receives a considerable amount of visitors daily . A new medium fosters unprecedent behaviour

and a research (G-rated) reflector needs to be looked after most of the time. For that purpose, Rio Internet TV administrators invited some of its regular and trusty users to be part of the daily reflector's administration. They have access to a password protected part of the web site that acts as a control panel for the reflector. From there they are able to take out unwanted users of the reflector and to help this emergent community to shape a digital communication culture.

5. Conclusion and Future Work

This paper reports the experiment involving a live transmission–video and audio–of some events of the XIV Brazilian Symposium of Computer Networks. This was the first live transmission of this kind using the Brazilian Internet backbone.

We built a chain of CU-SeeMe reflectors and used it to broadcast the video and audio using a CU-SeeMe client at the symposium's hotel. Traffic was kind on the Internet. The main complain we received from the viewers concerned shattered images–we took some steps to minimize the problem.

Currently we are using this technology to conduct some face-to-face meetings of the Human Resources Working Group of the Management Comittee of the Brazilian Internet.

6. Acknowledgments

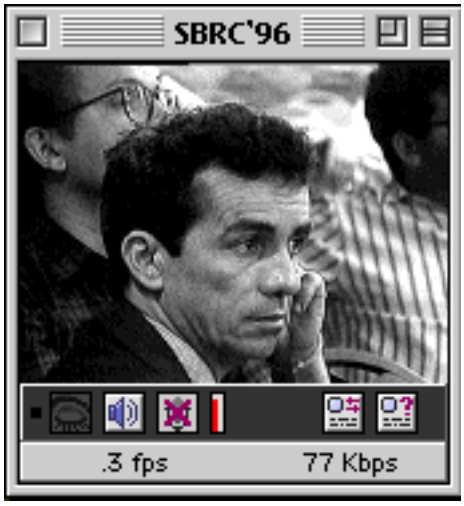
This work was partially supported by CNPq: Hugo Fuks grant nº 524557/96-9 and Liane Tarouco grant nº 523203/95-0).

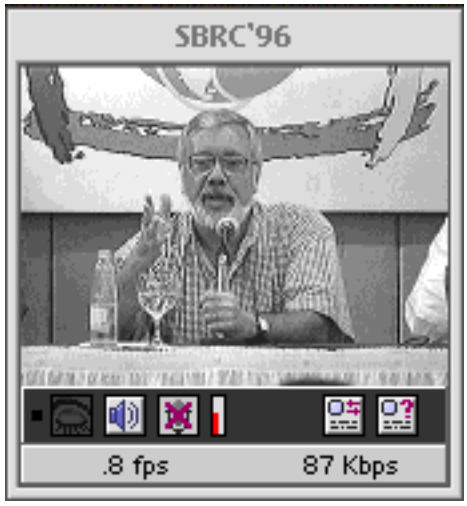
A special thank-you goes to Jaqueline Gomes Pedreira (right), who stayed in Rio and organized and created the configuration files for all the reflectors making the chain possible. The authors were at the symposium dealing with the generation and transmission of the events. Thanks to all the people responsible for the reflectors, especially the LNCC one that played a central role in our experiment. Thanks to Carlos Laufer and to Cassio Gondim for their help regarding Rio Internet TV reflector.

Thanks to Elivaldo from Teleceará and to Ricardo from RNP, (both on the left), who made the 2Mbps connection from the symposium's hotel possible.

Thanks to Mauro Oliveira (left below) and Professor Luiz Fernando Gomes Soares (right above)–the Symposium's General Coordinator and Chairman who invited us to do the transmission.

Last but not least, we thank Professor Carlos José Pereira de Lucena (right below), Executive Secretary of the Management Comittee of the Brazilian Internet– who is making the Internet a valuable asset for the Brazilian computing community.





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