SIMnet: An Internet-Based Video Conferencing System Supporting Metrology

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Abstract *– SIMnet is a computer network implemented in 1999 to facilitate international comparisons, and foster collaborations between national metrology laboratories in the Americas. The system employs standard hardware and a special network server to allow audio, video, and data exchange between multiple participants.*

1. Introduction

Within the past several years, hardware and software have become available that makes it possible to communicate using real-time audio and video via the Internet. The major breakthroughs have been inexpensive digital video cameras that are now available for most computer ports and buses and video conferencing software that compresses and sends audio and video through the Internet.

In the field of metrology, the advantage of an Internet-based system is that metrologists at two or more locations can now collaborate at the test bench rather than in a video conferencing room. Real-time images of equipment and connections greatly enhance the metrologists' ability to describe test procedures and do remote troubleshooting. Projects in *telemetrology* and *e-calibration* are being implemented at NIST and other calibration laboratories around the world.

2. SIM

The Interamerican Metrology System (SIM) was established in 1979 to assist the 13 member Latin American countries set up and maintain national metrology laboratories (NMIs). In the 1990s, it was expanded to include most of the countries in the Organization of American States, which has 34 member countries. SIM consists of five geographical metrology regions: NORAMET (North America), CAMET (Central America), CARIMET (Caribbean), ANDIMET

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(Northern South America) and SURAMET (Southern South America). One of the main objectives of SIM is to harmonize the basic measurement standards in each country in the hemisphere. SIM international comparisons support this objective.

SIM-sponsored international comparisons in mass, pressure, volume, and electricity were started in the latter half of the 1990s. These comparisons use traveling standards that are calibrated at each of the participating laboratories. In the electrical comparison, for example, five digital multimeters (DMMs) were calibrated at NIST (pilot lab) in 1997 and then sent to pivot labs in each metrology region. The pivot labs circulated the traveling standards to the NMIs within their region.

Communication between metrologists has been a major problem in these comparisons. Once the traveling standard has passed through customs and arrived at the laboratory, there is the problem of explaining test procedures and connections, and troubleshooting test setups if things don't work.

By 1997, many of the NMIs in SIM were connected to the Internet and communications were enhanced using email. But incompatible systems often did not accept attachments with photos, diagrams, and data. In early 1998, electrical metrologists from NIST, NRC-Canada, and ICE-Costa Rica began experimenting with Internet-based video conferencing to solve these problems and assist with the ongoing SIM Electrical Comparison. During this experimentation, several video conferencing software packages were evaluated and digital video cameras from a number of manufacturers were tested.

3. SIMnet

In September 1998, a project began at NIST to establish an interactive network between NMIs within SIM. This network, dubbed SIMnet[1,2], is a network of computers devoted to video and data conferencing through the Internet to facilitate international comparisons, foster collaboration between metrologists, standardize test procedures, and share software and data.

Early experience, using Internet-based video conferencing software, demonstrated how sensitive performance was to different hardware, software drivers, and operating systems. As a result, the SIMnet video conferencing stations were designed around a specific computer, operating system, conferencing software, camera, headset, and instrument control bus (IEEE-488).

In addition to improving the reliability and quality of video conferencing, the station has an important advantage in international comparisons where computer-controlled instruments are used as traveling standards. Control software is used to program instrument parameters and collect data and it is difficult to verify that this software is implementing the agreed upon test procedures. With the standard SIMnet station at each NMI, it is possible to run the same software with the same IEEE-488 commands at each lab. This software can be used to test the local control software. Or, with input from all the SIM participants, it could grow into general-purpose software used for SIM comparisons, with the latest version available for download at a SIMnet website.

The stations employ video conferencing software based on the International Telecommunications Union (ITU) Standard H.323. Connections are made by entering the Internet Protocol (IP) address of another computer or server, at which point a video window is displayed, with an image from the other participant (see figure 1). The moveable digital video camera can deliver good full motion video and excellent close-ups. Even small hardware details and instrument connections can be examined remotely via the Internet. If low bandwidth or Internet traffic reduce the video quality, the camera can be used to capture higher quality still images that can be attached to a shared application or electronic notebook. Audio is the most critical parameter and when it is unacceptable, participants switch to the telephone.

Other useful tools in the commercially available Internet video conferencing software include options to:

- Share a common electronic notebook that can include text, graphics (plots, hand-drawn figures, etc.), and photographs - higher quality photographs, taken with an auxiliary digital camera, can be pasted into this notebook.
- Share other applications - participants can share the window of a currently running program, like a spreadsheet.
- Remotely control applications - if the participant sharing an application enables this option, others in the conference can not only observe the screen of the running application but also take over the mouse and the keyboard of the remote computer.
- Transfer files from any participant to all others in the meeting.

Unlike the real-time audio and video, which are sent using H.323 protocols, the above options employ file transfer protocol (ftp) to transfer information without error. This can result in delays, depending on the local network traffic and bandwidth, but it ensures that all participants will receive the same quality text and graphics.

While the above-mentioned tools are available to a multi-participant meeting, the software allows only two participants to send and receive audio and video. If a third party wants to send or receive, one of the two active participants must manually switch to the third. Simultaneous handling of such a switch becomes unmanageable with several active speakers.

To help solve these problems, a multipoint server was set up at NIST[3]. This server is also a 400 MHz computer running special software that can process and send audio and video to as many as 24 participants, again using H.323 protocols. All conference participants log-on to the SIMnet server, which detects and distributes the audio and video of the last speaker to all participants. Switching is voice-activated. However, with transmission delays, even this system can become unmanageable when two or more participants speak at the same time. So meeting rules and discipline are necessary.

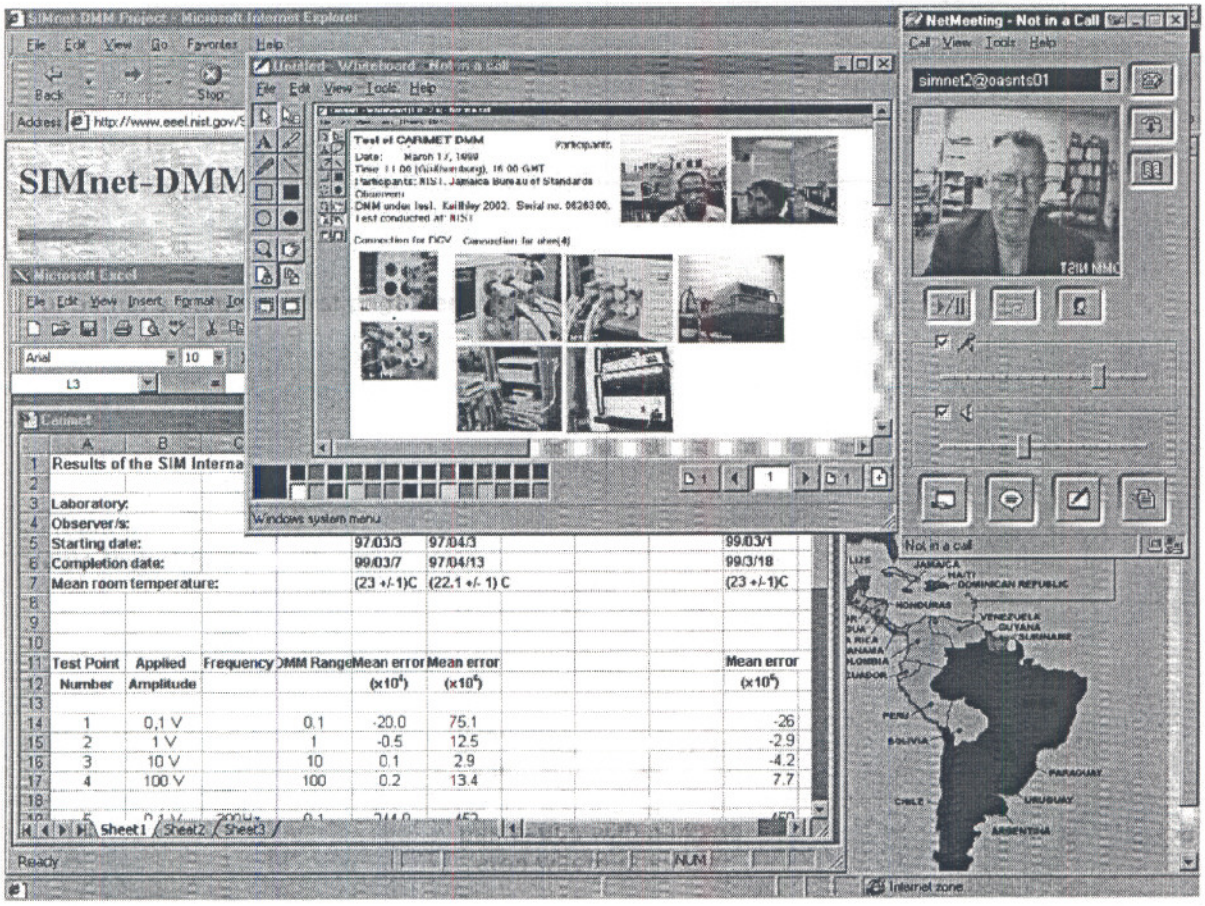

Figure 1. Typical video conference screen with the SIMnet webpage in the background, a shared notebook in the center, the video image of one of participants on the right, and a shared spreadsheet in the on the lower left.

Since its inauguration in December 1998, SIMnet has been continuously tested. In March 1999, it was used for multipoint video conferencing during the SIM International Comparison of Electrical Units. During this comparison, five multimeters, from three manufacturers, were tested at NIST (the pilot laboratory for this comparison). The meters were then tested at the NMIs within each region. Once measurements were performed by all of the participating NMIs, the multimeters were returned to NIST for final tests. During these final tests SIMnet was used to describe the test to other NMIs. During these meetings several problems were revealed. As expected, the audio connection was the most critical, particularly when communicating over long distances between North and South America. Participants with effective Internet bandwidths below about 40 kbps had difficulty remaining connected to the server.

In 2000, SIMnet has been used for collaboration and training in Latin America. For example in February, a power expert from Uruguay presented a seminar on digital sampling techniques to participants in Mexico, Panama, Ecuador, and Costa Rica. The seminar was held early in the morning to avoid complications with Internet traffic.

4. Conclusions

SIMnet has now been in use for over a year. Upgrades to the server and video conferencing software, installed in April 2000, have made the system much more robust. However, there are still connection problems associated with bandwidth.

Another looming problem is network security. Presently available Internet-based video conferencing software is not yet fully compatible with corporate network *firewalls*. This issue is being addressed in the newer versions of the software and its success is of primary importance to the future of calibrations between NIST and U.S. industry[4,5].

The security issue not withstanding, the authors and others involved in this project believe that e-calibration will soon be a standard method of delivering NIST services. The SIMnet project, which connects the NMIs within the Americas, is one of the first steps in this direction. NIST staff are now working on the natural follow-up, WORLDnet, a network to connect the world's metrology institutes. A similar network, MEASUREnet, connecting the state Bureaus of Weights and Measures, is in the testing stage and will be on-line this year.

Further information is available at the following web site:
http://www.eeel.nist.gov/SIMNET-DMM/

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