

# Lucent Uses MathWorks Tools to Test Internet Telephone Communications

Bell Labs at Lucent Technologies leads a burgeoning trend in telecommunications: voice over Internet protocol (VoIP), in which telephone conversations are transmitted over packet-based Internet technology rather than by conventional switched circuits.

This new technology creates challenges for design and test engineers. The network must handle increasingly large volumes of data, which can lead to network overload and signal degradation.

Jim McGowan and colleagues at Bell Labs, Lucent's R & D arm, have developed tools that simulate what happens to a signal when it is transmitted over a network. These tools let them test voice communication systems without building custom hardware prototypes and assembling expensive network test configurations in the lab.

Throughout their work, the team relies on MATLAB®, Simulink®, Real-Time Workshop®, the DSP Blockset, and xPC Target. "These MathWorks tools put a whole new spin on the way the design process can be done," McGowan says.

## THE CHALLENGE

Engineers tasked with improving the quality of next-generation network audio products face three major obstacles. First, research on voice transmission over traditional telephone systems no longer applies in the new, non-linear world of IP and data communications. As a result, developers do not know how a voice should sound over a network.

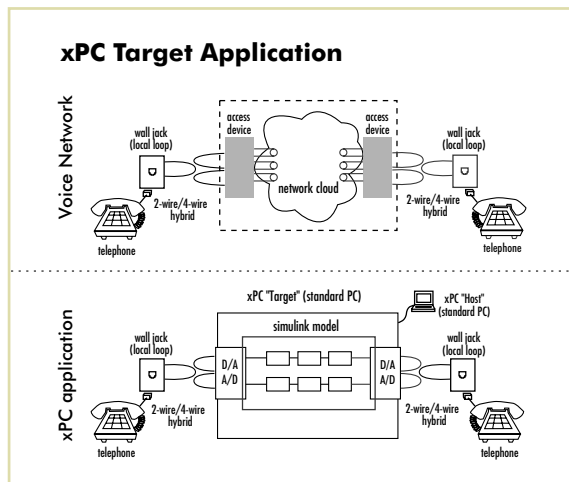
Second, traditional testing methods, based on listening to prerecorded samples, or passing a

series of tones through the network cannot test for the effects of variable delay, echo, packet loss, and codec distortion that degrade signal quality when a voice is transmitted over the network. Third, testing usually occurs too late in the design process to affect some significant aspects of product design.

McGowan and his team set out to develop a testing method that would give product designers the vital missing information. Their goal was to use readily available software and hardware to simulate a two-way communication system in real time and then to feed the results into the design cycle early enough to enable effective change.

## THE SOLUTION

Using simulation tools from The MathWorks and a standard PC, McGowan and his team simulated live, two-way telephone conversations, subjected the test signals to a range of network degradations, and then monitored how these impairments affected voice quality.



The test setup for the voice communication network at Bell Labs.

## THE CHALLENGE

To evaluate the effect of design alternatives on VoIP voice quality early in the development process

## THE SOLUTION

Develop a parameterized model of the network in Simulink, use Real-Time Workshop to generate C programs from the model, and then run the programs on a standard PC using xPC Target

## THE RESULTS

- Time and money saved
- Reusable models
- An improved end product

They developed a parameterized model of the network in Simulink, used Real-Time Workshop to generate C programs from the model, and ran the programs on a standard PC using xPC Target. They used an NI PCI-6052E data acquisition card to interface the real-time network model to a standard telephone receive-and-transmit local loop at narrowband, wideband, and custom sampling rates.

Using Simulink and the DSP Blockset to build their models, they could easily add new tests without writing code. The open interface of Simulink enabled them to use available standard components, such as speech coders, in their models.

The configuration included an object-oriented MATLAB interface that lets them change network conditions, such as echo or packet loss, during a live, two-way conversation. Digital recordings of the live conversations can be sent directly to disk for additional analysis.

This Simulink and xPC Target simulation and testing platform has dramatically changed the development process at Lucent. Instead of testing a design after implementation, the team can now compare design options at the concept stage, before any hardware is built. And they can use the same platform for final testing of the implemented design before the product is released.

Having hardware-in the-loop increases the range of possible product tests considerably. Perhaps the most important benefit of modeling and simulation, McGowan says, is that “We can fully evaluate the effect of alternative designs all the way back at the beginning of the process, when the product is just a sketch on the chalkboard. This means that we are actually writing design targets for products rather than just testing them at the end.

#### APPLICATION AREAS

- DSP and communications
- Simulation
- Telecommunications
- Test and measurement

#### PRODUCTS USED

- MATLAB
- Simulink
- DSP Blockset
- Real-Time Workshop
- xPC Target

“These tools from The MathWorks put a whole new spin on the way the design process can be done. We can create a real-time simulation from specs that will sound exactly the way the product would after it’s been built. And that results in time and money saved.”

Jim McGowan, Lucent Technologies

My team’s goal is to make the voice flow through the chalk on the board. With xPC Target and the other MathWorks system-level simulation tools, we’ll get there.”

## THE RESULTS

- **Time and money saved.** Simulating and testing a complete VoIP system before implementation enables design flaws to be detected and corrected early. McGowan says, “We can create a real-time simulation from specs that will sound exactly the way the product would after it’s been built. And that results in time and money saved.”
- **Reusable models.** An added downstream benefit for McGowan’s team is that they can reuse their Simulink component and network models and test procedures. This enables them to streamline testing on new designs and to share tests with other groups at Lucent.
- **An improved end product.** Engineers can model network effects and simulate design concepts quickly, enabling them to test the “what ifs,” and thereby leaving products with fewer design errors and better speech quality.

To find out more about Lucent, visit [www.bell-labs.com/software](http://www.bell-labs.com/software)

[www.mathworks.com](http://www.mathworks.com)