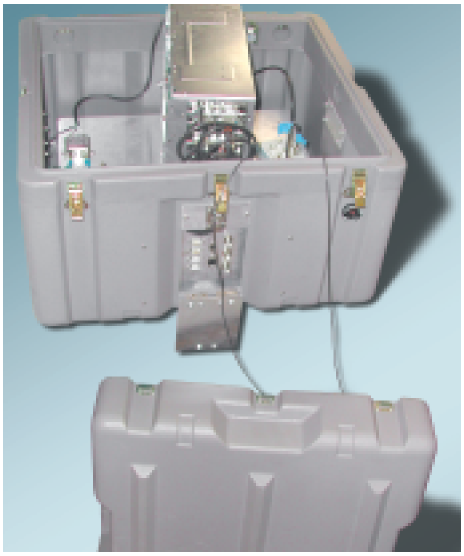
Los Alamos National Laboratory Reduces Battery Power Requirements with MathWorks Tools

THE CHALLENGE
To develop a proof-of-concept prototype that uses modulated reflectance to reduce power requirements for battery-dependent wireless devices

THE SOLUTION
Use MATLAB and related toolboxes to build and validate a rapid prototype of the modulated reflectance-based technology

THE RESULTS
- Development time reduced by 70%
- Data collection and analysis accessible from a single environment
- Patent accepted for the technology



INFICOMM reflective wireless communications system.

Despite advances in battery technologies for wireless devices, typical active-usage times are still limited to two to four hours. INFICOMM, a technology developed by University of California researchers at Los Alamos National Laboratory (LANL), solves this problem by reducing the power requirements for battery-dependent wireless devices by as much as 90% using modulated reflectance.

Like sunlight reflecting off a mirror, modulated reflectance reflects signals back to the base station without using the device's battery. By replacing direct, two-way radio frequency (RF) communications with modulated reflectance, INFICOMM enables cell phones, wireless local area networks, and other wireless devices to operate without transmitting any RF energy.

Los Alamos researchers used MATLAB® and related toolboxes to develop and validate a rapid prototype of INFICOMM in just three months.

"MathWorks products cut our software development time by 70%, and helped us deliver INFICOMM within a tight timeframe and budget," says Scott Briles, lead engineer for Los Alamos National Laboratory.

THE CHALLENGE
To move beyond the basic research phase, LANL would need to build a proof-of-concept prototype of INFICOMM with low-cost, off-the-shelf components. The prototype would need to operate in a wide area mode of approximately 1 km and transmit large data applications, such as digital images, across the wireless link.

Because they would need to create the rapid prototype in just three months—before the end of the fiscal year—there was no time to develop RF boards or test and refine the design manually. LANL sought easy-to-use rapid development tools and vendor demonstration boards.

THE SOLUTION
Using MathWorks tools, LANL built and validated a rapid prototype of INFICOMM and applied the concept of modulated reflectance in a flexible communications demonstration system that could be modified for various implementations.

The team used MATLAB for front-end analysis of the demo system to determine the system's power requirements and expected range. They relied on MATLAB for real-time control of the RF components and for demodulating the signal.

"Since the design stitches together packaged components and off-the-shelf vendor boards,

> MathWorks products cut our software development time by 70%...without MATLAB, I would have had to write C code and compile it on my own.

Scott Briles, Los Alamos National Laboratory

it was essential to have MathWorks tools to control the mating of the components," explains Briles.

The team verified that the system could transmit digital images by compressing still video images and using the Image Processing Toolbox to send a bit stream across the communication link. Using MATLAB, they then decompressed and displayed the images. They used the Signal Processing Toolbox to control the frequency and the MATLAB RS-232 serial port interface to control the carrier-wave signal source.

"With the Signal Processing Toolbox, I can control the frequency to a single kHz in the 2 to 3 GHz band and can also control the output power of the signal source via the RS-232 interface," says Briles.

Next, the researchers used the Data Acquisition Toolbox to control the outgoing signal on a digital I/O board and MATLAB to control the filter/amplifier PCI card. They built the control by writing small C-language functions that they converted into MEX functions for interfacing with MATLAB.

"Instead of writing everything in C, I wrote a small function that controlled the card and used the MATLAB interface to call the function," says Briles. "This lets me control the amplification of the return signal and its bandwidth."

The researchers also used the Data Acquisition Toolbox to control a Measurement Computing analog/digital converter (ADC) board and digitize the reflected signal from the modulated reflector. The collected data was streamed into memory. Then they used the Communications Toolbox to demodulate the frequency shift keying (FSK) modulation.

"Once the signal was on the ADC board, I knew that whatever demodulation was needed could be done in MATLAB," says Briles. "Plus, MATLAB lets me investigate different modulation schemes, such as CDMA, more quickly than C code."

LANL is approaching companies in various industries about using INFICOMM commercially, including oil companies for down-hole telemetry and communications companies for wireless LAN applications.

THE RESULTS

- **Development time reduced by 70%.** "Along with the savings in demodulation and image reconstruction time, the MATLAB interface to the digital converter boards helped me avoid writing custom code," says Briles.
- **Data collection and analysis accessible from a single environment.** "Instead of collecting, moving, and looking at data; fixing the problem; and then changing, compiling, loading, and executing code in different environments, MATLAB lets you grab the data anywhere, fix the problem, and start again," says Briles.
- **Patent accepted for the technology.** After filing four patents for the INFICOMM technology, LANL has received approval on the first patent and is awaiting approval on the others.

To learn more about Los Alamos National Laboratory, visit **www.lanl.gov**

APPLICATION AREAS

- Communications
- Data acquisition
- Test and measurement

PRODUCTS USED

- MATLAB
- Image Processing Toolbox
- Signal Processing Toolbox
- Data Acquisition Toolbox
- Communications Toolbox

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