



## COMMUNICATIONS

Communications engineers and scientists are constantly seeking innovative ways to increase data rates, lower cost points, and design more complex communications systems and components. Major research laboratories, original equipment manufacturers, original design manufacturers, component/chip designers, and IP and service providers worldwide are meeting these challenges by using MathWorks products for data analysis, modeling and simulation, automatic code generation, and design verification. Here are some examples.

### Implementing a Digital Receiver on FPGAs



Sandia National Laboratories in New Mexico developed a high-performance digital intermediate frequency (IF) receiver using MathWorks and Xilinx tools. The digital IF receiver replaced the previous analog implementation. Sandia designed and simulated the receiver with MATLAB® and Simulink®, and then used the Filter Design Toolbox to design a highly parallel polyphasing decimation FIR filter/demodulator and compute the quantized filter coefficients. Simulink, the DSP Blockset, the Fixed-Point Blockset, and the Xilinx System Generator were used to create an FPGA design of the filter, which was then implemented, tested, and verified on the target hardware. The digital IF receiver, implemented on two Xilinx Virtex-II FPGAs, is running at 32 gigaMACs—levels of FPGA integration at orders of magnitude higher than Sandia had ever attempted. [www.sandia.gov/radar](http://www.sandia.gov/radar)

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### Testing an Internet Telephone Communications System

Bell Labs at Lucent Technologies in New Jersey simulated and tested an end-to-end voice over Internet protocol (VoIP) network using MathWorks products before building any hardware. Engineers 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. They then developed a flexible testbed by building a parameterized model of the network in Simulink and the DSP Blockset, using Real-Time Workshop® to generate C code from the network model, and running the code on standard PC hardware using xPC Target. A point-and-click user interface, created with MATLAB, enabled them to change network conditions while running their tests. [www.bell-labs.com/software](http://www.bell-labs.com/software)

### Developing Low-Cost Semiconductor Products

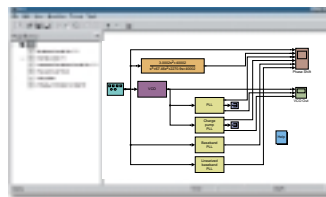


Zyray Wireless in California used MathWorks model-based design tools to develop the SPINNER™ family of semiconductor products for next-generation mobile devices. SPINNER<sub>chip</sub> is a WCDMA add-on baseband processor that reduces handset manufacturers' development cycle time and minimizes dual-mode

GSM/GPRS and WCDMA handset component and development costs. Zyray used MATLAB and Simulink to represent the algo-

rithms, timing, and concurrency for implementation, with customized Simulink blocks encapsulating their hand-written C code for easier incorporation in their models. Engineers modeled and validated their design against requirements using MATLAB and Simulink. They then implemented their validated design in downstream tools. Finally, the Simulink model was used as a test harness to verify the implementation. [www.zyraywireless.com](http://www.zyraywireless.com)

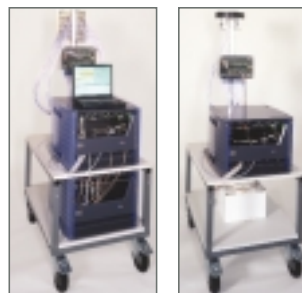
### Speeding up Analog/Mixed-Signal Simulations for PLL Design



The Motorola Wireless Subscriber Systems Group (WSSG) used Simulink to design phase-locked loops (PLLs), a key component in ensuring reliable communication between their mobile handsets and the base station. Previously,

Motorola used SPICE to develop their PLLs. Simulation took nearly two days using a SPICE circuit simulator. MathWorks system-level design and simulation products, with true continuous-time solvers and zero-crossing methods, provided analog resolution without sacrificing simulation speed. Motorola benchmark tests showed that a Simulink model could run a 100-microsecond PLL simulation with subpicosecond resolution in just 10 minutes. [www.motorola.com/wireless-semi](http://www.motorola.com/wireless-semi)

### Developing a High-Resolution Radio-Wave Measuring System



Elektrobit AG in Switzerland used MathWorks tools to develop the PropSound™ radio channel sounder, a high-resolution radio-wave measuring system that detects the propagation of radio waves in time and space by identifying radio holes in network coverage. PropSound uses MATLAB to display all relevant radio waves in

real time, providing input for research on smart antennas and MIMO (multiple-input, multiple-output) systems. Elektrobit used Simulink and the DSP Blockset to model and simulate the system. The engineers built analysis functions in MATLAB to postprocess large volumes of collected data. [www.elektrobit.ch/products/propsound](http://www.elektrobit.ch/products/propsound)

## Developing Mobile Internet Prototypes



RTX Telecom in Denmark developed an advanced mobile voice and data 3G TD-SCDMA Test Terminal

using Simulink, the DSP Blockset, and the Communications Blockset. They selected the emerging TD-SCDMA radio interface specifications for its handling of symmetric and asymmetric traffic. They designed and simulated the entire physical layer using MathWorks tools. The model included base station and wireless channel models that acted as the test harness for the test terminal. This approach enabled them to understand and mitigate the impact of multipath impairments by implementing advanced techniques outlined in the TD-SCDMA specification, including joint detection and advanced power control. RTX delivered a high-quality prototype in a PDA form factor to their customer in record time. [www.rtx.dk](http://www.rtx.dk)

## Developing an Airborne Adaptive Antenna Array

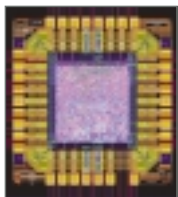


The Communications Research Laboratory (CRL), a governmental-based research institute attached to the Ministry of Public Management, Home Affairs, Posts, and Telecommunications in Japan, developed a novel communication system using high-altitude platform stations to provide a movable wireless network infrastructure. CRL used Simulink as the main development platform for the system, including the

design of the real-time direction-of-arrival (DOA) algorithms. These algorithms are a basic function of antenna array design that estimate the angular direction, enabling “localization” and “beam-forming” of the antenna pattern to electronically maximize the quality of the transmission. Simulink enabled CRL to change the program in the field, which increased flexibility for the engineers and saved programming time. [www.crl.go.jp/overview](http://www.crl.go.jp/overview)

## Designing Chips in 24 Hours

The University of California's Berkeley Wireless Research Center (BWRC) developed a methodology that enables the design of a signal



flow-intensive chip in just 24 hours. The BWRC approach is based on a high-level description, with a single team managing both system-level design and coding. It uses precharacterized high-level macros and hardware components on a highly parallel chip architecture. MathWorks tools provide a unified workflow, enabling BWRC to automatically generate physical information

from a system-level specification. BWRC uses Simulink to create a high-level signal-flow diagram, Stateflow to describe control flow within the diagram, and the Fixed-Point Blockset to identify signals. BWRC continues to refine the chip-in-a-day design flow for signal flow-intensive chips with minimal control. <http://bwrc.eecs.berkeley.edu>

## Building a Reflective Wireless Communication System

A technology developed by University of California researchers at Los Alamos National Laboratory (LANL) could provide battery-dependent wireless devices, such as laptop WiFi, with virtually unlimited usage time. INFICOMM replaces direct radio frequency (RF) transmission with modulated reflectance, enabling a wireless device to transmit to its base station without consuming battery power. The researchers used MATLAB and the Data Acquisition Toolbox to manage signal sources into the system from data acquisition boards and RS-232 controlled instruments to control the



amplification and bandwidth, shape the return signal, and analyze the data. They used the Signal Processing, Image Processing, and Communications toolboxes to encode, decode, and process signals and images. LANL saved an estimated 70% in software development time by using MathWorks tools. [www.lanl.gov](http://www.lanl.gov)

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