Issues and Trends in Wireless System Testing

By Gary Breed
Editorial Director

Today's wireless systems are complex in their circuit design, modulation/demodulation specifications, signal propagation and coexistence with other users of the radio spectrum. These factors combine to make testing a major issue (perhaps the single biggest issue) in bringing a new wireless product to market, especially when system complexity is combined with the urgency of time-to-market pressures.

This report is simply an introduction to the issues that must be dealt with, along with some of the hardware, software and engineering techniques that can help cope with the complexity of wireless system testing. The article that follows this report continues our coverage on this subject.

Verification, Not Just Testing

Wireless system operating standards exist primarily to assure interoperability of equipment from different manufacturers. Each system has complex functionality in its data format and modulation scheme, and spectrum occupancy regulations impose limits on adjacent-channel (and beyond) energy that might hamper other system users.

The modulation types currently in use require a highly linear transmit signal path to simultaneously meet functional requirements, as measured with bit-error rate (BER), and spectral energy requirements, as measured with parameters such as Adjacent Channel Power Radio (ACPR).

Today's test engineer must obtain more than fundamental operating parameters; he or she must verify that the equipment being developed will operate according to the standards, and be confident that it will do so in the final operating environment.

Test Hardware Trends

The use of standards-based "personalities" is a trend that is expanding among instrumentation providers. For example, a spectrum analyzer is no longer simply a general-purpose instrument. Predefined limit lines, detection parameters and sweep setups are available for measurements required by each specific wireless application, which may be W-CDMA, Digital Television, WLAN, etc.

As another example, a power amplifier test system is no longer just a signal generator and a power meter. These are augmented by additional instruments to provide test signals and capture measurements which characterize PA performance under conditions that accurately mimic an operating wireless system.

Further enhancements in test hardware include instrumentation that can emulate real-world impairments—noise, interference of all types, multipath and various defects in signal integrity. System-specific test sets can be obtained for production line testing of equipment for that system, as well as for testing required for system installation and maintenance.

Designing and Testing in Parallel

A developing trend is the combination of circuit/system computer simulation with test instrumentation, to test and verify portions of a design as they are completed and prototyped. Like the development issues it addresses, this approach is complex, but the task will become easier as EDA tool and instrument vendors gain experience combining simulation and instrumentation.

With parallel design and test (you can use "verification" interchangeably with "test" in this context), an overall block diagram becomes progressively more detailed. For example, an upconverter block might start as a "black box" defined by a particular transfer function. When a specific circuit is designed, the circuit simulation replaces the functional description. When that circuit is prototyped (perhaps as a new RFIC back from the foundry), the software can drive the hardware with a simulated test signal that becomes an actual signal at the output of an arbitrary waveform generator. The prototype circuit's response is measured with the appropriate instruments and the results returned to the simulation platform to create a new as-built characterization of the circuit. In this scenario, no portion of the system needs to wait for testing and verification.

This technique is in the early stages of implementation and we are carefully monitoring its development. An application of this technique for power amplifier testing is described in the following article.

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