Adding the 802.11b wireless LAN standard to the I/Q Simulation
Software WinIQSIM™ again considerably expands its wide-ranging functionality for generating test signals in combination with the tried and tested R&S AMIQ and R&S SMIQ generators [1 to 3].

Increasing importance of wireless networks
The modern work environment increasingly requires the quick and straightforward creation of local networks, e.g. for data exchange between PCs or mobile access to databases and the Internet. Wireless LANs enable you to do this without any cabling of rooms and terminal equipment. All the functions a permanent connection to a wired LAN offers should also be available in wireless form. There are different approaches such as HiperLAN/2, HomeRF, the proposals drawn up by the Japanese MMAC* and in particular the standards specified by the IEEE under 802.11.

The total turnover in the WLAN sector is forecast to grow from € 1.1 billion in 2001 to € 5.5 billion in 2005**. The IEEE 802.11b standard introduced in 1999 stimulated WLAN business. The standard operates at 2.4 GHz and permits maximum data rates of 11 Mbit/s (FIG 1).

The 802.11b wireless LAN standard is a packet-oriented method of data transfer, Data packets are transmitted and received on the same frequency in time division duplex (TDD), but without a fixed timeslot raster. An 802.11b component can either only transmit or only receive. Data packets are transmitted and received on the same frequency in time division duplex (TDD), but without a fixed timeslot raster. An 802.11b component can either only transmit or only receive.

Simulation of 802.11b signals with WinIQSIM™

Radio transmission can alternatively use frequency hopping spread spectrum (FHSS) or direct sequence spread spectrum (DSSS). Originally, two data transmission modes were defined for DSSS:
- data rates up to 1 Mbit/s with differential binary phase shift keying (DBPSK),
- data rates up to 2 Mbit/s with differential quadrature phase shift keying (DQPSK).

Both modes spread the information data sequence with an 11 chip Barker sequence, and operate with a rate of 11 Mchip/s.

Early in 1999, the OFDM mode 802.11a for the 5 GHz frequency was added to the standard. The combination of the software products WinIQOFDM [4] and WinIQSIM™ from Rohde & Schwarz can simulate test signals to this standard.

Soon afterwards, in summer 1999, the DSSS mode, too, was extended by the new data rates of up to 5.5 Mbit/s and 11 Mbit/s and defined in the 802.11b standard. Two modulation modes were additionally included: CCK (complementary code keying) and PBCC (packet binary convolutional coding).

* Multimedia mobile access communication systems
** Source: Frost & Sullivan report 3984 (May 2001)
receive packets at any particular time. A distinction must be made between packet types with a long or short physical layer convergence protocol (PLCP).

WinIQSIM™ can generate 802.11b signals in two different modes. In framed mode, the software generates data packets with the frame structure defined in the standard. In unframed mode, a non-packet-oriented signal is generated without a frame structure but with the modulation and data rates defined in 802.11b. This mode is suitable for simple initial tests focusing only on the modulation and spectrum of the test signal.

**Framed mode**

Framed mode allows configuration of a signal that generates a series of PLCP protocol data units (PPDUs), separated by the idle time. The information data is spread to the consecutive packets, i.e. it is not repeated from one packet to the next. This allows transmission of long PRBS data sequences to measure BER for example.

Such a packet always consists of a preamble, a header and the actual information data part. In addition to the number of packets to be transmitted, you can select between the two formats long and short PLCP defined in the standard (FIG 2). The frame structure of the packets is adapted automatically. All fields of the preamble and header such as SYNC, SERVICE and CRC are generated automatically in line with the standard. Besides the data rates 1 Mbit/s with DBPSK and 2 Mbit/s with DQPSK defined in 802.11, the software also provides the higher data rates 5.5 Mbit/s and 11 Mbit/s. The standard defines two different modulation modes for higher data rates: CCK and PBCC. With CCK modulation, 8 chips make up a CCK symbol. At a data rate of 5.5 Mbit/s, 4 data bits are mapped to a CCK symbol, and 8 data bits at a data rate of 11 Mbit/s.

PBCC uses a convolutional coder with half rate to realize the coding gain required. BPSK is used for data modulation at a data rate of 5.5 Mbit/s, QPSK at a data rate of 11 Mbit/s. Another coding layer generates the complex output symbols. For detailed information on the modulation methods, refer to the standard and [5].

**MAC header**

In real IEEE 802.11b systems, a medium access control (MAC) header is transmitted in the PSDU before the actual data part; the header contains control information from higher layers. In addition, it is possible to protect the PSDU by means of a checksum. These two functions can be set in WinIQSIM™ (FIG 3).

**Signals for receiver tests**

The 802.11b standard defines RF parameters to which receivers must conform. Four tests are specified to verify these parameters:

- minimum input level sensitivity,
- maximum input level,
- adjacent channel rejection,
- clear channel assessment (CCA).

WinIQSIM™ can generate signals for all these tests. The receiver must demodulate the signals and measure the frame error rate for example.

**Further tests**

It is possible to configure the MAC header in WinIQSIM™, so all the frame formats defined in the standard can be generated (see also [5]). This permits the generation of a wide variety of 802.11b-conformant signals for all kinds of tests, e.g. RTS/CTS (request to
send/clear to send), or simulation of packet retransmission to examine a receiver’s reaction to corrupted packets (see also [5]).

R&S SMIQ or R&S AMIQ?

The new standard is offered together with WinIQSIM™ as software option K16 for both the R&S AMIQ and the option SMIQB60 (arbitrary waveform generator). These two platforms offer solutions for WLAN 802.11b measurement tasks with different focuses.

R&S SMIQ standalone

Equipped with the options Arbitrary Waveform Generator SMIQB60 and SMIQK16 (option 802.11b), the R&S SMIQ is the perfect solution for testing receivers as defined in the standard and thus for verifying the RF parameters of 802.11b equipment.

R&S AMIQ

The same applies to the I/Q Modulation Generator R&S AMIQ (with option AMIQK16), but with further advantages. This solution is particularly suitable for extended receiver tests and tests with different MAC frame formats. Long BER measurements are possible because of the capability to generate sequence lengths with up to 200 frames (with AMIQ04, oversampling 4, maximum number of data bits per frame). The R&S AMIQ demonstrates its proven assets such as digital and differential outputs and allows precise tests directly in the baseband. If an RF test signal is required, an R&S SMIQ should be added.

Summary

With the new 802.11b standard, WinIQSIM™ together with the R&S AMIQ and the R&S SMIQ presents comprehensive functionality for generating signals to test components and systems that considerably surpasses the scenarios specified in the standard.

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REFERENCES

[5] Application Note 1GP49 from Rohde & Schwarz