Emerging WLAN Market
According to In-Stat/MDR, production volume of next-generation WLAN devices is expected to rise sharply in the coming years. Production volume for 802.11a devices is expected to increase from 805,000 in 2002 to 16,331,000 by 2006. Meanwhile, 802.11g device volumes are projected to increase from 6,700,000 in 2003 to 23,700,000 in 2006. A key driver for the growth will be applications for the home user. According to Cahners In-Stat, the residential market is the fastest growing segment of the wireless LAN business, with residential WLAN chipsets accounting for 47% of all WLAN chipset sales by 2005, a total of over 21 million units.

Although this increasing volume is good news for the WLAN market, it raises serious testing challenges due to the complexity and increasing levels of integration in WLAN chipsets. Keep in mind that testing costs need to be kept to a minimum for devices slated for consumer applications.

WLAN chipsets have already been reduced from five chips to four, with the integration of the baseband processor and medium access controller onto a single chip. Some WLAN chip manufacturers will use direct conversion technology to combine the RF/IF and Modulator/Demodulator chips into one, reducing the number of chips even further. But it does not stop there. Single-chip solutions have already been announced. A typical chipset partitioning for a WLAN module today is shown in Figure 1.

Figure 1. WLAN Chipset

Adding to the complexity are the multiple WLAN standards that exist today – including IEEE 802.11a, 802.11b, and 802.11g. Each of these standards features a different combination of frequency, occupied bandwidth, carrier technique and modulation format, and data rate. To further confuse the market, there are already discussions on various WLAN: What it is and where it is used
WLAN is a high-bandwidth, two-way data communication network that operates over a limited distance, up to approximately 300 feet, and uses radio as the transmission medium rather than copper cable or optical fiber. By eliminating the physical constraints and installation of wires— which can be expensive, time-consuming, and often disruptive— WLANs offer a variety of benefits:

- Ease of installation
- Flexibility
- Scalability
- Cost savings
- Mobility

Installing a WLAN network is as simple as connecting an access point to a wired network and plugging network interface cards (NICs) into all PCs, laptops, PDAs, printers, and other devices that require access to the network. No new network cables need to be installed in walls, floors, and/or ceilings to connect the different devices, saving on labor and minimizing disruptions. Furthermore, changing the location of network devices—or adding devices such as additional printers—is quick and easy. Those users with WLAN equipped portable computers can roam around the building, and will have continuous access as they are handed off from one access point to another.

As WLAN grows in popularity, many different public facilities are installing access points to provide Internet services in a variety of locations outside of the home. Whether you’re waiting at the airport, train station or subway—or getting coffee on a Monday morning—you can pull the latest information you need from the Internet. Even StarbucksTM and other commercial establishments are becoming WLAN-equipped—ensuring you have network access anytime, anywhere. WLAN provides mobile access to central databases in real time for medical staff, warehouse workers, students and so on. It also enables instant networking capability in dynamic environments, minimizing the overhead caused by moves, extensions to networks, and other changes.

We have seen numerous standards for WLAN, and they have gone through many changes in specifications and requirements. Table 1 lists the different characteristics of the various IEEE WLAN standards.

<table>
<thead>
<tr>
<th>Standard</th>
<th>802.11a</th>
<th>802.11b</th>
<th>802.11g</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency</td>
<td>5 GHz U-NII</td>
<td>2.4 GHz ISM</td>
<td>2.4 GHz ISM</td>
</tr>
<tr>
<td>Data Rates</td>
<td>6, 9, 12, 18, 24, 36, 48, 54 Mbps</td>
<td>1, 2, 5.5, 11 Mbps</td>
<td>1, 2, 5.5, 6, 9, 11, 12, 18, 22, 24, 36, 48, 54 Mbps</td>
</tr>
<tr>
<td>Carrier Technique</td>
<td>OFDM</td>
<td>DSSS</td>
<td>OFDM, DSSS</td>
</tr>
<tr>
<td>Modulation Format</td>
<td>BPSK, QPSK, 16 QAM, 64 QAM</td>
<td>CCK, QPSK, DQPSK, DBPSK</td>
<td>BPSK, DPSK, QPSK, DQPSK, DBPSK, 16 QAM, 64 QAM, CCK, PBCC</td>
</tr>
<tr>
<td>Occupied Bandwidth</td>
<td>16.6 MHz</td>
<td>22 MHz</td>
<td>22 MHz</td>
</tr>
</tbody>
</table>

Table 1. WLAN Standards
Exceptional Chip Complexity

Increasing functionality on fewer chips ultimately results in unprecedented chip complexity in WLAN devices. The RF/IF chip includes the following functional elements: LNA, downconverter, upconverter, and driver amplifier. The main purpose of this device is to amplify the received RF signal using the LNA and downconvert the signal to an intermediate frequency (IF) for additional processing by the demodulator and baseband processor. The upconverter will upconvert the modulated IF signal from the modulator to a RF signal for amplification by the driver amplifier and finally, the power amplifier prior to transmission via the antenna.

Baseband processors (BBPs) usually integrate media access control (MAC) logic, baseband processing functions, host interfaces (e.g., USB, PCI, CardBus, etc.), and analog-to-digital (ADC) and digital-to-analog converters (DAC). In 802.11a, for example, an OFDM baseband processor typically supports all mandatory and optional data rates using binary phase shift keying (BFSK), quadrature phase shift keying (QPSK), 16 QAM and 64 QAM modulation schemes. Additional features may include forward error correction coding, signal detection, automatic gain control, frequency offset estimation, symbol timing and channel estimation. Baseband processors can also perform receive and transmit filtering, frame encryption/decryption, and error recovery operations as defined by the IEEE 802.11a standard.

True Performance Verification and Faster Test Times

Due to the complexity of WLAN chipsets, test is the dominant factor in the overall cost of manufacturing – both in actual cost and its impact on time to market.

Wide Bandwidth RF Receiver

Most instruments and test systems are limited to 10 MHz bandwidth, making it difficult to perform the wide-bandwidth measurements required of WLAN RFICs. Traditional systems use a technique called stitching – taking multi-mode chipsets. This includes WLAN/WLAN modes as well as WLAN/Bluetooth and WLAN/Cellular.
multiple acquisitions to get the necessary bandwidth and “stitching” them together – in order to make such measurements, reducing test accuracy and increasing test times.

In contrast, Agilent’s RF Measurement Suite for the 93000 SOC Platform offers more than enough receiver bandwidth required for the wide bandwidth measurements, such as Error Vector Magnitude, Adjacent Channel Power, and transmit spectrum mask. By using the RF Measurement Suite’s 40MHz IF bandwidth receiver, these measurements can be made in a single acquisition, eliminating the need for stitching and thereby improving accuracy and minimizing test times – ultimately lowering cost of test.

Error Vector Magnitude
EVM, using magnitude and phase measurements, is called out in several system standards including GSM, PHS, and WLAN. EVM quantifies the errors in digital demodulation, is sensitive to any signal impairment that affects the magnitude and phase of a demodulated signal, and can now be performed on advanced ATE equipment. To demodulate the data, the test system has to determine the exact amplitude and phase of the received signal for each clock transition. These values define the actual or "measured" phasor signal. EVM is the distance between the end points of the measured and reference phasors (i.e., the magnitude of the difference vector), and is usually recorded as a percentage of the peak signal level (typically the constellation’s corner states).

EVM testing offers one of the most effective ways to truly test the performance of the WLAN transmitters and receivers. It has the greatest breadth of capturing the various problems and impairments, such as LO stability, IF filter, compression, DAC/DSP, symbol rate and interfering tones. The ability to perform EVM measurements allows the Agilent 93000 RF Measurement Suite to test WLAN devices under conditions similar to its final use environment. This, in turn, allows the true performance of the device to be verified.

802.11a and 802.11g OFDM RF signals have high peak-to-average power ratios requiring highly linear and efficient power amplifiers. The back-off, or headroom needed to avoid nonlinear compression effects, determines system cost and performance and directly affects the EVM, output power spectrum, and power consumption specifications. Consequently, by measuring EVM, the linearity and efficiency can be verified.

Testing EVM also provides the opportunity to replace other RF tests, such as phase and magnitude imbalance, and sideband and LO suppression. As a result, EVM not only provides a better measure of a WLAN device’s performance, but also reduces test times. The Agilent 93000 RF Measurement Suite offers EVM capability for both the transmitter RF output and the receiver baseband output.

The Agilent 93000 SOC Series with RF Measurement Suite
With these new enhancements to the RF Measurement Suite, the 93000 SOC Series provides cost-effective test capabilities for both the RF and Baseband sections of WLAN chipsets. The 93000 provides all the necessary test capability – including RF, analog, digital, embedded memory, and scan – to meet the test needs of highly integrated WLAN chipsets today and in the future.

For more information on the:
Agilent 93000 WLAN test solutions visit: www.agilent.com/see/93000wlan
Agilent SOC test solutions visit: www.agilent.com/see/soctest