

WLAN Systems Lead Wireless Market Growth

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During the past year, one of the few truly bright spots in the high frequency market has been the popularity of wireless local area networking (WLAN). Businesses appreciate the reduced cost of WLAN, compared to the installation (or re-configuration) of cabled networks, especially in older buildings and in areas where tough building codes govern wiring installation procedures. Consumers appreciate the value of a convenient wireless connection, with hardware prices that are affordable for systems with enough data transfer speed to avoid the problem of slow downloads.

The same forces that are driving consumers away from dial-up Internet connections are helping WLAN business. Cable modem and DSL technology has delivered on the promise of fast, always-on Internet access for many consumers. With better access, there is greater demand to distribute that Internet connection throughout a household or small office—WLAN is gaining ground on Ethernet wiring as the networking method of choice.

IEEE 802.11b (WiFi) leads the way

The 11 Mb/s speed of IEEE 802.11b is, by a large margin, the leading technology for WLAN systems. The promotional efforts of the WiFi consortium have made a significant contribution to that success. Reasonably-priced network cards and access points are offered by most of the mass-market computer accessory companies. Laptop cards can be found for as

little as \$45, access points for about \$120 and print servers for \$139.

A visit to the web site of one major online computer software and equipment supplier revealed the extent of WLAN equipment offerings. Table 1 is a list of brands included in wireless product listings. Approximately 95 percent of all products were identified as '802.11b' or 'WiFi.' The remaining products were a mix of older 900 MHz technology, 5 GHz 802.11a and a few proprietary systems.

The shelves of major retail outlets have a much smaller selection of products. Retail economics leads to less duplication—similar products from different companies are minimized. At one large discount store, only four brands were offered: Compaq, Linksys, Netgear and DLink. The same store also had one older 900 MHz print server/PC card package still available.

5 GHz IEEE 802.11a systems

The next step in WLAN evolution appears to be 5 GHz equipment, offering data rates that are nearly five times that of 802.11b. A small number of products are on the market and the companies offering them have elected to keep the pricing competitive. For example, a 2.4 GHz 802.11b laptop card might be \$79, while an equivalent 5 GHz 802.11a model from the same company is just \$119. This is good news for performance-conscious consumers.

Further good news is that intense development effort is underway to further reduce the cost of pro-

Actiontec	Sony	Sierra Wireless
Agere Systems	IBM	ShAir
Belkin	Intel/PRO	SMC
Breezecom	Enterasys	Sony
Buslink	Hawking	Targus
Casio	Hewlett Packard	Toshiba
Cisco	Linksys	US Robotics
Compaq	Netgear	Xircom
Control	Nortel Networks	Zoom
DLink	Proxim	

Table 1. Companies offering WLAN products, found on just one online retailer's web site.

ducing 802.11a components. It is a safe assumption that, after witnessing the success of 802.11b, companies are willing to make a greater investment in what is generally accepted as the next generation of WLAN technology.

The attraction of 802.11a is speed. 54 Mb/s is fast enough to be indistinguishable from 100 Mb/s Ethernet, and “turbo mode” enhancements double the speed to 108 Mb/s, slightly exceeding what most wired networks are now using. Gigabit Ethernet is faster, of course, but few home or small business networks require that much speed. When the time comes that video is distributed via standard computer networking, such speeds will become more desirable.

OFDM technology

The speed of 802.11a is achieved through OFDM modulation (Offset Frequency Division Multiplexing). OFDM is an impressive engineering solution to the combined problems of high speed data transmission and indoor propagation characteristics at 5 GHz. The high speed data is divided into a series of 52 lower data-rate subcarriers, distributed over 20 MHz of spectrum. Interference between adjacent subcarriers is minimized by making them orthogonal (90-degree relative phase).

The main propagation effect is multipath. At 5 GHz, in an indoor environment, the delay spread ranges from 50 ns in a home or office, to 300 ns in a warehouse or factory floor. To overcome multipath effects, the OFDM signal includes an 800 ns guard interval to avoid interference between an arriving new symbol and a reflected version of the previous symbol.

To help deal with errors due to direct and reflected versions of the same symbol, training sequences are included in the data burst. With these training

sequences, signal processing circuitry can automatically compensate for the time difference between several direct and reflected images of the signal.

Every technique used to compensate for signal degradation adds overhead to the transmitted data, reducing the theoretical maximum data rate. 802.11a OFDM's multiple subcarriers permit data rates that exceed what is possible in a single channel at 5 GHz. The cost is increased spectrum occupancy and complex signal processing. The spectrum issue was addressed when the 5 GHz band was re-regulated to permit unlicensed wireless systems such as these. The signal processing issue is handled with the power of DSP, which is readily available in standard and custom integrated circuit solutions.

Hardware issues

The issues with hardware design for 802.11a WLAN equipment can be summed up in three words: *frequency, complexity and cost*.

5 GHz receiver, transmitter and antenna technology is in the traditional microwave region, where past technology has been labor intensive, produced in relatively small quantities, and expensive. Fortunately, the continued evolution to higher frequencies has helped wireless product manufacturers quickly learn how to make highly integrated and mass-reproducible components that operate these frequencies.

The complexity issue, as noted above, is handled nicely by DSP technology, which has advanced in both the capability of the devices and in the understanding of signal processing mathematics.

Cost of production has also experienced a significant step forward in its evolution. Components and finished consumer products have benefitted from better overall project management techniques, but more companies must adopt these methods to assure their success in this market. A future report will take a closer look at some of the management techniques that enable new technologies to be developed quickly and economically.

Final Comments

While there are a few proprietary WLAN products (mostly 100+ Mb/s high performance systems), this part of the high frequency industry has been an excellent example of the value of standards. With 802.11b/WiFi, consumers know that they are not restricted to a single vendor for upgrades and expansion of their WLAN systems. 802.11a will likely have the same positive effect on 5 GHz system sales.

Bluetooth is notable by its absence in this report. Few products are on the market, and there is little to report at this time. We will continue to watch developments and report on them in future issues.

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