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The Next Phase of the Wireless Revolution

By Ted Rappaport

Wireless communications is entering a new phase of growth, and fortunately for those of us who have been waiting for services in and around buildings, that growth will soon reach us!

Cellular/PCS was originally designed to be an outside service where tall tower tops and building perches gave way to smaller micro-cells that added capacity for burgeoning subscriber growth. The 20 to 30 dB penetration loss of most buildings' external walls made it difficult, however, for cellular carriers to reach users in the structures where they work and live. Now, finally, after years of dabbling in the concept, cellular carriers are beginning to aggressively install infrastructures that ensure cellular systems have both the coverage and capacity to serve users inside buildings.

City governments are also paying more attention to in-building coverage for both public safety and commercial carrier capabilities. Recently, the New York City Fire Department issued a request for proposals to ensure that as many as 5,000 of Manhattan's tallest buildings have sufficient wireless coverage for public safety frequencies. And wireless in-building service providers are beginning to develop sizeable portfolios for managing cellular, PCS, and Wi-Fi network deployments in shopping malls, hotels, and airports.

Today, the wireless industry lies at the dawn of a new age. Circuit-switched cellular is being complemented by networks that have evolved out of the Internet age. And information technology (IT) professionals, not RF engineers, are deploying these systems. Instead of radio propagation, the new army of wireless integrators think in terms of delay jitter, throughput, and end-user applications. Radio designers are now software engineers, implementing smart algorithms in field-programmable gate arrays (FPGAs) for flexible receiver designs.

In this transition from radio engineering to the wireless Internet, IT professionals need software that allows them to provision and manage Wi-Fi wireless networks, just as was done for the wiring closets of wired networks. Companies like Wireless Valley are providing tools that allow IT staff without extensive RF expertise to properly provision and manage wireless assets.

Copious quantities of new spectrum are now available without a license, and the FCC appears to be enlightened to the fact that some radio regulations for interference protection are overly conservative, failing to take advantage of modern interference rejection and the adaptive capabilities of today's wireless modems. Wireless is morphing from a world of circuit-switched, high-quality, low-bandwidth communications to a world of contention-based, bursty, hopefully on, broadband communications.

Yet this is just the tip of the iceberg. In various wireless industry standards bodies, work is under way to bring unprecedented data capabilities inside buildings. The IEEE 802.15.3a ultra-wideband (UWB) standardization effort will bring devices to market within the next 18 months that feature data rates of up to 480 megabits per second. At these operating speeds, it is not only possible to provide the wide bandwidths required for wireless multimedia applications and wireless USB, but it also becomes possible to provide position location and topographic imaging with accuracies of a few inches. New safety features and location capabilities will come with UWB technology, and since companies such as Texas Instruments, Motorola, and Intel are actively involved in the process, success is relatively certain. Already, Xtreme Spectrum is making UWB chips capable of such enormous data rates and precise ranging.

Thinking ahead a few years, the 59 to 64 GHz band — portions of which have already been approved for unlicensed use in the United States, Japan, and Europe — looms large for the future of wireless. The 60 GHz band offers more spectrum, licensed and unlicensed, in its single unlicensed allocation than has ever been available to the entire wireless industry since the invention of radio.

Within the next decade, hard drives and memories will undergo radical transformations as the in-building wireless pipe opens up to support massive data transport from 60-gigahertz memory smarcards without wires. As integrated circuitry (CMOS) line widths decrease to 90 nanometers and below, and as silicon germanium processes improve, Moore's Law dictates that it is only a matter of time before low-power 60-gigahertz electronics become affordable and as ubiquitous as AC outlets are today.

While the future looks bright for enhanced services and the transition from voice to broadband data, there is still a great deal of work to be done. Cell phone coverage inside buildings remains second-rate, and we are still in the early days of an infrastructure buildout that will eventually exploit the already-installed worldwide fiber-optic infrastructure.

Millions of buildings, so little time.

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