HONEY, I SHRUNK THE CELL SITE!

Will we be carrying our own antennas in the future?

BY SEAN HEATH

Digital technology has contributed greatly toward making the electronic devices we use smaller and less noticeable, while at the same time becoming more useful. Music players, for example, used to be brick-like things that could only play a cassette's worth of songs at a time. Now, the latest mp3 players can slip inside your pocket, hold a week's worth of tunes and video, and some can even make telephone calls as well.

As Wi-Fi is becoming a more and more pervasive in cities across the nation, wireless users are beginning to see gaps in their wireless umbrellas. Simply being next to a "hot spot" does not ensure a successful connection. A building or billboard might be blocking the signal, for example. A new category of cell site, femtocell, may help solve this problem—since it would seamlessly switch calls from Code Division Multiple Access (CDMA) or Global System to Mobile Communication (GSM) to the building's wireless-Internet backbone, and vice-versa.

Femtocell technology in a building promises to be just as innovative and convenient as the switch from cassette to mp3. Acting like a cable modem or DSL router, a femtocell could link together all the communications devices in a home or a small office, as shown in the graphic below, and could be available for $100 to $300 in your local consumer electronics store within the next 12 months.

A recent study released by ABI Research estimates that there will be 102 million users of femtocell equipment on 32 million access points by 2011.

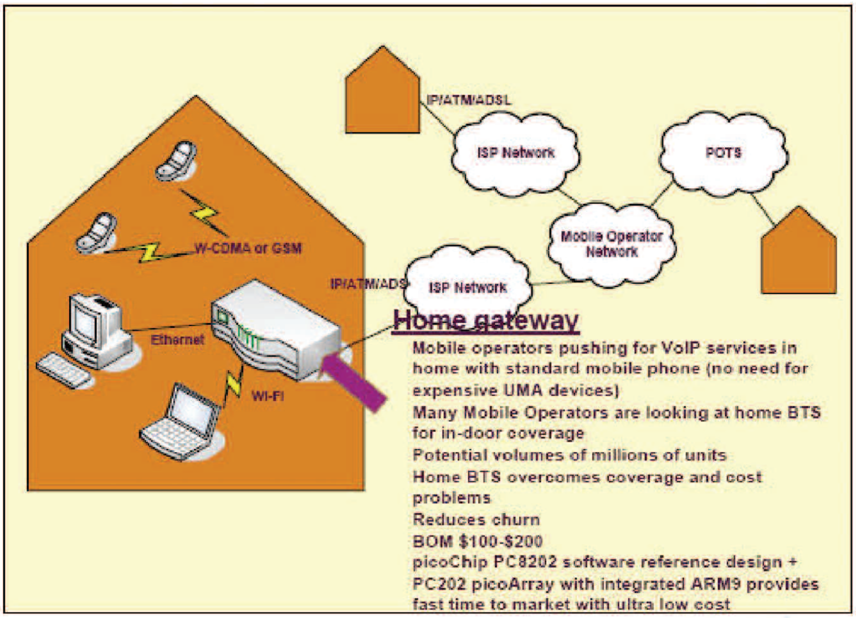
"The most interesting characteristic of femtocells," says Stuart Carlaw in an article for Wireless Developer Network, "is that they can give operators a cost-effective way to [bring] broadband features like TV over the Internet into the home.

Recently, UK chip maker picoChip and Korea Telecom formed a partnership to introduce femtocells in certain Korean cities.

Generally speaking, wireless sites can be broken down into five classifications relating to facility size, or more specifically the size of an individual tenant's demised area. The first three ratings (macrocell, minicell and microcell) were originally coined by the California Department of Transportation, and the latter two ratings (picocell and femtocell) were first used in articles published by CNet.com and Information Week.

As cell sites have gotten smaller, engineers have borrowed metric prefixes as the basis for their labeling. Micro- (meaning 1 millionth), pico- (1 trillionth) and now femto- (1 quadrillionth) have been used

Femtocells—Your Link To the Outside World



to describe smaller and smaller cell sites. However, the practical definition of their broadcast radii does not hold true with their conventional metric definitions.

Microcells generally consist of one to two panel antennas mounted on street signs or light poles and are typically used to fill in small coverage gaps in residential neighborhoods. Picocells are being installed in hard-to-cover, high-volume areas like airport concourses, shopping malls, subways and tunnels. They are also used as the basis for the wireless "hot spots" at your local bookstore or coffee shop.

Typically, as population density increases, so does the density of sites. As the density of sites increases, their broadcast radius decreases, as shown below. The following graphic also illustrates how femtocells represent the latest miniaturization of wireless technology: from macrocells at the top of a mountain to femtocells at the top of your bookshelf.

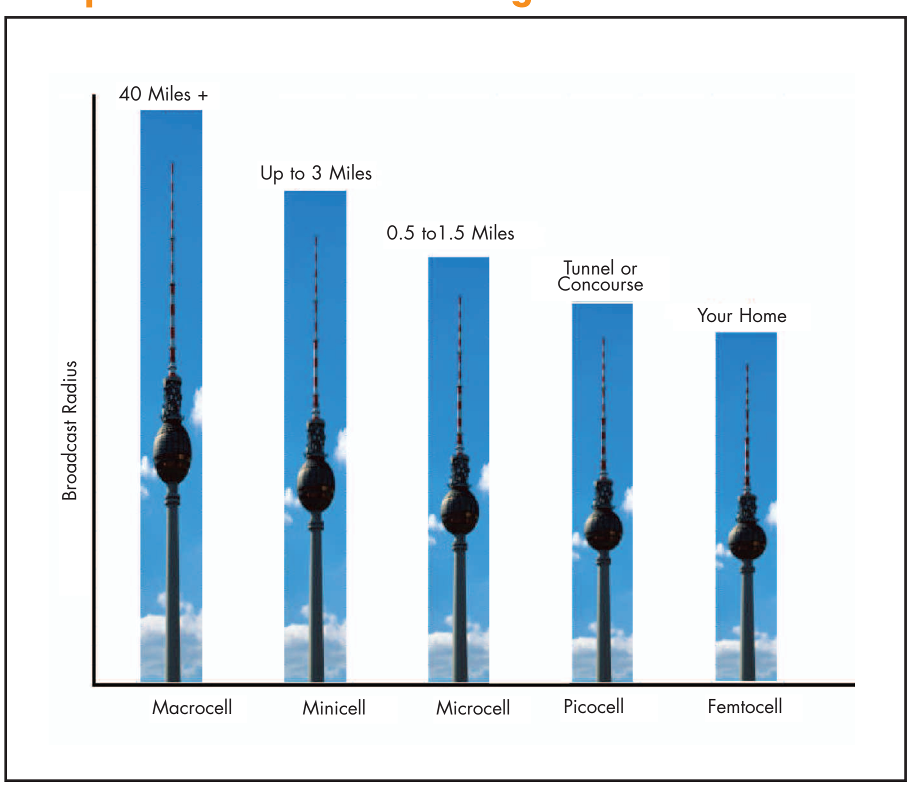
Each time a new communication standard is introduced, cell sites built for that standard are introduced in a repeating pattern: start high to cover as broad an area as possible and then subdivide into smaller cells as call-demand increases (see comparison of Broadcast Ranges).

In the U.S. alone, more than one billion wireless calls are made every day. The demand for more bandwidth to handle the transmission of higher levels of data (from analog calls to digital calls, text messages, photos and MP3s, to DVD-quality video) puts increasing pressure on engineers to develop new communication standards to better accommodate the volume of data flying through the air.

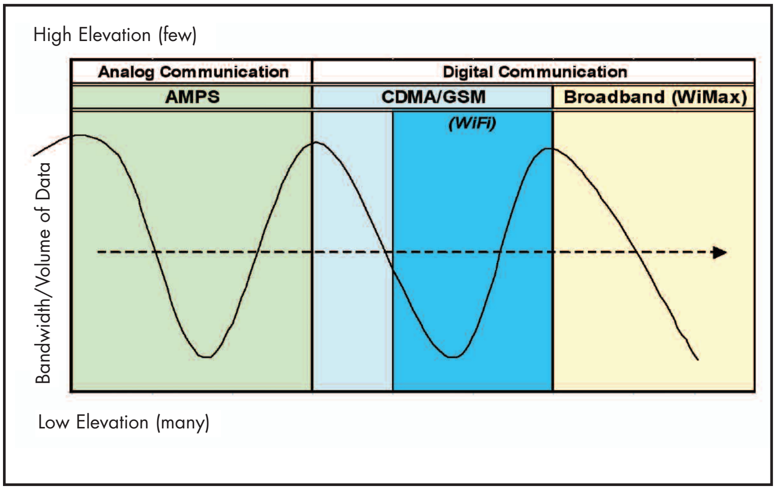
Since most Wi-Fi antennas are already low to the ground (30 feet or less in most cases), the only practical remedy for seamless coverage is to broadcast from a higher elevation and at higher speeds. At the present time, we are approaching a transition in digital communication from CDMA and GSM to the higher bandwidth and speed promised by WiMax. In terms of bandwidth, WiMax portends the ability for several users in the same area to watch DVD-quality video on the same channel at the same time.

As with any innovation, there are downsides. In the case of femtocells, the popular criticism has been that it will put pressure on handset manufacturers to add outdoor and indoor functionality. While outdoors, the handset will behave like a standard CDMA or GSM product. In the family room, the phone will switch to a different standard like Wi-Fi without creating conflict with other home electronics.

Comparison of Broadcast Ranges



Cell-Site Development Pattern



For example, you wouldn't want to send photos from your new camera phone to your wireless printer only to discover that the same frequency is used by your wireless iPOD speakers. Or, finding out that your satellite radio prevents you from using your Bluetooth headset to answer a call from your parents.

Certain regulatory issues may have to be resolved, such as the requirement for the operator of a network to be able to show exactly where each base-station is located. Imagine walking up to a local Cingular kiosk and asking for a wireless-coverage brochure. How will carriers be able to keep this information current, and stay away from false-advertising claims, if base stations are sold directly to consumers?

Other bugs need to be worked out as well. One WiMax standard (802.16d) currently does not recognize moving base stations (like people walking around, or driving in cars), and the other standard (802.16e) cannot yet support rapid call-handoff from cell to cell—an important ingredient for mobile broadband.

According to Guy Kewney, reporting for newswireless.net, one problem affecting rapid call handoff is the differing speeds required for data and voice. "A voice call," he writes, "is transmitted at ten kilobits per second and has a delay built into its [transmission] to cope with interruptions. By comparison, a data stream is sent on the order of megabits per second."

Sprint-Nextel, the nation's third-largest carrier with 51.7 million subscribers, announced in August of 2006 that they would spend up to $3 billion to roll out a mobile WiMax network by 2008, backed by Intel.

Traditionally, cellular networks have been closed systems—proprietary antennas and equipment running incompatible communications standards like CDMA or GSM. Companies like Sprint-Nextel and Intel hope to eventually create a global wireless network based on an open, universal standard mirroring the Internet.

Sprint's billion-dollar gamble could put pressure on competitors like Cingular and Verizon Wireless, and on equipment makers, to move toward more open standards and what the industry refers to as "network neutrality," a network design in which all types of data traffic are treated equally by the network operators.

In theory, our handsets and the cell sites that support them, should act seamlessly switching from one communication standard to the next depending on its local environment (see Cell-Site Development Pattern).

If this labeling trend stays consistent, the next stage of cell-site development might be a nanocell: a personal server that would double as a cell site. Intel researchers are developing a new class of mobile device that leverages advances in processing, storage, and communications technologies to provide ubiquitous access to personal information. And applications through the existing fixed infrastructure. The "personal server" will be a small, lightweight computer with high-density data storage capability. It requires no display, so it can be smaller than a typical PDA. A wireless interface enables the user to access content stored in the device through whatever communication standard is prevalent in the local environment.

Purists might argue that nanocells should be larger than their femtocell cousins, and they would be right if these prefixes were used in their metric sense. Yet, our popular lexicon has taken to using "nano-" to introduce any tiny element. The study of the very small is called nanotechnology; the smallest particle would be a nanoparticle.

Along these lines, then, the smallest cell site should therefore be called a nanocell—a cell whose boundaries are just large enough for one person.

If our world of information were a single room, then a nanocell would represent that smallest element—a solitary particle of dust in the wireless ether. We are already surrounded by a cloud of information, and our access to that information is becoming more seamless all the time. Ultimately, what this will mean is that we will (at some point) all have personal cellular base stations to assist us in tapping into that data cloud. We won't have to worry about being next to a "hotspot" or monopole for the best reception, since we will be carrying our own antennas with us wherever we go.