THE NEW SKIN OF WIRELESS

BY SEAN HEATH

Telecom cells and the cells of your skin are not as different as you might think.

In both contexts, cells serve as basic building blocks, from which larger organisms can be created. Within a wireless context, cells are both a basic building block for a larger organism (the cellular network) and an agent for social interaction.

According to Dr. Charles W. Emarine, a radiologist with Kaiser Permanente in San Diego, Calif. skin cells grow in a process called epithelization. When we receive a cut or wound, new epithelial cells (skin cells) begin to grow from the edges of the wound toward the center. The better the blood supply to the underlying dermis, the faster the epithelial growth. Eventually, these new skin cells will form fibers (or "corridors") across the healing wound, as the clusters of new skin cells start to link together. Eventually, these various fibrous corridors will merge resulting in a fully-covered wound.

Telecom-cell growth has, and continues to, spread across this country in irregular ripples, from population centers to rural areas, and from business cores out to the "burbs." At its simplest, cell growth goes through distinct stages of development (See Table 1):

1.) Cluster growth in test markets.

2.) Formation of a backbone, linking clusters together.

3.) Branches form off of the central backbone.

4.) Coverage gaps are eventually filled in with smaller and smaller cell sites, until the area in question is "filled in" with wireless coverage.

5.) Renewal, as older cells are replaced with newer ones.

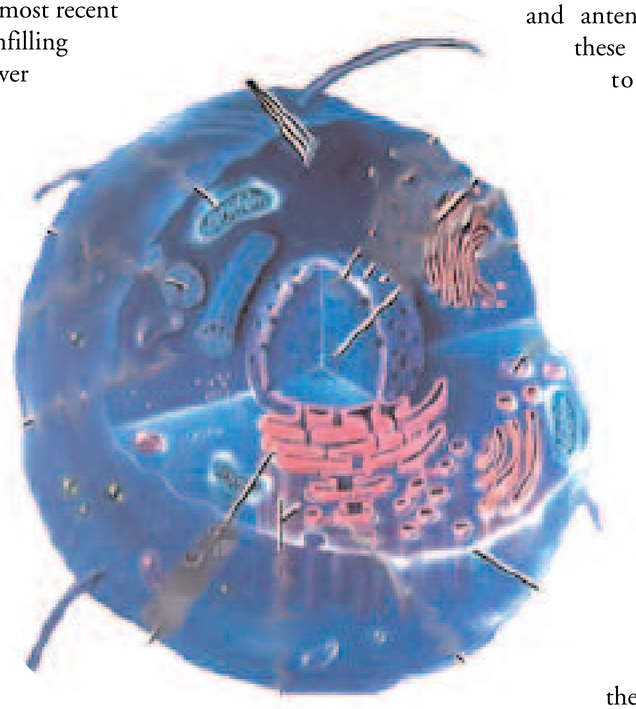
STAGE	SKIN CELLS	TELECOM CELLS
Growth of Clusters	New cells along periphery	Selected sites in large cities
Backbones	Special cells lay down strips of replacement collagen	Build-out along interstate between clusters
Branches	Skin cells grow atop these collagen strips, forming branches and woven patterns	Build-out along surface streets
Filling in the Gaps	As the collagen weave gets tighter, more epithelial cells grow to fill in the gaps, until the wound is completely covered with new skin.	Cellular service moving into residential areas

TABLE 1

TYPE	HEIGHT	BROADCAST RANGE
Mountain-top	Depending on evaluation	Up to 40 miles
Lattice tower or guyed mast	Up to 300 feet	Up to 5-10 miles
PCS monopoles	Up to 50 feet	Up to 3 miles

TABLE 2

"The stages of wireless growth resemble patterns of hierarchical diffusion discussed by Peter Gould," wrote Thomas Wikle in The Geographical Review. Wikle is a professor of geography at Oklahoma State University in Stillwater, Okla. "As Gould noted, rather than spreading uniformly across the landscape, innovations spreading through hierarchical diffusion begin in central places that serve as focal points, then move to smaller cities and so on down the hierarchy. Wireless networks in the United States began in a few large cities and subsequently spread to other large and medium-sized cities in order to serve business needs. The expansion of networks is also represented by the spread of towers along heavily traveled interstates and, subsequently, secondary highways. The most recent expansion of networks is characterized by infilling within cities and suburban areas, as tower networks become denser in response to greater competition and efforts to increase calling capacity in order to meet growing demand."



Just as with skin cells, as the weave of wireless fibers grow closer together, the gaps of coverage in between these fibers become smaller. In turn, the cell sites being built to fill in those coverage gaps are also getting smaller.

Table 2 highlights this developmental trend and the different types of telecom cells currently in use today. Although a cell site's radius depends upon its surrounding topography and its capacity to handle calls, cell sites in rural areas generally have a radius between five and eight miles, and cell sites in urban areas typically have a radius between two and five miles.

As call volume increases within a given cell, demand for frequency reuse (in other words, the cell's ability to handle more calls) will also increase until the cell reaches its maximum processing capacity. Therefore, to preserve wireless coverage and to provide for future growth, carriers are breaking up larger sites into smaller ones. Depending on the specific topography of the area to be covered, a handful of smaller sites at lower elevations could be substituted for one high-elevation site at capacity.

So, how small is small?

Microcells (see photo on page 25) generally consist of one to two panel antennas mounted on street signs, light standards or utility poles. In Southern California, sites like these are being used by carriers to fill in coverage gaps in residential communities. They are also used to cover small stretches of road that could not be covered practically with a larger site at a higher elevation.

Picocells represent the latest in telecom-cell development. With equipment small enough to fit inside a suitcase, and antennas the size of a deck of cards, these cells are being installed in hard-to-cover, high-volume areas like airport concourses, shopping malls, subways and tunnels.

Our need to share information is analogous to the flow of blood for skin cells. As Dr. Emarine pointed out, increased blood flow can lead to faster epithelial-cell growth. Consequently, increased telecom-cell growth is usually the end result of an increased need to share information.

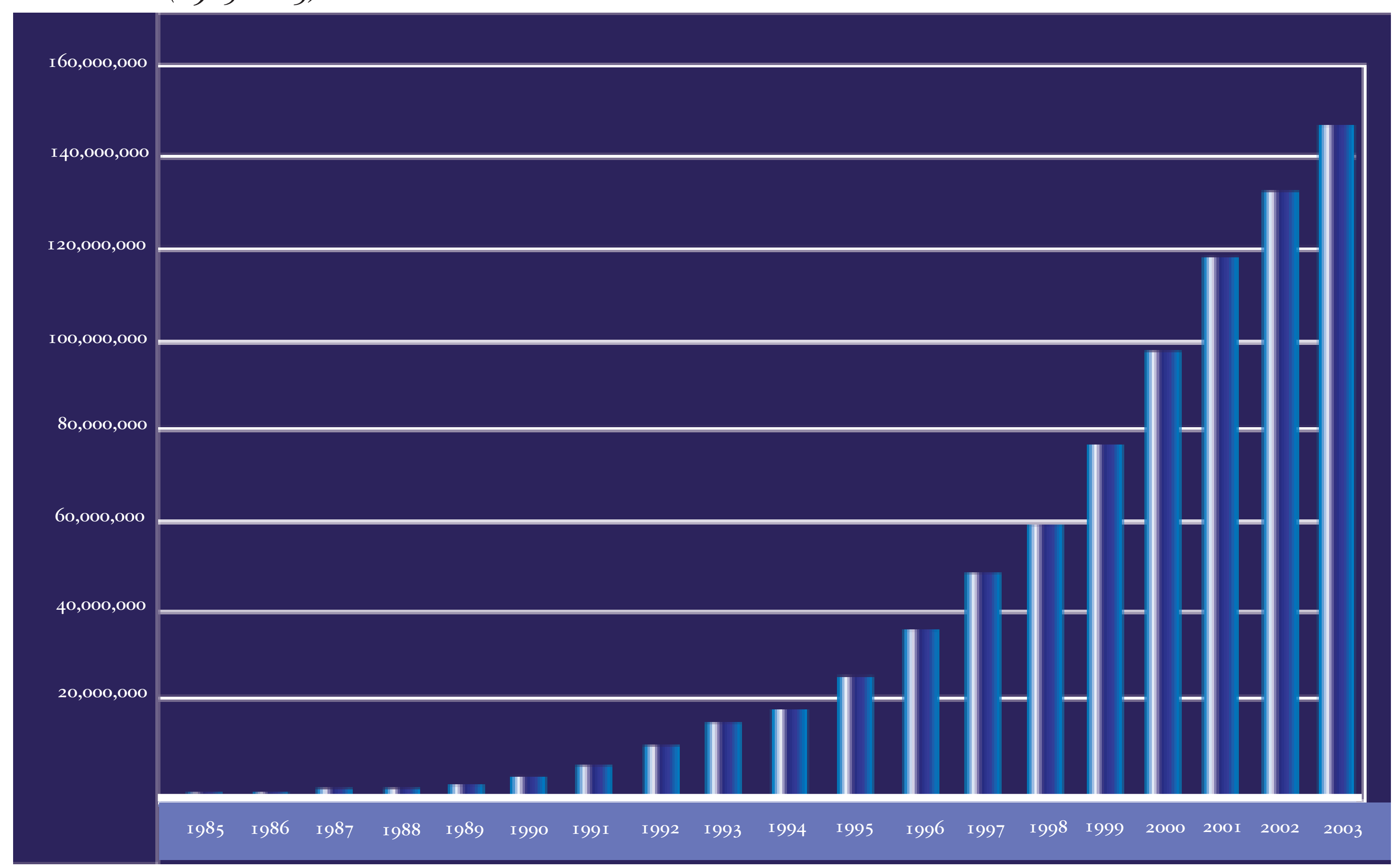
In 1996, the total number of cell sites in service, according to the Cellular Telecommunications and Internet Association (CTIA), was 30,045 sites. One year later, this number rose to 51,600 -an increase of 71 percent. At this time, 38 million cell phones were in use across the country, and the average consumer used his or her phone for 122 minutes per month. By 2003, almost 163,000 cell sites had been built, and the average subscriber was spending more than 300 minutes per month on the phone. According to the latest CTIA data, the number of cellular subscribers in 2003 equaled half of our country's population. Figure 1 highlights the explosive growth of cell phones over the past 18 years, demonstrating a 10 percent year-over-year growth.

Considering the exponential rate that cell sites are being placed into service, there will come a point in the not-too-distant future when carriers will have achieved truly universal wireless coverage - a skin of cellular service. In this type of environment, according to futurists, exchanging information could be accomplished through a number of different portals - PDAs, cell phones, kiosks, wireless modems, electronic message boards, or other interactive devices. The Internet as we know it today, will not be a destination reached by a mouse-click. Instead, it will be all around us.

In a Wired Magazine article published in January of 2000, author George Johnson describes the vision of some computer scientists for a new wireless "web."

"There will be a day, maybe as soon as 2010, when the Internet disappears, when computation and connectivity become so pervasive that you forget they are there. Today's metaphor is the network - a vast expanse of nodes strung together with dark, gaping holes in between. But as the threads inevitably become more tightly drawn, the mesh

ESTIMATED CELLULAR SUBSCRIBERS
Nationwide (1985-2003)



Source: Cellular Telecommunications and Internet Association.

will fill out the fabric, and then - with no voids whatsoever - into an all-pervasive presence, both powerful and unremarkable."

"Your environment will become alive with technology," Leonard Kleinrock, the UCLA computer scientist responsible for setting up the first Arpanet (precursor to the Internet) node three decades ago, said to Johnson in this same Wired article. "The walls will contain logic, processors, memory cameras, microphones, communicators, actuators, sensors. Your wristwatch will communicate with devices in your belt - a 'bodynet' - which will talk to your desktop."

In the future, there will be hundreds of billions of embedded chips and sensing devices integrated into everything from key chains and swimming pools to your apartment's walls and even your skin. All of these devices will be able to compute, sense and communicate with each other.

Potential applications of this new wireless skin or "Omninet" as futurists have labeled it are as numerous as the faces of people in a city. Some of the ideas being tossed around include:

•Traffic sensors embedded in freeways for real-time traffic updates.

•Sensors embedded in the concrete of bridges and overpasses designed to measure structural fatigue. An engineer, driving a specially-outfitted van, could gather the data from the sensors merely by driving over them.

•Sensors placed on individual electrical wires in a high-rise office building could wirelessly report power-consumption data to offsite building managers more accurately, and more conveniently, than submeters (which require onsite inspections).

In fact, as technology gets smaller and more sophisticated, we will increasingly turn to biological vocabulary to describe its form and function, and to frame its development within a context we can understand. Words like cells, virus, immune systems and feedback, have all found digital corollaries.

It's the same with skin. Our skin cells act as a protective shield against bacteria and viruses. Telecom cells protect the flow of information and ideas, which as Steven Johnson explains in his book "Emergence," can be vital to the health of a thriving city.

"Cities have a latent purpose as well: to function as information storage and retrieval devices. Cities were creating user-friendly interfaces thousands of years before anyone even dreamed of digital computers. Cities bring minds together and put them into coherent slots. Cobblers gather near other cobblers, and button makers near other button makers. Ideas and goods flow readily within these clusters, leading to productive cross-pollination, ensuring that good ideas don't die out in rural isolation. Cities store and transmit useful new ideas to the wider population, ensuring that powerful new technologies don't disappear once they've been invented."

By cutting the phone cord, we have, in essence, established a more efficient flow of information through the wireless skin over our heads. Somewhere in the city below, this data stream will shower down to seed new opportunities and innovation.

So the question remains…

Are you unplugged? ❖

REFERENCES

[1]Wikle, Thomas, "Cellular Tower Proliferation In The United States", The Geographical Review 92 (1): 45-62, January 2002.
[2]Picocell-antenna photo courtesy of Racal Antennas, and can be viewed at http://www.mobilecomms-technology.com/contractors/base/racal2/racal22.html.
[3]From "Only Connect", written by George Johnson in Wired Magazine, Issue 8.01, January 2000. This article can be read in its entirety at http://www.wired.com/wired/archive/8.01/nets_pr.html.