Wireless Gets Real

Simson Garfinkel goes on the road, gets unplugged, and finds out how close we really are to an untethered nirvana.

Illustrations by Lou Beach

Improved satellite tech and new FCC policies could precipitate affordable ubiquitous wireless service. The spectrum is there. But will we manage to make room fur everyone?

Being wired is nothing to brag about. Connected by a copper tether to some wall, today's information networks chain our bodies even as they liberate our minds. Ever try to find a phone jack in a crowded airport, coffee shop, or shady park? To be truly wired, you must be wireless!

Fortunately, the promise of a fully wireless world is close to being realized. Across the US, vast networks of radio antennas are fanning out to seamlessly connect mobile users with existing data networks, in much the same way cell phone systems have. Over the past year, I have experimented with a half-dozen of these systems - in effect taking a historical tour of wireless technology. The systems developed in the 1980s established proprietary services that allowed your laptop to link to a nationwide, albeit patchy, network of radio transmitters. Throughout the 1990s, several strategies evolved: developing more Internet-compatible systems for laptops such as Metricom's Ricochet; pumping up the two-way capabilities of smaller devices, like pagers; or morphing cell phones into data transmitters.

All these wireless services, however, still rely on land-based networks. But that's beginning to change. As we move into the future, giant networks of low-Earth-orbit satellites will provide even greater wireless coverage.

First generation: radio networks

Last December, my wife Beth and I took a 5,950-mile road trip from Martha's Vineyard, off the coast of Massachusetts, to Seattle, by way of Texas and California. The goal was simple: get across the country, avoid the winter storms, do some touring, and avoid losing my job. Being a journalist who writes about the Internet, that meant remaining in constant email contact.

The obvious way to stay in touch was to use a cellular telephone and one of those US$300 credit-card-sized cellular modems. (Normal PC card modems don't work over cellular phones - the sound quality is too poor, and calls fade in and out.) But when you are roaming, cell phone connections average $1.40 per minute! Picking up my typical 100 daily email messages would be a $20- to $50-a-day proposition.

Instead, I got two wireless email accounts: the first with Wynd Communications, and the other with RadioMail. Rather than use the cellular phone network, these providers lease time on the nation's two wireless data networks, ARDIS and RAM Mobile Data. Both work with radio modems that plug into a PC-card slot, and both offer nationwide coverage without roaming fees. At least in theory.

Despite being bitter competitors that use different equipment and communications protocols, ARDIS and RAM are virtually indistinguishable. Both are built upon a nationwide network of radio transmitters. Both connect their base stations with leased lines. Both transfer data somewhere between 4.8 Kbps and 19.2 Kbps. And because both combined have spent more than $1 billion over the past decade, neither has yet seen a profit.

ARDIS was conceived by Motorola and IBM in the early 1980s as a wireless network for IBM's service fleet. An engineer in the field could quickly get assignments, check on parts inventories, and send email. After some early headbanging, in which both Motorola and IBM backed out and then reentered the deal, they created ARDIS in 1990. Today, ARDIS provides service to more than 400 metropolitan areas in the US, claiming to cover more than 90 percent of the business activity and 80 percent of the population; service is also available in Puerto Rico and the Virgin Islands.

RAM Mobile Data, on the other hand, is the child of BellSouth and RAM Broadcasting, a cellular and wireless company. Created in February 1992, the Woodbridge, New Jersey-based company uses a technology called Mobitex, an international standard for two-way wireless data communications. The network consists of base stations (they have 1,200 today and plan to double that over the next few years), local switches, regional switches, and a network control center. ARDIS and RAM largely cater to vertical markets: companies like Pepsi-Cola, Illinois Power & Light, Guaranteed Overnight Delivery, Bank of America, the California Highway Patrol, Holmes Protection. This has kept their growth steady but slow, says Bill Frezza, a freelance analyst who follows the wireless data industry. What eludes both ARDIS and RAM is a killer horizontal application that can link with a company's existing, nonwireless system. For years, many thought email might be that application. The idea is seductive: to pick up your email, just take out your laptop and type Command-M. No worrying about hooking up to a telephone line. But even Frezza, who sits on the board of Wynd Communications, admits that the systems are too difficult to use. The software is nonstandard. The radios are finicky. And the coverage is barely adequate.

I discovered as much during my drive. Even in the middle of a so-called "coverage" area, reception was inconsistent, especially inside buildings. In a New Jersey hotel, for example, my RAM Megahertz All Points radio modem worked if I was sitting at the desk near the window, but not on the bed. In Philadelphia, I could use my Motorola PM100D wireless modem card on one side of an apartment building but not the other. And neither worked in rural areas, where wireless is potentially the most useful. An hour outside Philadelphia, both radios lost contact with their networks. The problem, says ARDIS president Walt Purnell, is too much space and too few customers: "We are just not going to have 100 percent coverage, especially in a country like the US," he said. "It's just not economical."

One solution is to use a satellite communications system as a backup, says Janet L. Boudris, RAM's senior vice president of strategic marketing. But the system requires that customers travel with both a RAM radio modem and a satellite device. And the radio is both heavy and power-hungry - so much so that you can't run it off batteries; you need a power source like an alternator in a truck.

Two-way pagers let you answer without finding a phone, or even leaving your seat.

Second generation, part I: shrink it

Second-generation wireless data systems try different approaches. One is to shrink the combo laptop/two-way data radio until it's about the size of an electric razor and can run for weeks on a single rechargeable battery. Put one of these on your belt, and you've got a wearable computer that sends and receives email.

Both ARDIS and RAM now offer a small palm-sized device that has a fliptop lid with a full QWERTY keyboard underneath. The device, called a two-way pager, is manufactured by Research in Motion of Waterloo, Ontario. RIM chair Jim Balsillie says that RAM and ARDIS provide nationwide two-way messaging for about $30 a month. SkyTel, one of the nation's largest paging companies, also offers a similar two-way paging system based on technology called ReFlex 50, which it developed with Motorola.

One of the biggest problems facing traditional pagers is that the network doesn't know where the pagers are and if the pages are received. So every page has to be broadcast throughout the entire coverage area, a technique called "simulcast," but which insiders refer to as "spray and pray." Such retransmitting rapidly consumes the paging system's capacity. Alphanumeric pagers compound the problem because their longer messages require more airtime to send.

Two-way paging, on the other hand, continuously tracks each pager's location. SkyTel's 2-Way pagers contain a tiny 1-watt transmitter that sends a "heartbeat" signal every half-hour or so. SkyTel's computers listen for that heartbeat through special receive-only antennas that are scattered around more than 100 cities nationwide. Each page is transmitted only in the pager's vicinity, and each is acknowledged by the pager itself. This capability harbors a huge potential: "The paging industry is going two-way, whether they know it or not," says Ira Brodsky, president of Datacomm Research in Chicago. The reason? Two-way networks allow a company like SkyTel to offer nationwide one-way paging at about half the price of its competition (starting at $39.95 per month, which includes 600 ten-character message blocks but not rental of the pagers). That's because SkyTel's new one-way pagers are really two-way pagers in disguise. They can't reply to messages, but their built-in transmitter lets the system track them and guarantees that each page is received.

Beth and I carried SkyTel's 2-Way pagers for nearly three months. Receiving a message is nothing like getting paged - it's more like getting email and being able to send back an instant reply. With the two-way pager, you can answer a message without looking for a phone, interrupting your meeting, even leaving your seat. People can send you a message by email, from SkyTel's Web site, or by calling an 800 number. The message -• up to 500 characters - is displayed on the tiny screen. You can then peck out a reply or pick one of the built-in responses. Click Send and you have just completed a two-way communication. There's also a cable that lets you hook up to a laptop or palmtop, in case you want to send longer messages or download pages and archive them to your hard drive.

Like ARDIS and RAM, SkyTel is plagued by mediocre coverage. There are dropouts in the middle of coverage areas - say, the University of Washington Medical Center in Seattle. Still, SkyTel has signed up more than 68,000 customers for its advanced messaging service - around the same number of subscribers ARDIS and RAM each have after nearly a decade of persistence.

Rather than "spray and pray" coverage, SkyTel pinpoints each pager's location by tracking its "heartbeat/

Second generation, part II: faster, cheaper, better coverage

A second wireless strategy focuses on boosting the speed and the quality of services, while continuing to rely on laptop computers. These systems offer dramatically faster data transfer and better urban coverage, but within a limited geographical area.

Here, the only player today is Metricom's Ricochet, whose wireless network depends on spread-spectrum, packet-data technology. The system provides service at speeds up to 28.8 Kbps and speaks standard TCP/IP. Coverage within designated areas is excellent: I've used my Ricochet modem at home, in coffee shops, and even in aircraft (while sitting at the gate, of course). The monthly price is $29.95, plus an additional $15 per month to rent the original radio modem, or $299 to buy. One drawback: right now the system is only available in Seattle, the San Francisco Bay area, and Washington, DC.

Three components make up the Ricochet network. The first is a sleek black radio that looks like a walkie-talkie and carries a battery that lasts about four to six hours. It velcros onto your laptop computer and plugs into a standard RS-232 serial port. Ricochet's network speaks standard PPP, allowing you to use it with any Internet-capable Mac, PC, or palmtop.

The second part of the network is a series of radio transceivers deployed in clusters that hang upside down from the tops of utility or light poles. They are arranged in a mesh over the covered area, with roughly one radio every quarter to half mile. These radios are repeaters: they listen for data packets transmitted by modems and rebroadcast them. The third component of the Ricochet network are base stations, which Metricom calls Wired Access Points, typically located atop a tall building. Each contains eight flat-panel antennas and a leased line connecting it to Metricom's frame-relay network.

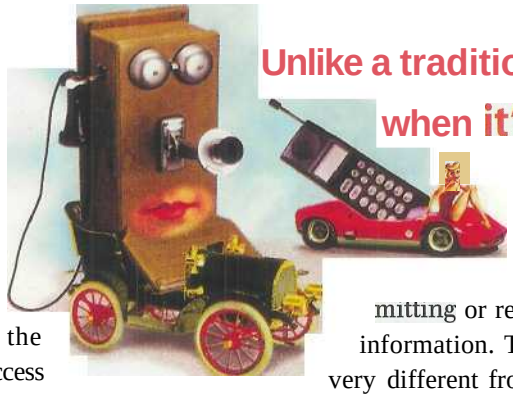
When your computer sends a message, the Ricochet modem transmits the information to the nearest poletop radio, which then relays that information to another and another and then another until the packet reaches the closest Wired Access Point. From there the packets travel over landlines to Metricom's Internet gateway.

Metricom operates within the license-free band of the radio spectrum (902-928 MHz), so it transmits with less than 1 watt of power. That has saved Metricom tens of millions of dollars in license fees. And by passing the packets from poletop to poletop, Metricom saves the cost of bringing a separate leased line to every radio's location. But the flip side is that Metricom spends a lot of time and money hanging the thousands of radios that make up its metropolitan networks.

The Ricochet radios employ a spread-spectrum technique, constantly shifting between 162 different transmission frequencies every 25 milliseconds. "It fires the packet and then hops to another frequency," explains Metricom president Don Wood. As radios within a neighborhood find each other, they follow the same pattern, essentially doing a wireless dance. Metricom's capacity can be boosted simply by hanging more radios. Each poletop adio has a bandwidth of roughly 100 Kbps, Wood says; faster radios are being developed.

Bob Egan, an analyst at the Gartner Group, says that the Ricochet technology has incredible latent potential. "The greatest thing is that some mainstream carrier can align itself with Metricom and get that thing pervasively deployed," he says. "There have got to be a number of local carriers looking at that."

A big advantage of Ricochet is that users can stay continuously linked to the Internet. A "connected" Ricochet radio uses resources only when it's actually transmitting or receiving information. This is very different from a traditional ISP, whose limited number of phone lines can be tied up quickly by continuous connections.



Unlike a traditional ISP, Ricochet is "connected" only when it's actually transmitting or receiving.

One disadvantage, however, is that the radios have so little power that small local variations in topology - a hill or a metal building, for instance - can severely impact reception. When I got my modem, I had lousy coverage at our house, so I called Metricom. A week later, however, service suddenly got better. A few houses away, a new radio had been hung on top of a lamppost.

It's this flexibility that distinguishes Metricom's offering from ARDIS, RAM, and even conventional cellular systems. A typical ARDIS or RAM radio site takes months of planning and costs tens of thousands of dollars to install. Metricom's poletop radios cost $700 apiece and can be installed by one person in five minutes.

Nearly a third of the Ricochet modems are used with desktop systems. Ricochet's price of $45 per month (including modem rental) is strategically placed just below the cost of a second phone line plus an account with an ISP. And the speed is decent: somewhere between that of a 14.4 and a 28.8 modem. In less than a year, the company has grown from 800 to 10,000 customers.

If you limit your travel to Metricom's three geographic areas, Ricochet works well. Indeed, according to Wood, 90 percent of wireless customers aren't traveling from city to city, but within their cities. "The markets are regional," he explains. "ARDIS and RAM are both built around the concept that you are a globetrotter. There are people in that market, but that's only 10 percent of the population or less."

Ricochet may also demonstrate that the wireless future isn't with the old dinosaurs who have been slugging it out for the past decade, but with a new flock of companies. Still, Metricom's having a tough time: while its customer base is growing quickly, the business lost $39 million in 1996. Wood says he's not worried, and expects the San Francisco Bay Area network, at least, to be profitable within a year.

So why hasn't Metricom spread out beyond just three cities? Because the company refuses to license its technology to other service providers. Instead, Metricom has directly approached municipalities and utility companies, trying to cut its own deals for permission to hang its radios from poletops.

Consider Boston. "We'll be happy to build there," says Wood. "But we need the cooperation of the public utility companies and the cities to use their light poles."

That's wrong, counters Frezza. Instead of building the network themselves, Metricom should sell franchisees to locals who will have a vested interest in seeing that the system gets deployed - and intimately know the local power brokers.

This is what the cable industry did, explains Frezza. "All of the limited partners become minimillionaires," he says. "And the national operators eventually bought the system back."

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Third generation: cellular to the rescue

Unlike ARDIS and RAM, the nation's cellular phone system (aka advanced mobile phone service, or AMPS) doesn't have a coverage problem. Tens of thousands of those funny-looking three-pronged cellular base stations are scattered throughout the country - beside state highways in Indiana, in the oil fields of Texas, alongside cacti outside Phoenix. And unlike Ricochet, you can buy a cell phone in Chicago and use it anywhere in the United States, as well as in Canada and parts of Mexico.

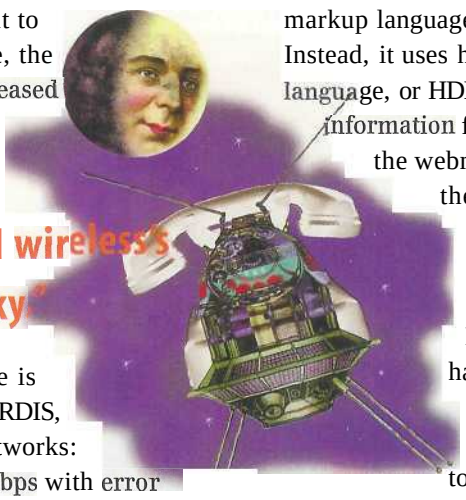
There are now 30,045 cell sites in the United States, roughly 10 times as many sites as ARDIS and RAM have combined. Somewhere between two-thirds and three-fourths of the country's geographical area is covered, and more than 95 percent of the nation's population is served by wireless phones, according to the Cellular Telecommunications Industry Association. On my cross-country trip, there was just one 30-mile stretch where my cell phone said it was out of range - on Highway 1 in California, just south of Big Sur.

What's funded this coverage are the astonishing fees that people are willing to pay for their mobile phones: 50 cents per minute in some cities, adding up to more than $22 billion a year industry-wide in revenues. It's amazing that people who object to paying more than $29.95 a month for Internet access have no problems shelling out $50 or even $100 a month for their cell phone.

If the cellular telephone system is so pervasive, why not use it for sending data? One problem: AMPS is analog. If you want to send bits by air, you've got to first convert them into sound with a modem. But you can't use just any modem, because the cellular sound quality is terrible. Between the poor fidelity, the bursts of noise, and the cell-to-cell handoffs, it's hard to get a decent signal. Still, data services represent an enormous potential market. So cellular phone companies are exploring two approaches to putting data on their networks.

One idea is to ditch the AMPS system entirely and go with a pure digital system - the same technology used for the next generation of digital telephones. Companies building all-digital cell phone networks plan to treat data as if it is voice, sending it along as just another stream of bits. Qualcomm, a San Diego-based manufacturer of digital cellular telephones, has even put a cable connector on its new line of digital phones that lets you connect to a standard laptop. To the computer, the phone looks like a 14.4 modem; faster speeds are possible. This digital wireless phone network, however, has a long way to go to equal the analog one that's already running.

Another idea is to retrofit existing AMPS systems with a technology called cellular digital packet data. Like the other wireless data networks, CDPD breaks information down into packets which are transmitted from a handheld unit to a base station. There, the packet travels over leased telephone lines to a network center. The over-the-air data rate is also similar to the ARDIS, RAM, and SkyTel networks: roughly 9.6 to 14.4 Kbps with error correction. The similarities end there.// Unlike the technologies used by the other systems, CDPD is based on the same TCP/IP as the Internet, making such systems friendly to Web browsers and email.



Low-Earth-orbit satellites will greatly expand wireless's reach, some even promise "Internet-in-the-Sky"

AT&T Wireless and Bell Atlantic Nynex Mobile are two big proponents of CDPD. Instead of the bulky laptop, AT&T wants the cellular telephone to become the day-to-day information appliance, letting people get news headlines, directions to a restaurant, or the name of a nearby hotel. Shipping companies could use these next-generation cell phones to route their trucks, and executives could scan the messages waiting in their electronic mailbox.

AT&T Wireless sells this service today - it's called PocketNet, and it's based around a CDPD-compatible phone manufactured by PCSI. The phone, which I tried for a few weeks, has a built-in Web browser and can send and receive email. My biggest problem was battery life: I got roughly four hours of "talk" time on AT&T's CDPD network. Another serious problem with the PCSI phone was its interface. PocketNet runs software developed by Unwired Planet, a Redwood Shores, California-based software start-up that's funded by some big names in the cellular industry. Ironically, despite the fact that PocketNet has four times as many buttons as my two-way pager, it was harder to use to peck out email messages.

But what frustrated me most about the CDPD telephone was the built-in "Web browser." It doesn't speak the hypertext markup language used by every Web site. Instead, it uses handheld-device markup language, or HDML. If you want to access information from a particular Web site, the webmaster has to download the HDML developers' toolkit and then create Web pages and services that speak the new language. Not surprisingly, only a handful of sites have done that. The Net and the phone have a lot of work to do on their relationship.

Next generation: satellites

In the coming year, expect to see wireless networks and services competing as never before. Part of this will result from ongoing attempts to balance the federal budget. In the past few years, the FCC has raised billions of dollars by auctioning spectrum for so-called personal communications services, such as digital cellular telephones. Throughout the 1990s there was a choice of only two different cell phone vendors

within each market - soon there will be as many as seven.

At the same time, several companies will launch constellations of low-Earth-orbit satellites, or LEOs, that will greatly expand the reach of wireless. Unlike geostationary satellites that hover more than 22,000 miles above the earth, these satellites will orbit only a few hundred miles up.

Orbcomm is one system that should be fully operational early in 1998, allowing two-way paging and wireless email anywhere on the planet. But the service will not come cheap: Orbcomm might cost as much as a penny per character sent, says Don Meyer, a spokesperson for Magellan Systems, which has designed a handheld unit that can send and receive messages via Orbcomm.

Teledesic is another LEO system that promises "Internet-in-the-Sky" service, giving businesses anywhere on the planet a 2-Mbps connection to the Internet. To do that, Teledesic has to give up some degree of mobility: the receiver requires an antenna about 18 inches across and a clear view of the sky. That's a problem for handheld devices.

The bottom line: In just a few years, the combination of cheap radios that can transmit and receive at high frequencies, the further development of satellite communications, and new FCC policies will open the door to high-speed, ubiquitous, wireless data communications.

Eventually we will discover that there is more spectrum than there are people to fill it - if it's efficiently managed.

Many businesses are already discovering that it's cheaper to install point-to-point radio links than pay the local phone company for a high-speed leased line. As portable radios are developed to transmit at higher frequencies, there will be increasing amounts of spectrum available for general use. Eventually we will discover that there is more spectrum than there are people to fill it - especially if that spectrum is efficiently managed.

Meanwhile, wireless coverage will get consistently better because of new technology that uses the same network for both data and voice. If ARDIS and RAM had teamed with the cellular telephone industry, instead of building their own orthogonal data networks, they would have excellent nationwide coverage today throughout both rural and urban America. And if the cellular industry had built in data capabilities from the very beginning, they would be reaping even higher profits today. They didn't. Now someone else will. • • •

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