1 The Wireless World

In this chapter...

- Cutting the Cables 4
- From the 20s to the 2000s 10
- Buying a Cell Phone 14
- Summary 18
Wireless technology is changing the world. Where communication has hitherto relied on cables strung on poles or dug into the ground, we are now able to send voice and data through air and empty space. Without wires holding us back, we will be able to stay in contact wherever we are. New services can be set up in minutes, without spending months negotiating rights of way or constructing tunnels.

The preceding paragraph could have been written a hundred years ago. At the beginning of the twentieth century, wireless technology also promised to revolutionize communications. It did, but it took many decades before it could be combined with another of the twentieth century’s new technologies—telephony. A second wireless revolution occurred in the 1990s as wireless transmitters became small and lightweight enough to be built into hand-held telephones. Rather than simply watching TV or listening to radio, the majority of people in some countries were broadcasting signals of their own.

The effects of this second revolution continue into the 2000s, as both wireless technology and telephony converge with the Internet. The result may eventually be a single network for both voice and data, with wireless as the dominant access method. Most information will still travel over high-bandwidth fiberoptic cables for parts of its journey, but the phones and computers through which people actually interact with the network will not require wires.
WHAT'S IN A NAME?

Wireless technology is littered with three-letter acronyms (TLAs). Those that appear in this book are spelled out when first used and sometimes again in later chapters. They are also listed and defined in the glossary.

A few are impossible to spell out; this is because some vendors and standards groups develop a kind of “acronym envy” over the capital letters that acronyms usually use. These people insist that their technologies be capitalized, even though they don’t actually stand for anything.

Still more vendors like to take an existing acronym, often one of an official standard, and change or add one letter (often m, for mobile). This is an attempt by companies to differentiate themselves from the competition, but it has the opposite result—many very similar-sounding products or standards.

The situation is further complicated by the way that certain acronyms change over time. For example, the basic cellular standard in the United States is called AMPS, which originally stood for Advanced Mobile Phone System. As technology progressed, it began to seem anything but advanced, so the A changed to Analog. When a digital version was developed, it changed again to the more accurate American. All three are still in use.

The terms cell phone and mobile phone mean almost the same and are often used interchangeably. Technically, cellular is a subset of mobile, but a large one: Most mobile systems are cellular, and all cellular systems are mobile. In general, the British tend to say mobile, whereas the Americans say cell. The industry prefers mobile, because it implies freedom, whereas cell suggests imprisonment. A few companies don’t like the term phone, because newer devices are more like small computers. For this reason, they are often referred to as terminals.

One advantage of cellular/mobile telephony is that it can compete with monopoly wireline phone companies. These monopolies are known by a variety of names, not all of them printable, but are officially called Incumbent Local Exchange Carriers (iLECs, or simply incumbents), because they own the telephone exchange. In the United States, they are sometimes called Regional Bell Operating Companies (RBOCs), after the Bell system from which they are descended. In most other countries, they’re called Post, Telegraph, and Telecommunications Authorities (PTTs), because they used to be (and in some cases still are) run by the country’s Post Office.
CUTTING THE CABLES ...........................................

The wireless revolution cuts both ways: It changes the Internet and the phone system, but also requires change in the wireless technology itself. Digitization and Internet protocols enable radio to carry much greater amounts of data than its nineteenth-century pioneers thought possible, all personalized for individual listeners. Instead of poor-quality television programs broadcast to everyone, users may eventually have virtual reality on demand.

By mid-2000, more people in Europe had a mobile phone than had a PC or a car. By the end of 2001, the world’s most popular online service was one that could be accessed only through a cell phone, not a computer. Analysts predict that the trend will continue, with wireless gadgets overtaking traditional computers as the dominant Internet access means at some point between 2004 and 2006. Unlike the relatively primitive, text-based Internet phones that appeared in 2000, these new gadgets will allow true Web surfing, as well as location-based services and other enhancements that take advantage of mobility.

This shift from fixed to mobile access could have profound effects on the Internet, which, in its early years, was dominated mainly by the wealthy, the young, and the male. That will change: Mobile phones are more evenly distributed across society, and even the cheapest models are beginning to incorporate some kind of Internet access. Though these cost slightly more to produce, operators often subsidize the manufacturing to promote usage.

And wireless technology isn’t just for rich consumers in the West. In the late 1990s, cell phones enabled many people all over the world to make their first-ever calls. In the next few years, they will also be sending their first e-mails—again, wirelessly—and probably from something that more closely resembles a phone than a traditional PC. The Web will become truly worldwide.

Most of the excitement is justifiably about mobile wireless, but there are also significant advancements in fixed wireless, which is used to replace local telephone wires. Satellite systems can be either mobile or fixed, with some systems, such as the futuristic Teledesic, planning both. These are aimed both at globe-trotting travelers and at parts of the world that have no communications infrastructure at all. A combination of cellular and satellite technology can often bring telephony and Internet access to areas that would have to wait many years for cables.
Network Philosophies

In the wired world, boundaries between networks are quite clearly defined: Whoever owns the cables or the devices connected to them controls the network. There are generally two types:

- **Wide Area Networks** (WANs) cover a long distance, from several kilometers to the entire world or beyond. They are usually run by telecom companies and carry voice or data for various customers. The Internet and the phone system are both comprised of many WANs. They are often called *public* networks, because they carry traffic for anyone who can pay. (In this case, public does *not* refer to ownership: Whether owned by a government, a traded corporation, or a private individual, a network that carries traffic for others is considered public.) WANs are sometimes divided into subgroups, of which, the most important is the **MAN** (Metropolitan Area Network), a type that covers a city or other region of only a few kilometers. Because radio waves have a limited range, most wireless WANs are MANs. The exceptions are satellite networks, which can cover intercontinental distances.

- **Local Area Networks** (LANs) cover only a short distance, usually 100 m or less. They are usually installed within homes or offices and are accessible only to the residents or employees. For this reason, they are referred to as *private* networks. The **PAN** (Personal Area Network) is a special case of a wireless LAN, with a particularly short range. It can cover a distance of only 10 m and is envisaged as a way to connect devices carried by a single individual.

In the wireless world, the distinctions between LAN and WAN or between public and private networks are less clearly defined. Radio waves don’t respect legal boundaries or even physical walls, meaning that private transmissions can spill over into the public space. The first effect of this has been to expose private data to all comers, thanks to unencrypted wireless LANs. In the future, it could change how people access the Internet or make phone calls.

The companies that run wireless networks want people to use the public WAN. Their vision of the future is something similar to that shown in Figure 1.1, where each wireless device has its own separate, long-distance connection. This means that users have to pay the companies for access and that the devices can be used almost anywhere. A cell phone user can travel many miles while making a call, often without the connection being broken.
Many people have an alternative vision, shown in Figure 1.2. This uses a small LAN access point within the home or office, connected via a fixed network to the Internet and the phone system. Cordless phones and wireless-equipped computers communicate with the access point, which aggregates all their voice and data together and sends it over a single connection. The advantage of this is that it’s cheaper—one connection costs less than many—and can achieve higher data rates, thanks to the shorter range of the wireless signal and the high capacity of the fixed network. The disadvantage is that the phones and computers can’t be carried out of range of the access point while maintaining a connection.

For narrowband voice, the WAN philosophy seems to be winning: Many people in Europe have a mobile as a “primary” phone, using it for all calls, even when at home. The same is beginning to happen in North America, though only for long-distance calls. This is partly because the cell phone is more convenient and partly because aggressive competition keeps cell phone charges relatively cheap, whereas fixed telephony is often run by a de facto monopoly.

For broadband data, the situation is reversed. No WAN technologies can yet match the speed of wireless LANs, so many people prefer to set up their own wireless LAN and connect it to some kind of high-speed fixed-access technology. This is usually a cable in the ground, as shown in the figure, but in future may be a point-to-point wireless system, such as a laser beam. It’s also possible that the WAN and LAN will converge as mobile operators set up wireless access points of their own.
Cell Phone Generations

The present hype is around third-generation (3G) phones, which will provide most of the advanced services planned until at least 2010. But it’s worth looking at the other generations and the features they offer:

- **1G.** First-generation phones are analog, meaning that they send information as a continuously varying wave form. They can be used only for voice and have highly variable call quality, thanks to interference. Another serious disadvantage is that they are very insecure; snoopers can listen in on calls with a simple radio tuner or can even charge calls to another person’s account.

  Almost no new 1G networks are now built anywhere in the world, but the phones to use with them are still manufactured. Europe and Japan both gave them up in the 1990s, upgrading to digital systems. North America is not as far advanced, but it’s moving in the same direction: At the beginning of 2002, about 30% of U.S. subscribers relied on 1G phones, down from twice as large a proportion two years earlier. They are more popular in some parts of Africa and South America, thanks to their low cost, but even there, they will soon be squeezed out by second-generation (2G) and even 3G technology.
• **2G.** Second-generation phones convert all speech into digital code, resulting in a clearer signal that can be encrypted for security or compressed for greater efficiency. Most also include some kind of simple text messaging, as well as support for Centrex-style services, such as voice mail and Caller ID. The most popular is the Global System for Mobile Communications (GSM), but several others are used around the world. They can send data, but usually at less than 10 kilobits per second (kbps); by comparison, most modems achieve a real speed of at least 30 kbps. Some data-only devices, such as two-way pagers, are also considered to be 2G, because they send a digital signal at relatively low speeds.

Most cellular operators are upgrading their 2G networks to higher data speeds, theoretically more than 100 kbps but more realistically those of a fast modem (about 40 kbps or less). These are referred to as 2.5G, because they are significantly better than existing 2G systems but less advanced than the more futuristic 3G. As well as offering higher data rates, they often use packet-switching for data, a more efficient way of sharing a connection between many users. This is the same system used by the Internet, so it makes interconnection between the phone and the Internet easier.

Some 2.5G upgrades don’t try to reach higher data rates, instead adding the capability for specific applications. Wireless Application Protocol (WAP) and i-mode both use a compressed version of the Web to fit into a mobile phone’s slow data rate and small screen. Location technologies can find a user’s exact position, intended both for emergency calls and for services such as maps.

• **3G.** Third-generation systems will provide a variety of advanced services, including data transfer at up to 2 megabits per second (Mbps) and videoconferencing. Instead of phones, many terminals will be small computers or PDAs (personal digital assistants) with built-in Web browsers and possibly other applications, such as word processors, spreadsheets, and address books. They will include small keyboards, handwriting recognition, and, eventually, voice recognition.

Like many new technologies, 3G has initially been disappointing. The first data rates of the first terminals are only 64 kbps, less than those once envisaged for 2.5G, let alone 3G. Many companies admitted that the expected 2 Mbps would be available only for users standing right next to a base station tower. These initial services are sometimes referred to as 3G lite. At the other end of the scale, many researchers are working on enhancements to 3G that they claim really will reach the hoped-for data rate and beyond. These are known as 3.5G.
Many 3G terminals will also be able to link to a PAN, which links all the devices in a very small area, such as a room or even a person’s pocket. The most promising technology for this is Bluetooth, which puts a very low-power radio into a single microchip. Bluetooth’s designers envisage a chip inside almost all household devices, as shown in Figure 1.3, enabling them all to connect to the Internet via a 3G terminal.

- **4G.** Fourth-generation networks are already in the labs, with Japanese operator NTT DoCoMo planning to offer the first commercial services in 2006. They will offer very high data rates, perhaps as much as 100 Mbps, enabling new services that have not yet been invented. They will also be focused primarily on data, using packet-switching for all traffic and replacing basic voice service with video or even virtual reality.

Many wireless LAN technologies already come close to 4G’s hoped-for data rates, though they don’t offer the service guarantees or roaming capability that users of cell phones expect. If these can be added to wireless LANs, 4G may actually arrive earlier than expected.
FROM THE 20S TO THE 2000S...............................

As far as the economy is concerned, we’ve been here before. In 2000, some farsighted stock market analysts compared the 1920s to the 2000s, implying that the economic boom of the 2000s, like that of the 1920s, would result in a huge crash and worldwide depression. So far, the bears have been accurate. The actual similarities are scarier than that, because the two booms also share the same driving technology—wireless.

In the 1920s, wireless was everywhere. Radio was a new technology that, like the wireless Internet today, people believed would change the world. Though investors lost a lot of money, the people developing the technology were ultimately proven right. Companies fell, but radio did change the world, and that change hasn’t finished yet.

Moore’s Law (named after Intel cofounder Gordon Moore) states that the number of circuits packed into a given area of a silicon chip doubles approximately every 18 months, leading to a similar improvement in processing power. Today’s supercomputer is tomorrow’s wristwatch. In the late 1990s, the rate of advance actually increased: Mobile computing is accelerating at a rate faster than Moore’s Law.

The Wireless Economy

The wireless industry got caught up in the Internet bubble of 1998–2000 and in the subsequent crash. Although this means that many people and companies may have made bad investments, it doesn’t mean that wireless (or the Internet) has no future. Some companies will go bankrupt, but the infrastructure they build will live on. Unlike Enron and most of the dot-coms, wireless network operators are creating something that is permanent and useful. They may fall, but their legacy can benefit everybody.

Companies such as Iridium and Metricom have already demonstrated this: They were at opposite ends of the mobile networking scale—Iridium built a global satellite network for voice traffic, whereas Metricom built a high data rate system that served just a few cities—but their rise and fall followed similar paths. Both won plaudits for their technology but few customers. Both went bankrupt months after they began service, leaving behind networks so useful that the military or police kept them going even after they’d officially been shut down. Both were eventually bought by new companies for about a hundredth of what they cost to build. With the networks already in place, the new companies hoped to operate them profitably—bad news for the stockholders in the original companies but good news for everybody else.

Many mobile phone operators, particularly in Europe, have spent vast sums of money on licenses to operate 3G networks. Paying so much was probably a mistake for the companies involved, but again, it is good news for everybody else. European governments are using the revenues from these to cut taxes and increase spending on services that benefit their entire population. Perversely, the large amount already
spent may actually encourage the companies to spend even more on actually constructing networks. The licenses are nonrefundable and are automatically cancelled if the operators fail to meet an aggressive deadline for network buildout. The only way that the companies can hope to recoup their costs is to build a network and operate it profitably. The odds of doing this may be slim, but like gamblers who refuse to take a loss, they have no choice but to double up and take an even larger gamble.

Some economists argue that companies who follow this path are committing the Concorde fallacy—throwing good money after bad. It’s named after the plane developed by the British and French governments in the 1970s, which took far longer to develop than originally planned and cost millions of pounds more than estimated. At more than one point during the development cycle, the governments realized that the costs of finishing the project would be more than the potential revenues it could generate. In this case, the rational economic choice was to cancel the Concorde and write off the millions already spent. Economists argue that the same applies to 3G: The costs of actually building a network are more than some estimates of the potential revenues, so the companies should just abandon their licenses and try to invest their money in other, more profitable services.

Concorde wasn’t cancelled, for reasons of national pride and to avoid political embarrassment. Similarly, 3G won’t be cancelled, because many wireless operators have said that high-speed mobile data is their whole raison d’être. Individual shareholders are free to take a loss and try to find a better investment—indeed, many have done so, hence the fall in the stock prices of companies holding 3G licenses—but companies often are not. In the case of Concorde, the losers were the British and French taxpayers, while the winners were a few transatlantic business travelers and frequent-flying celebrities. In the case of 3G, the losers are likely to be investors in wireless operators and the winners everyone.

Japan’s experience during the 1990s shows that wireless technology can make great advances, even during an economic depression. It can even be profitable, as both NTT DoCoMo and many smaller companies have found. Similarly, the U.S. computer networking industry suffered its worst ever year in 2001, thanks to the bursting dot-com bubble. One of the few bright spots was the wireless LAN market, which continued to grow even as the economy shrank.

**Visions of the Future**

Companies pushing wireless technology often make extreme predictions, such as one prediction that human brains will be wirelessly networked to each other by the year 2030. (This came from British Telecom, back when it still ran a mobile network.) Some of this hype is justified, but much of it isn’t. In the late 1990s, the industry was burned by underestimating the potential of wireless technology: The first phones to
provide even limited Internet access were snapped up so fast when first launched in mid-1999 that many people had to wait a year before they could get one. Analysts repeatedly had to raise their predictions of the mobile phone’s popularity in Europe as it became ubiquitous, first in Finland and then in Norway, Sweden, and Britain.

Two years later, mobile technologies were failing to live up to their hype. They arrived late, they didn’t perform as expected, and they weren’t as popular as most of the cell phone companies had hoped. Their predictions for market growth usually relied on cell phone penetration reaching more than 100%—often 400% or 500%, which would mean people buying and operating four or five cell phones each. The companies envisaged customers maintaining one for business, one for the home, and several for various different social activities.

This hasn’t happened: Though a large proportion of cell phone users have bought or owned more than one during their lives, this is only because their previous model has been broken, or stolen, or has become obsolete. People do not buy several different cell phones and keep them all active at once, because a mobile phone subscription usually costs at least $20 per month (and often a lot more). Some critics remarked that this was blatantly obvious: The market for almost anything will stop growing once everybody already has one.

Although some new wireless technologies seem disappointing, these are just the first versions. WAP has been a lot less popular than mobile operators hoped, but it has actually grown faster than the wired Web did in its early years. Some of this growth could be due to hype, but other types of wireless Internet service are popular. As of January 2002, the world’s largest Internet Service Provider (ISP) is NTT DoCoMo. It has over 30 million users, more than AOL or any other ISP that offers wireline access. All of these are in one country (Japan), all access the Web via a cell phone, and the majority actually pay for content.

Similarly, the first 3G systems have not lived up to expectations, but they eventually will. GSM, now the world’s most popular mobile system, was first developed in the early 1990s. At the time, few customers wanted it, and it was written off as a failure. Today, more than 10% of the Earth’s population carries a GSM phone.

Among the more interesting uses for 3G and other wireless technology:

- **Videophones.** Combining a Web cam and a mobile phone with a Palm-type device, these also allow fast access to the Web. They’re already here, but not popular. It’s likely that they never will be, but the technology exists if people want it.

- **Voice Recognition.** The cumbersome twentieth-century method of entering text into phones will eventually be abandoned as phones gain the ability to recognize and understand human commands, even against the background noise of the mobile environment. In 1999, British Telecom predicted that it
would be widespread by 2002. In 2001, the Universal Mobile Telecommunications System (UMTS) Forum predicted some point between 2005 and 2010, which is more realistic.

- **Web Phones.** In 2000, many mobile phone manufacturers said that *everything* they sold would be Web-enabled by 2002. This prediction was largely right, though often using more primitive WAP technology, rather than the true “Web.”

- **Retinal Displays.** British Telecom predicted in 1999 that these would be possible by 2003. They will use tiny projectors mounted in the frames of glasses to shine images directly onto a user’s retina, allowing access to information services while walking around or interacting with other people. More cumbersome goggles are already available, but they don’t permit contact with the real world: Users must immerse themselves completely in virtual reality.

- **Wireless LAN Ubiquitous.** Many analysts predict that wireless LAN antennas will be standard on all computers by 2005. They are already built into most high-end laptops.

- **All Phones Become Mobile.** The difference in cost between mobile and fixed telephony has all but disappeared in some areas. Analysts predict that mobile operators will eventually have to rely on value-added services to make their money. Phone numbers will refer to people, not places. British Telecom predicts that, by 2006, the idea of standing in a fixed spot while making a call might seem rather quaint.

- **Internet on Mars.** NASA is planning to launch a series of communications satellites into Martian orbit, all based on the same standard protocols as the Internet. The network should be running by 2008, then extended outward in the following decades and centuries.

- **Internet Appliances.** Some members of the Bluetooth Special Interest Group predict that, by 2010, it will be rare to find new white goods—refrigerators, dishwashers, and the like—that do not have a built-in Internet connection. The Net will be as ubiquitous as microchips became in the 1990s.

- **Remote-Controlled Cars.** Researchers in government and industry are already working on these: Japan hopes to have one operational before 2015, and in 2001, the U.S. government approved a communications system in dedicated spectrum. Roads will be made safer as powerful traffic computers take over driving, preventing accidents and automatically routing every vehicle via the most efficient path.
• **Holophones.** British operator Orange predicts that, by 2020, mobile phones will be able to project three-dimensional moving images of people and other objects.

• **Mind Reading.** British Telecom predicts that, by 2025, thought recognition will become the standard form of input. Primitive mind-reading techniques were used by computer games in the 1990s, but this technology will be used on a far greater scale. Machines will act as an extension of the user’s body. Making a call in a public place will no longer disturb others.

  The same researchers predict that, five years later, this could evolve into a full, direct brain link. People will have wireless data devices hardwired into their brains, allowing instant telepathic communication. Learning will become obsolete because high-speed networks will allow people to access the sum total of all human knowledge as easily as they access their own memories. Such technology raises all kinds of objectionable possibilities, from *Star Trek’s* Borg to a literal thought police.

**BUYING A CELL PHONE**

Back in the real world, choosing a cell phone can be a complicated decision. Beware of slick salespeople offering “free” phones, often with bundled accessories and other freebies, such as televisions or computers. They require you to sign a service contract that lasts at least a year and can be difficult to get out of after that. The companies make up more than the cost of the phone in monthly service charges, and most people end up paying hundreds of dollars.

This isn’t to say that all the cheap or free phones are necessarily a bad thing; it’s standard practice in many countries for the operators to subsidize the cost of phones, and sometimes the service contracts offered are good value. But it is important to shop around. “Prepay” deals with no contract attached may be better if you need a phone only for emergency use, whereas if you want Internet access, it may be worth turning down the free phone in favor of a more advanced model.

Each mobile operator typically offers many rate schedules and payment plans, seemingly designed to confuse. In general, paying a high monthly line rental leads to reduced per-minute charges. But even for the same monthly fee, there are usually choices, such as how much to pay for different kinds of calls and whether international roaming is allowed. Pick the wrong one and you could end up paying far too much, or you may even find that your phone doesn’t work when you most need it.
Posers

Companies like Nokia freely admit that many of their phones are sold on appearance, not features. They target specific models at groups they call “posers” and “yuppies.” A case in a fashionable color will often prove more popular than Internet access or long battery life, and visual appearance is expected to become more important as the diversity among users widens. The same applies to other mobile devices; the most sought-after Palm PDAs tend to be those with the most stylish case, not the most technically advanced.

The trend toward stylishness could continue as computers move from functional devices to consumer products, but phones won’t become less functional. Most manufacturers plan to build some kind of wireless Internet capability into all of their mobile phones, along with basic computer functions. There is already a wide choice of phones and other devices based on WAP and similar standards, with better services that approach the quality of the wired Web on the way.

If you want the mobile Internet now, your choices depend mainly on where you live. In Europe and America, WAP is becoming ubiquitous. Most analysts agree that it is more of a gimmick than a true wireless Internet service, but it could still be worthwhile. WAP’s main problem has been that users needed to dial in to a computer to use it, meaning they are charged for every second spent online and can’t make phone calls at the same time. In Japan, the i-mode system overcomes both these problems and has become more successful than anyone predicted. New 2.5G and 3G technologies could enable WAP to do the same.

The most successful wireless data services don’t mean accessing the Web at all. Short messaging, originally intended just to test the capability of GSM phones, is hugely popular in both Europe and Japan. Messages are still fairly primitive because they’re limited to a few characters, rather like telegrams from many decades ago. Emerging standards will change this, adding multimedia and, more importantly, integration with Internet e-mail.

Globalization

Movies like to show the hero using a cell phone aboard a jumbo jet or underneath the desert in Iraq. Both these scenarios will remain fiction for many years; it’s still impossible to get a cell phone that will work everywhere in the continental United States, let alone the world. Only satellite systems achieve true global coverage, and they don’t work indoors.

For world travelers, the best choice is probably GSM, but this is actually available in five different varieties. There are two versions of the American Digital AMPS (D-AMPS) system and two of cdmaOne, the Code Division Multiple Access (CDMA)
cellular technology first developed by Qualcomm. Many phones support more than one version of a system, or even different systems, but it’s important to make sure that the one you choose will work where you want to take it. In particular, American GSM uses different frequencies than does European GSM, and phones supporting both are still quite rare. The companies assume (probably rightly) that most people who buy a cell phone in Europe will never take it to America, and vice-versa.

Despite early hopes of a global standard, the incompatibility is set to continue into 3G. This is due partly to the commercial interests of rival companies, partly to the political machinations of national governments, and partly to genuine practical difficulties in making a new system compatible with older networks. Because 3G networks are initially limited to a few small areas, people want phones that can also be used with existing 2G networks. This affects the design of the 3G networks themselves, as it’s easier to make dual-mode phones for systems that have something in common.

There is officially a worldwide standard for 3G, but it’s really just a name (“IMT-2000”). It contains so many options that no phone or network will support them all. Three countries built 3G networks in 2001—Japan, Korea, and the Isle of Mann—and all used different systems. Whereas all European countries are building the same system, America will be a microcosm of the world: U.S. cellular operators are planning at least three different types of 3G, which may splinter into even more.

There is greater hope for worldwide standards in shorter range wireless systems, which are already replacing wires as a means of connecting computers together and may form the basis of 4G mobile. Wireless LANs based on the Institute of Electrical and Electronics Engineers (IEEE) standard 802.11 (Wi-Fi) system can be used nearly everywhere, as can the emerging Bluetooth technology. These really will enable a phone or a computer to communicate anywhere in the world.
WEB RESOURCES

www.s3.kth.se/radio/4GW/
The Personal Computing and Communication research group at Sweden’s Royal Institute of Technology is trying to develop a 4G mobile system for the year 2010 onward. Its site has lots of interesting papers covering different possible directions that mobile communications could take in the future and a free 100-page report (in PDF format) called Telecom Scenarios 2010.

www.bt.com/bttj/
British Telecom publishes the quarterly BT Technology Journal, a combination of in-depth tutorials on 3G technology and futurology covering the wider applications of 4G.

www.wirelessweek.com
The trade magazine Wireless Week publishes most of its daily news stories online and has a huge archive of information about the cellular industry.

www.wirelessdevnet.com/
The Wireless Developer Network is a news and analysis site that covers every aspect of the wireless industry from the perspective of programmers and Web designers.

www.thefeature.com
The Feature is an online magazine about wireless technology and its applications. The site is run by Nokia, so its analysis is hardly objective, but it can still be interesting.

www.unstrung.com
Unstrung is an online magazine featuring daily news and analysis of wireless technology, applications, and business.
The Web is going wireless. By 2003, more people will access the Internet via mobile phones than through computers.

Most existing mobile phone systems are 2G. New 3G terminals will support higher-speed data services. Further in the future, 4G may enable true mobile broadband.

Short-range wireless LANs and longer range cellular systems are fundamentally different, but can be used for similar applications. They are both competing and complementary.