

NETWORK COMPUTING FEATURE

The Road to a Wireless Future

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For each of the past five years, industry pundits have been convinced it would be the year of wireless data in the wide-area environment. And every year it was for a different reason: support for IP protocols; phones with microbrowsers; support from industry giants, such as Microsoft and IBM; and new platforms, such as handheld computers. This year's reasons include WAP (Wireless Application Protocol) and the forthcoming GPRS (General Packet Radio Service). Meanwhile, the latest buzz is about third-generation cellular and data throughputs of 2 Mbps just over the horizon.

Network managers are faced with a difficult situation. The people they support are increasingly demanding wireless access to the corporate network. These people have experienced the advantages of wireless networks for voice communications. Now they want those advantages for data communications, especially as massive promotional efforts by major operators have significantly increased awareness of these services. Meanwhile, millions of palm-sized devices are just begging to have wireless connections for applications such as e-mail and schedule synchronization. And who wouldn't want to be able to remotely access a Microsoft Exchange or Lotus Notes server when stuck at an airport gate? Wireless networking promises both greater work productivity and increased flexibility in our lifestyles.

But today's solutions often involve specialized gateways, middleware or reformatting of content. The higher data rates promised by future cellular networks are tantalizing because for the first time it might be possible to use e-mail, groupware, database access and VPNs (virtual private networks) as they are used over dial-up or DSL types of connections.

By next year, cellular operators will be offering IP packet-data services with rates as high as 144 Kbps, though 56 Kbps will be more typical of downlink speeds. This is in sharp contrast with today's services, which are limited to about 9.6 Kbps. However, the industry is fragmented, with multiple wireless technologies deployed, each with its own data strategy. Understanding how these data services will evolve will let you take better advantage of these developments.

Market Forces

To obtain some fundamental insight into this industry, you should realize there are huge market forces at play that will determine how and when next-generation data services will be deployed. Unfortunately, these forces are not all in alignment. Understanding this interplay will help you make your own predictions. One force driving the broad deployment of new data services is the huge success of wireless voice, leading the industry to view data as a vast new source of potential revenue. Data is also now an integral part of next-generation cellular systems, not just an afterthought. Complementary industry developments, including new handheld platforms and new delivery methods, such as WAP, also help. Finally, the massive consolidation in the wireless industry will make it easier for operators to deploy services over a nationwide if not a global scale.

Other forces are acting in opposition, however. Because of the limited success of wide area systems so far and the unproven business case, as well as an unclear perception of what customers really want from wireless data, operators and vendors are proceeding tentatively. Also, Internet access speeds via wire line (DSL, cable and so on) are being pumped up to a rate where wireless will continue to be slower than wire line for at least the next several years. Finally, the industry is still grappling with multiple wireless standards, leading to confusion and fragmentation. High-speed cellular data will prevail, but it will be a rocky and inconsistent evolution.

The State of Wireless

Let's quickly highlight the key attributes of today's services. First, they are slow. They weren't when they were designed, at the beginning of the 1990s, but today's typical rates of 9.6 Kbps to 14.4 Kbps simply do not stand up to demands of rich Web pages and heavy-duty productivity applications like Microsoft Exchange and Lotus Notes. Second is an emphasis on circuit-switched connections. With data as an afterthought for current digital cellular systems, a dial-up model for data is easier to deploy than a packet-switched architecture. But dial-up means connection delays, an inability to push data to mobile users and having to pay for connect times even when sessions are idle.

Beyond cellular networks, other wireless WANs, such as the Motient network and the BellSouth Wireless Data Network, are deployed. These networks, however, are being repositioned for messaging applications versus general-purpose wireless data.

Today, cellular operators are emphasizing mobile phones with microbrowsers, which is understandable given the limitations of today's networks. You don't need much bandwidth to fill up a six-line display of 12 characters. This kind of platform is useful for some corporate tasks, such as helpdesk functions, remote pricing information and telephone databases, but it constitutes only a small subset of the information that an IT manager might want to make available to mobile workers.

Nevertheless, today's wireless networks can be used quite productively--as long as only small amounts of data are involved. In many instances, customers need to employ wireless middleware solutions that account for the limitations of today's wireless networks. Internet portals are also now targeting this industry by developing mobile content that can be accessed by new microbrowser-equipped cell phones, giving users access to their e-mail; calendar, travel, entertainment and restaurant information; sports results; package tracking; horoscopes; and so on. Despite some of these new consumer-oriented services, wireless networks today are used mostly for messaging applications or in vertical markets (field service, for example). But things are about to change.

What's in the Pipeline?

Not only is there a tremendous amount of new wireless technology in development, but a good chunk of it is about to be deployed. The best way to get a clear picture is to examine the data strategies for the three principal digital cellular technologies. In the United States, the two dominant cellular technologies are TIA/EIA-136, which is a TDMA (time-division multiple access) technology, and IS-95, a CDMA (code-division multiple access) technology. TDMA, the oldest U.S. digital technology, divides radio channels into three time slots, with each user receiving a distinct slot. This method lets three users on each radio channel communicate without interference. CDMA, a newer U.S. digital technology, uses spread-spectrum technology, in which many users share the same radio channel simultaneously but are distinguished by unique pseudo-random codes. Both are considered second-generation cellular technologies, with analog cellular being first generation.

The largest TDMA carriers are AT&T Wireless Services and SBC Communications, while the largest CDMA carriers are Sprint PCS and Verizon. GSM (Global System for Mobile Communications) technology is a distant third in the United States but dominates worldwide. In the United States, the dominant GSM carrier is VoiceStream. AT&T Wireless Services, Sprint PCS and VoiceStream all offer nationwide coverage.

Developed in Europe, GSM is the most mature cellular technology worldwide. Analog systems in neighboring European countries were not compatible, increasing the motivation for a consistent digital cellular standard there. In the United States, TIA/EIA-136 was the first digital technology deployed, but upstart Qualcomm introduced its CDMA technology as an alternative, and the cellular world has not been the same since. In fact, all new third-generation systems are now based on CDMA, though as luck and intellectual-property disputes would have it, there are multiple incompatible flavors of CDMA (see

"Wireless-Data Developments," page 148).

The highest level of excitement is about third-generation--or 3G--cellular, called IMT-2000 (International Mobile Telephone 2000), an international standardization effort orchestrated by the ITU (International Telecommunications Union), under the United Nations. IMT-2000's original goal was one worldwide cellular standard, but its outcome was different. IMT-2000 mandates mobile (driving speed) data rates of 144 Kbps, outdoor pedestrian rates of 384 Kbps and indoor rates of 2 Mbps. Why higher indoors? Because higher rates will demand a greater portion of the radio channel, which can be accommodated only by much smaller base-station coverage areas. This in turn allows for more efficient reuse of the same radio channels, requiring indoor micro-base stations.

Each of the three cellular technologies has a 3G solution. But before 3G becomes available, some operators are already beginning to deploy data services that people have dubbed 2.5G. With 3G networks years away from broad deployment but 2.5G networks about to roll out, network managers should seriously evaluate 2.5G services.

GSM: Everybody Wins

GSM has deployed data service longer than any other cellular network has. Millions of users, mostly in Europe, are taking advantage of circuit-switched data service at rates up to 14.4 Kbps. The first new higher-speed alternative is a service called HSCSD (high-speed circuit-switched data), which combines up to four time slots in each radio channel's eight time slots for download speeds up to 56 Kbps. Upload speeds remain at 14 Kbps. The most likely user devices will be PC Card modems. This service is about to be available from operators such as Orange in the United Kingdom, SingTel in Singapore and Sonera Corp. in Finland, but most operators are not pursuing HSCSD and instead are placing their bets on a 2.5G technology called GPRS.

GPRS is an IP-based packet-data system. By packet, we mean the channel is used only for the time needed to send a packet of data, and it then becomes available for other users, much like Ethernet. Packet capability is win-win for everybody. Operators like it because packet technology supports more users than circuit-switched technology does. Users like it because packet technology enables sustained virtual connections to services, eliminates long dial-up delays and allows information such as e-mail to be "pushed" to users. GPRS has a maximum theoretical rate of greater than 160 Kbps, but service and device implementations will limit speeds to between 28 Kbps and 56 Kbps on downloads and to 14 Kbps on uploads. User devices will include data-capable handsets and PC Card modems.

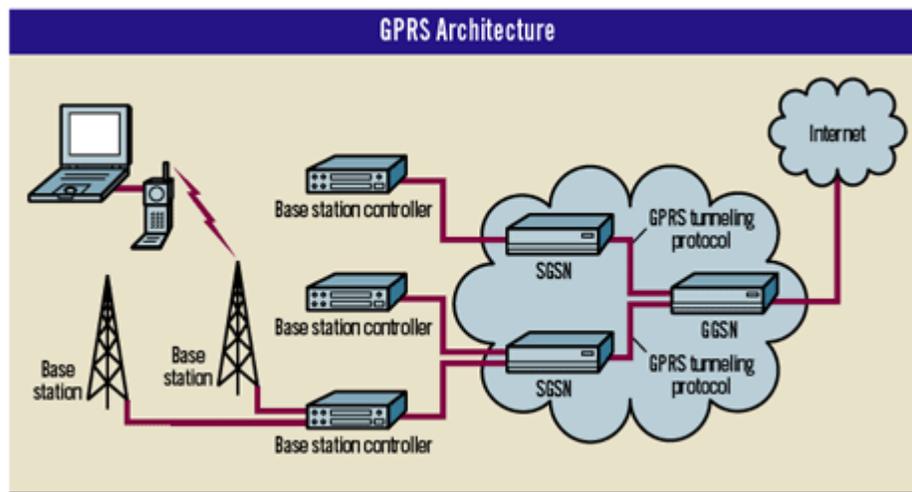
As shown in "GPRS Architecture" (right), two key infrastructure elements of GPRS enable the service. The SGSN (serving GPRS support node) keeps track of mobile nodes. It tunnels packets to and from the GGSN (gateway GPRS support node), which interconnects the GPRS network to other networks, such as the Internet. An operator might have multiple SGSNs, maybe one per city, but needs only one GGSN for each interconnecting network.

Operators already have GPRS in field trials. VoiceStream plans to turn on its service by the end of this year. By 2001, service should be available in many countries worldwide, though it may take another year before users can easily roam between service providers on a global basis.

A new radio interface, called EDGE (Enhanced Data Rates for Global Evolution), will propel GPRS to rates of 384 Kbps and a little higher under optimum radio conditions. EDGE, compared with GPRS, will be a costly upgrade for operators, many of whom might leapfrog EDGE and go directly to 3G systems.

The 3G solution for GSM is called W-CDMA (Wideband CDMA) and is also known as UMTS (Universal Mobile Telephone System). W-CDMA will require new radio spectrum as it operates in ultrawide 5-MHz radio channels. This type of CDMA differs from the competing 3G technology, CDMA2000 (see "The Battle for Cellular Supremacy," page 140). Auctions for new spectrum have begun in Europe and other

countries, but auctions in the United States won't occur until 2001. W-CDMA meets the IMT requirements of 384 Kbps outdoors and 2 Mbps indoors, but don't hold your breath for service. The earliest initial deployment will be by NTT DoCoMo in Japan in 2002, with other operators beginning in 2003 and later.



TIA/EIA-136: Long Wait for Data Service

Despite its size, the cellular industry cannot support three different cellular technologies worldwide. For this reason, the Universal Wireless Communications Consortium, which represents TIA/EIA-136 operators worldwide, has made a strategic decision to base its packet-data architecture on GPRS standards. By using the EDGE radio interface and a GPRS infrastructure, TIA/EIA-136 operators will by 2002 be able to offer a data service, technically referred to as EGPRS-136.

EGPRS-136 will let data customers roam between TIA/EIA-136 and GSM networks. Speeds will match EDGE performance for GSM networks: 384 Kbps and higher. Unfortunately, widespread service probably will not be available until 2003, and in the interim customers will have to make do with networks such as AT&T's Wireless IP service, which is based on CDPD technology. This situation could put TIA/EIA-136 operators at a significant competitive disadvantage if wireless data really starts to take off.

While EDGE uses 200-KHz radio channels to fulfill the IMT-2000 requirement of 384 Kbps outdoors, an even wider radio channel of 1.6 MHz is needed to comply with the 2 Mbps indoor requirement. However, there are no plans now to actually deploy this broadband capability.

Standards bodies such as the Third Generation Partnership Project (3GPP) are investigating the use of EDGE for more than data and are designing an architecture for VoIP (voice over IP) over EDGE. This strategy is consistent with the gradual worldwide migration of telecom networks to IP protocols.

One question is, What happens beyond EDGE? TIA/EIA-136 operators could adopt W-CDMA in new spectrum. They could also go directly to fourth-generation technology, which means almost anything beyond 3G.

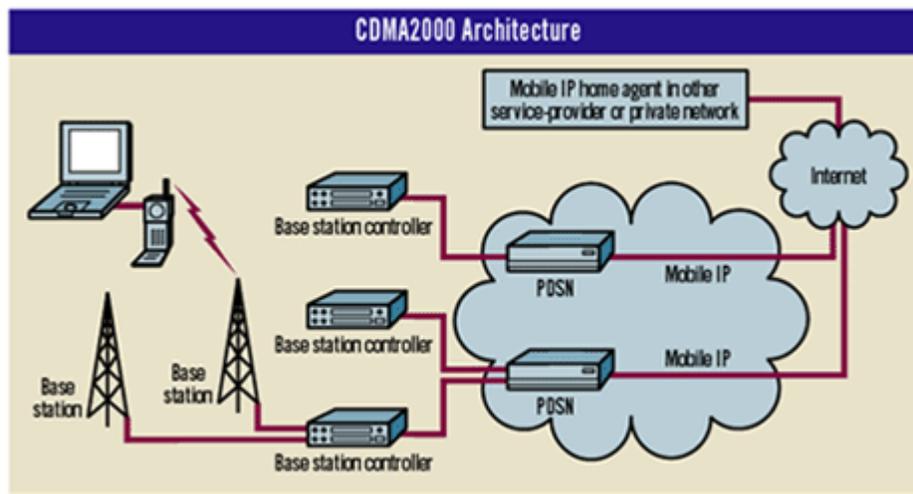
The Many Sides of CDMA

Today, CDMA networks based on the IS-95A standard offer circuit-switched data service up to 14.4 Kbps (with actual throughput closer to 13 Kbps). Operators in Japan and Korea have adopted an enhanced

version of the standard, IS-95B, which increases data rates to about 64 Kbps and is packet-based. However, U.S. CDMA operators are planning to skip IS-95B and to proceed directly to CDMA2000. CDMA2000 comes in two versions: 1X and 3X. Operators can readily deploy 1X technology in existing spectrum but may have to wait for new spectrum to deploy 3X, which combines three CDMA 1.25-MHz radio channels for higher-performance services.

CDMA2000 1X is a strong interim step for CDMA operators. Through improvements in modulation, power control and data encoding, it doubles voice capacity relative to IS-95A networks and adds a packet-data capability of up to 153 Kbps. Operators such as Verizon and Sprint PCS expect to start offering service in 2001. Because CDMA operators have broader coverage than do GSM operators in the United States, the 1X service could be the strongest candidate for higher speed wireless data in 2001, and IT managers should monitor its deployment carefully.

The architecture of CDMA2000, as shown in "CDMA2000 Architecture" (below), is fundamentally different from that of GPRS. Rather than using specialized data infrastructure based on cellular-specific protocols, CDMA2000 leverages Internet developments, and uses PPP to link users to a PDSN (packet-data serving node) and Mobile IP to support customers roaming between CDMA2000 networks. In fact, the Mobile IP option will let customers with their own IP addresses roam into CDMA2000 networks and keep those addresses active.



Beyond 1X, the data possibilities of CDMA bifurcate. CDMA2000 3X, using the same architecture as 1X, offers 384 Kbps outdoors and 2 Mbps indoors, but operators will most likely need to wait for new spectrum. However, Qualcomm has offered a new option: a technology once called HDR (High Data Rate) and now referred to as 1XEV, signifying an evolution of 1X technology. 1XEV uses a 1.25-MHz CDMA radio channel dedicated to and optimized for packet data, with throughputs of more than 2 Mbps. Operators can deploy 1XEV in conjunction with IS-95A or 1X networks, or can deploy 1XEV-only networks. Although no operator offers 1XEV service, a number are planning to test the technology in 2001. Based on the results of these trials and market demand, service could follow relatively quickly, perhaps as early as 2002.

Other Developments

Cellular technology gets the lion's share of attention, but network managers should keep their eyes open to other wireless providers. One is Metricom, which is rolling out a wireless data service called Ricochet2,

with rates of 128 Kbps. With strong backing from MCI WorldCom and Paul Allen, Metricom expects to have service deployed in more than 35 metropolitan areas by 2001, reaching 100 million potential subscribers. If cellular carriers execute their data plans aggressively, Metricom might offer too little too late, but if cellular carriers stumble, Metricom could scoop up bandwidth-starved mobile customers.

There is also a tremendous amount of activity in the broadband wireless area, including LMDS (Local Multipoint Distribution Service) and MMDS (Multichannel Multipoint Distribution Service) networks. But these are generally fixed wireless systems that compete with the likes of fiber, DSL and cable connections.

Don't overlook WLAN (wireless LAN) technology. Although it is targeted initially for private deployments, there is increasing interest in public deployments, such as at airports, shopping malls and hotels. While 384 Kbps over cellular sounds attractive, 11 Mbps over a WLAN connection sounds even better. In this space, the IEEE 802.11b standard (11 Mbps of raw throughput and 5.5 Mbps of effective throughput) will dominate for the next year. Further out, look for developments in higher-speed standards, such as IEEE 802.11a and HiperLAN, which will offer raw throughputs of 54 Mbps and sustained throughputs of more than 20 Mbps. Some cellular operators may eventually offer a blend of access options, with cellular in wide areas and WLAN technologies in high-density environments.

Despite other industry efforts, the cellular (including PCS) operators are in the best position to deliver high-speed wireless data over huge coverage areas thanks to their broad voice networks. They also have the cavernous pockets needed to finance these projects. All the technologies have sufficient momentum and backing to be deployed, so there is little technology risk for users. Most wireless networking applications will be based on IP, so going from one network to another will generally be as easy as buying a new modem.

Wireless Now

There are enough wireless data options available today that you shouldn't wait for these new services to dip your toe in the ether. But realize that today's mobile wireless connections rarely can substitute directly for a wired link. Instead, you will be working with a subset of your data, requiring you to carefully configure your applications, to use middleware or wireless portals, or to engage the services of a wireless application service provider (Broadbeam Corp., for example). Consequently, only a small subset of your communications-oriented applications will make sense with today's wireless networks. But that's a good place to start as there are lessons to be learned with wireless that will carry over to newer services. For instance, you will develop business relationships with wireless service providers, learn how applications function (or fail) as they go in and out of coverage, and get a better understanding of what applications people need for the most productivity when roaming and how to support those applications.

Realize that wireless networking raises the issue of different platforms. Many phones today have microbrowsers, which may be suitable for some applications or content, but other applications may demand a laptop. There are also an increasing number of wireless options for handheld platforms.

By being up on the technology, you will be in a much better position to evaluate newer services, such as GPRS and CDMA2000 1X, as they become available. You also will have a much better understanding of the expanded set of applications that these new networks will support. Realize that pricing of these new services, however, remains uncertain. High-speed data will consume far more spectral resources than voice, but how will operators charge for that? Some are leaning toward flat-rate pricing, while others are favoring usage-based pricing. However, usage-based pricing could prove expensive for bandwidth-hungry applications. Whereas the cellular industry has consistent voice pricing, data pricing could take time to settle down. Nevertheless, customers should eagerly anticipate these new networks as the higher speeds will do wonders to help deploy new applications.

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Executive Summary

Wireless WANs promise productivity enhancements and flexibility. Operators are broadly promoting new services, while new platforms, such as handheld computers and phones with microbrowsers, enable new applications. However, widespread use of wireless networking has proved elusive because of slow speeds, high costs and complex deployments that often require middleware. But forthcoming high-speed data technology could vastly increase the utility of these wireless services. The wireless industry is driven by the desire for new revenue sources and has designed data services as a core function of next-generation networks.

Three main cellular technologies dominate today: GSM (Global System for Mobile Communications), TIA/ EIA-136 and CDMA (code-division multiple access). Each has an evolutionary path to higher-speed data services. GSM, a European technology that is deployed in more countries than any other, will soon have GPRS (General Packet Radio Service)--packet-data capability with typical rates up to 56 Kbps. Operators have already launched service in some markets, and by the end of 2001, service will be available worldwide. TDMA, a U.S. technology, is basing its data future on EDGE (Enhanced Data Rates for Global Evolution), which uses GPRS at its core and features data rates as high as 384 Kbps. However, EDGE won't be available for a couple of years. Meanwhile, the CDMA camp has aggressive plans to deploy a data service called CDMA2000 1X, which will offer speeds to 144 Kbps, in 2001. This could be the first viable higher-speed wireless WAN service in the United States.

The Battle for Cellular Supremacy

The worldwide cellular industry is preparing for the battle of the decade, waged between the IS-95/CDMA 2000 and the GSM/W-CDMA standards. Is one technology inherently better? Working from a completely clean slate, the technologies offer similar capabilities. At various times in projected deployments, one may have the upper hand over the other, but the tables are turned down the road. For example, GSM service providers are about to deploy GPRS. But CDMA carriers will soon have CDMA2000 1X. GSM carriers can then offer EDGE, but then CDMA carriers will have 1XEV. And so on.

The real advantages to operators lie elsewhere. First, there are infrastructure considerations. W-CDMA builds on GSM core network protocols, so GSM service providers will find it easier to migrate to W-CDMA than to CDMA2000. The converse holds true for IS-95 service providers, which will find it easier to migrate to CDMA2000. Another major consideration is intellectual-property rights. Qualcomm, which owns many CDMA patents, has a stronger intellectual-property position with CDMA2000 than with W-CDMA. In fact, the European cellular industry invented W-CDMA partly to work around Qualcomm's patents. Qualcomm still has patents that pertain to W-CDMA, but not as many.

The United States will likely see both technologies deployed, but much of the rest of the world is leaning toward the use of W-CDMA. The potential domination of W-CDMA could well sway operators with IS-95 systems in countries such as Korea and Japan to accept W-CDMA, rather than risk having systems that are not compatible with the cellular systems in neighboring countries.

For customers, which technology prevails may not be a huge factor. Both technologies will offer high-speed wireless IP networking, and customers will easily be able to port applications from one network to the other. And multimode devices in the future may even make it possible to roam between these networks. In the meantime, this will be a grand spectacle to observe.