On The Road To PCS

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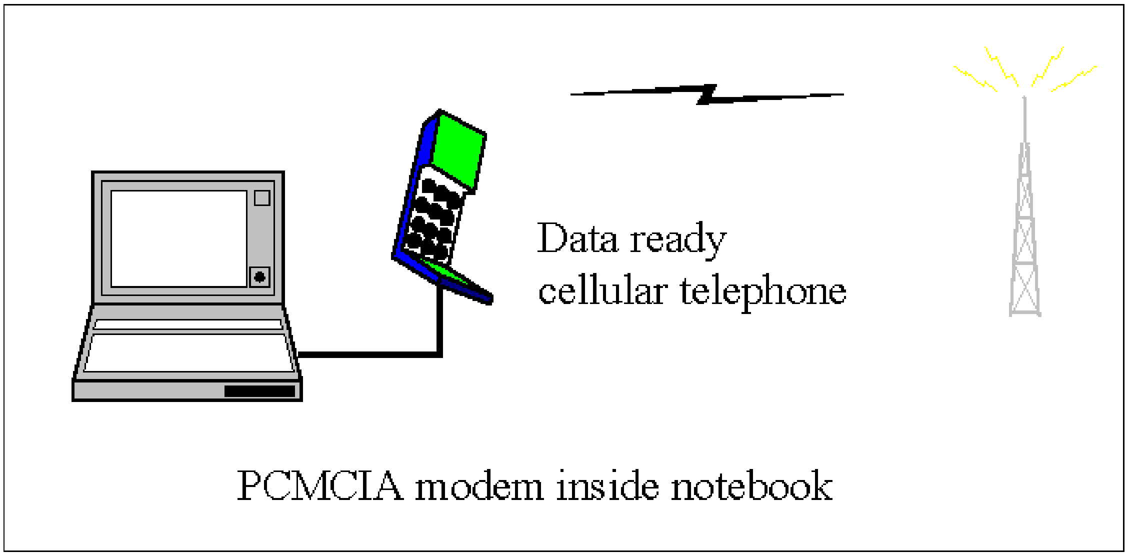
By most estimates, more than 90 percent of the traffic on the U.S. cellular phone network is voice, but data transmission on cellular systems is growing rapidly. With the right modems and a little cooperation from your carrier, it's easy to send faxes, move e-mail and even be a mobile remote LAN node.

Moreover, the data-only Cellular Digital Packet Data (CDPD) service is being rolled out in many parts of the country, offering low-cost access over TCP/IP. Still, it's probably no secret to most big-city cellular phone users that cellular networks are beginning to run out of capacity as demand increases and prices decline. So, most cellular operators are looking into digital cellular as a way to boost both capacity, and, in the bargain, offer even more comprehensive and capable data services. Want voice, data, fax, paging and mobility all in one system with one handset? Digital cellular could be it.

Of course, the big news in wireless is Personal Communications Services (PCS)--a new spectrum located in frequency bands recently auctioned by the FCC. Having paid big bucks (more than $7 billion) for the right to use these new frequencies, PCS carriers are working feverishly to define and deploy their all-digital integrated voice/data systems. Although volume PCS deployment is a few years away, network managers responsible for purchasing wireless data services need to prepare. But, since digital-cellular data services point the way for PCS data capabilities, the transition shouldn't be too onerous.

Before the sky gets too blue, it is important to recognize the hurdles that must be overcome before digital cellular data services become the norm. These challenges include competition from other wireless data networks (including packet radio systems and the emerging satellite-based services) and a seemingly unwieldy number of different digital cellular standards.

Starting From Analog The current cellular phone system, known as Advanced Mobile Phone Service (AMPS) was, believe it or not, designed in the 1960s--long before modems and faxes were commonplace. Nonetheless, with a modem supporting a cellular-compatible over-the-air protocol, users can get reliable circuit-switched data connections with uncompressed speeds of 9.6 Kbps, and, with good radio conditions, 14.4 Kbps. One drawback to achieving high performance, however, is that both sides of the connection require cellular-enhanced modems. If one side uses a conventional landline modem, connection reliability and throughput can suffer.



Data over analog cellular

Cellular service providers recently began to address this problem by deploying "modem banks" at Mobile Switching Centers. This lets cellular modem protocols terminate at the switch and conventional landline modem protocols operate over the rest of the connection. Digital cellular systems will also take advantage of such modem pools.

We should also mention that CDPD, which is similar in concept to the packet-radio networks run by ARDIS (Lincolnshire, Ill.) and RAM Mobile Data (Woodbridge, N.J.), is really a retrofit to the existing analog cellular system, moving digital packets over otherwise unused cellular channels. Packet services are best used when bandwidth demands are infrequent or bursty. Constant demand or interactivity is best served by a circuit connection using modems.

Digital Cellular Enters Two technologies are contending for the U.S. digital cellular market: Time Division Multiple Access (TDMA), promising a threefold increase in capacity over analog, and Code Division Multiple Access (CDMA), with an even greater increase in capacity--perhaps as much as 10 times more than analog. TDMA deployment is already underway in a number of markets, while CDMA should see installation this year. Individual cellular operators will decide which digital system they will deploy.

Two TDMA digital cellular standards have recently been released by the Telecommunications Industry Association (TIA): IS-135 (TDMA Services, Async Data and Fax) and IS-130 (TDMA Radio Interface, Radio Link Protocol 1). They govern how data calls are handled within TDMA. CDMA data capabilities are defined in the IS-99 standard (Data Services Option Standard for Wideband Spread Spectrum Digital Cellular Systems).

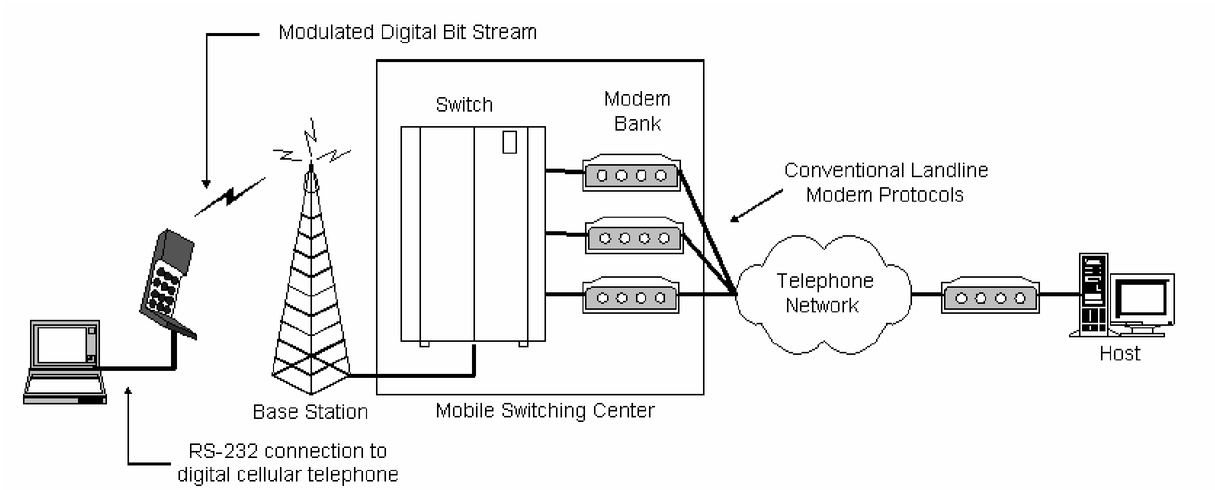
A mobile computer will connect to the digital cellular telephone using a simple serial connection, rather than an external modem, and will use the familiar "AT" commands implemented in most conventional landline modems. Users will be able to move data and faxes at 9.6 Kbps with both TDMA and CDMA, and possibly up to 14.4 Kbps with CDMA. Digital cellular systems will also support a "short message service," similar in function to paging, but providing reliable delivery. In fact, compared with data over analog cellular, data sent via digital cellular should offer significantly more reliability and greater immunity to RF problems such as noise and hand-off delays.

Both TDMA and CDMA digital cellular are designed to coexist with AMPS, so that a single cell (the area covered by one base station) can support both analog and digital service. Most digital cellular phones marketed in the U.S. also have an analog capability and are often referred to as "dual mode." But phones supporting both TDMA and CDMA are unlikely to appear. As carriers deploy PCS, we'll probably see dual-mode PCS/cellular phones--such as a CDMA phone that operates both at 1.9 GHz and the conventional cellular frequencies at 800 MHz.

Unfortunately, truly global digital standards are unlikely. In Europe, the Global System for Mobile Communications (GSM) digital cellular standard is already widely deployed, and it is planned for more than 70 countries worldwide. Japan is also deploying an all-digital system called Personal HandyPhone System (PHS), and both GSM and PHS support enhanced data service functions. Both are incompatible with the TDMA and CDMA systems planned by North American cellular operators.

At the physical (radio signal) layer, voice, fax and data services traffic are all just "data," when carried across a digital cellular network. As traffic moves up the network protocol stack, however, the differences between them matter, and the way they must be handled varies considerably. The digital cellular data standards specify link-level protocols that transport data reliably across the inherently unreliable airlink. For a call directed toward the mobile station, one phone number will be used for voice calls, and another number for fax and data calls. For outgoing calls, the mobile device will issue a command to the digital cellular telephone to specify the type of service desired.

Integration with existing wireline systems represents a slightly different challenge. Although the base station can efficiently receive a data transmission from a mobile unit, it must still communicate that data to a landline modem on the other side of the telephone connection. Consequently, a modem pool is required at the mobile switching center so that the data can be forwarded using conventional modem protocols such as V.32 and V.42, as well as Group 3 fax. Ultimately, this internetworking function will also support ISDN and many wide area data networks.



Modem Pools at the Mobile Switching Center.

Dark Clouds The primary motivation for digital cellular deployment is not enhanced data services. Rather, it is to solve a capacity problem some carriers have in some markets. Therefore, we don't expect digital cellular to become ubiquitous. Moreover, the market will demand the continued availability of analog cellular for quite some time, making analog cellular the lowest common denominator for the foreseeable future. This not only protects the installed base, but also will provide the only way for a roaming user with one digital system to operate in a region served by a carrier using the other.

Plus, the TDMA and CDMA data standards have only recently been finalized. Infrastructure equipment to support these data standards should soon be available from companies such as AT&ampT, Motorola (Schaumburg, Ill.), Qualcomm (San Diego, Calif.), Hughes Network Systems (Germantown, Md.) and Ericsson (Paramus, N.J.). The big question is how soon carriers will make data services available. CDMA carriers appear to be more aggressive, and plan on providing data services soon after they launch service. Since it is unlikely that digital cellular systems will be universally deployed over the next five years, demand for data services on digital cellular will likely take some time to develop.

Still, one way to look at digital-cellular data services is as a bridge to PCS. In fact, some cellular carriers may find it more lucrative to invest in PCS than to rebuild their AMPS infrastructures using digital technology. The name of the cellular game, after all, is building the subscriber base. Many carriers see PCS as a way to access new markets, whereas digital cellular will only let them increase their capacity in existing markets. While this could limit carrier interest in digital cellular, it is, on the other hand, highly likely that data services on PCS will closely resemble those being defined for digital cellular. Three of the seven air interfaces defined for PCS are variants of existing digital cellular standards, namely TDMA, CDMA and GSM. Consequently, these systems will likely inherit the data capabilities we've discussed, initially supporting circuit-switched asynchronous data communications.

Researchers and standards bodies associated with TDMA, CDMA and GSM are also looking at packet data capabilities. In fact, the link layer of the data service for CDMA has been designed so that CDPD protocols can be used at higher layers. Synchronous or isochronous data capabilities for digital cellular networks may also eventually become available for applications using video and multimedia. Here, GSM already has an advantage, with its ISDN signaling and easier connection to ISDN networks.

Higher data rates on digital cellular are also a possibility. TDMA, CDMA and GSM support the concept of channel aggregation for higher data rates. TDMA will allow three channels to be combined for user data rates of 28.8 Kbps, and CDMA could ultimately provide user rates as high as 64 Kbps.

In the end, services developed to work with digital cellular should be easily ported to PCS when PCS systems are broadly deployed. While the all-but-certain gradual phase-out of analog cellular service will likely take more than 10 years, digital cellular systems and their associated data services are the inevitable replacement. In Europe, where GSM already is broadly available, data usage is growing rapidly. Indeed, the demand for data services will be a key driver of future wide-area wireless growth.

Digital cellular is an important parallel development with PCS. The technological superiority of digital, including increased capacity, lower cost, enhanced features and reliable data, is a clear motivator for both carriers and users. However, upgrading existing networks to digital will take time and will not always be the highest priority for cellular carriers. While the data capabilities of digital cellular networks have attractive technical features, it is unlikely these data capabilities will be broadly available for perhaps three years or more. Still, the eventual deployment of high-capacity wireless data services is assured, and as workforce mobility continues to challenge the creativity of network managers everywhere, cellular and PCS carriers are finding that there's much more to their networks than voice.

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