If your new embedded product is mobile or destined for a remote location, your networking options are limited to wireless. Designers want a networking connection for remote control, database access, software modifications, customer service, and data acquisition. Although wireless carriers have more recently implemented all-digital wireless networks, you should consider CDPD (cellular-digital-packet data), which operates over the nationwide analog-cellular-phone system. CDPD stands out as the most widely available wireless-data-communications protocol and is ideal for applications that require short bursts of data, such as e-mail, credit-card verification, vehicle location, dispatch, order entry, and inventory look-up. Many police departments also use CDPD to give officers on the street instant access to local and national criminal-justice information.

CDPD shares radio-frequency channels with the AMPS (advanced-mobile-phone system), which has existed since 1983 (Reference 1). AMPS has been wildly successful as a cellular-telephone network, increasing its user base to more than 50 million users in 2000. You need an AMPS review to fully understand the details of CDPD. AMPS consists of a system of small transceivers arranged in a cellular pattern and operates at 824 to 894 MHz. Transmitters are low-power, averaging about 50W each. Small communities usually require dozens of transceivers or cells, but the number of transceivers grows into the hundreds for major metropolitan areas. Cells are hexagons that vary in size due to line-of-sight transmissions characteristics of 800-MHz frequency. Cells are small in downtown areas that have a lot of traffic and obstructions and are large in the suburbs.

A cellular-transceiver arrangement allows you to reuse the same set of allocated frequencies. Each AMPS channel occupies about a 30-kHz frequency, yielding a voice bandwidth of only 3 kHz, which is slightly less than a standard POTS (plain-old-telephone-system) wired connection. A full-duplex conversation requires two of the 30-kHz channels so that both parties can speak simultaneously. For AMPS, the Federal Communications Commission allocates approximately 50 MHz of the frequency spectrum, which supports slightly more than 800 conversations. However, because of the limited transceivers range, carriers may reuse frequencies, allowing many thousands of conversations to occur simultaneously. The cellular arrangement also allows the mobile phone or device to operate with a small, low-power transceiver with limited range. As AMPS users move within a cell or into
another cell, the conversation automatically moves from channel to channel and transceiver to transceiver. A brief tenth of a second gap exists in a voice call during the channel change. Roaming agreements between carriers give users seamless connections in most metropolitan areas.

Cell-phone calls are circuit-switched; that is, the call consumes the entire bandwidth of the channel and remains allocated throughout the call even when users are not conversing on the phone. To exchange data, designers first developed the cellular modems that customers use over the circuit-switched cellular network. Circuit-switched cellular requires that the two computers remain connected continuously throughout the data transmission. Circuit-switched cellular is useful for applications that require long connection times, such as file transfers and terminal emulation.

The growing popularity of the Internet and its TCP/IP packet-based transmission standard sparked cellular operators to develop the CDPD standard in 1993. Cellular providers were anxious to implement CDPD because they could get additional revenue and use the dead air space between circuit-switched connections (Figure 1). Cellular voice channels are statistically idle 30% of the time, even during heavy-traffic times.

Although CDPD shares the same frequency channels with AMPS, cellular carriers must install additional equipment for Internet connections, security, management, and accounting. Therefore, even when analog-cellular service covers a particular location, potential users must verify that CDPD service is also available. Because CDPD uses the space between phone calls, it can become blocked during times of high cellular activity. Many carriers have added dedicated channels for CDPD traffic only, although shared service is still available in some areas.

Packet data is broken into small pieces and combined with a destination address, data length, and error-correcting information. The transmitting device sends the packets in short bursts to an IP address rather than a phone number. This technique yields instant transmission and connections without dial-up or modem time and no busy signals. The receiving computer reassembles the packets to recover the original information regardless of the order in which the computer receives it. CDPD transmissions are billed by the packet instead of by the minute. A CDPD modem can stay connected indefinitely without charge if the mobile device sends no data.

Although it operates over AMPS, an analog-system CDPD is digital and uses GMSK (gaussian-filtered-minimum-shift-keying) modulation to encode data onto the carrier. The CDPD raw transmission rate is 19.2 kbps, but error-correcting bits and overhead reduce the useful data rate to about 12 kbps on a clean channel. CDPD networks limit the time that a transmitter can occupy a channel: a maximum of 64 blocks of 385 bits each for a single transmission (about 1 sec). The mobile device sends the CDPD data in 378-bit blocks that the Reed Solomon forward-error-correcting code encodes. Each block consists of 63 6-bit symbols, comprising 47 data and 16 parity blocks. The high number of parity bits enables the receiver to recover blocks when noise or other channel interference has corrupted as many as seven of the 63 symbols.

Once a packet reaches a base station, it completes its journey to the destination IP address over the Internet. For security, data sent across the wireless portion of the connection is encrypted using RSA (Rivest, Shamir, Adleman) public-key-encryption algorithms; however, as with all Internet traffic, intermediate data servers send the remaining portion in the clear. Users can add security software to their application to protect the entire transmission.

CDPD mobile transceivers are sophisticated and, therefore, expensive. Transceivers must be able to evaluate signal strength, select the optimum channel, and adjust transmitter power, depending on the distance to the base station. For example, Sierra Wireless (www.sierrawireless.com) offers a series of CDPD products, including the AirCard 300 for notebook and handheld computers with a
Type II PC Card slot (Figure 2). The AirCard 300 delivers 600 mW of transmitting power and works with most Microsoft operating systems, including Windows 95, 98, 2000, NT, Me (Millennium Edition), CE 2.11, Pocket PC, and Handheld PC 2000 (CE 3.0). The retail price for the AirCard 300 is $499.

AirLink Communications (www.airlink.com) offers the Raven II, a rugged, full-duplex CDPD modem that provides wireless-transmission capabilities for fixed and mobile applications, including telemetry, SCADA (supervisory control and data acquisition), public safety, dispatch, field service, financial-transaction processing, and security (Figure 3). The Raven's embedded TCP/IP stack enables virtually any type of remote device to access the CDPD network. Remote-terminal units that perform remote metering and monitoring functions in the oil, gas, water, and transportation industries currently include Raven modems. The CDPD Raven II costs $575.

CDPD service is available from most major cellular providers, including AT&T Wireless (www.attws.com), Cingular (www.cingular.com), and Verizon (www.verizon.com). Go America (www.goamerica.net) is unique because it combines CDPD with a wireless-Internet service and e-mail plan at approximately $60 per month for unlimited local service. The company allocates you 400 kbytes of data traffic per month outside your local service area. Thereafter, Go America charges $80 per megabyte to cover roaming fees and an initial activation fee of $29.95.

The Wireless Data Forum, a trade association for wireless data and mobile computing, maintains the CDPD specification. The Wireless Data Forum and the newly renamed Cellular Telecommunications and Internet Association have approved a merger. However, both organizations currently maintain separate Web sites. You can get a list of countries and cities that offer CDPD service at www.wirelessdata.org. You can also purchase a CD-ROM version of the CDPD specification at the same Web site for $125.

Reference