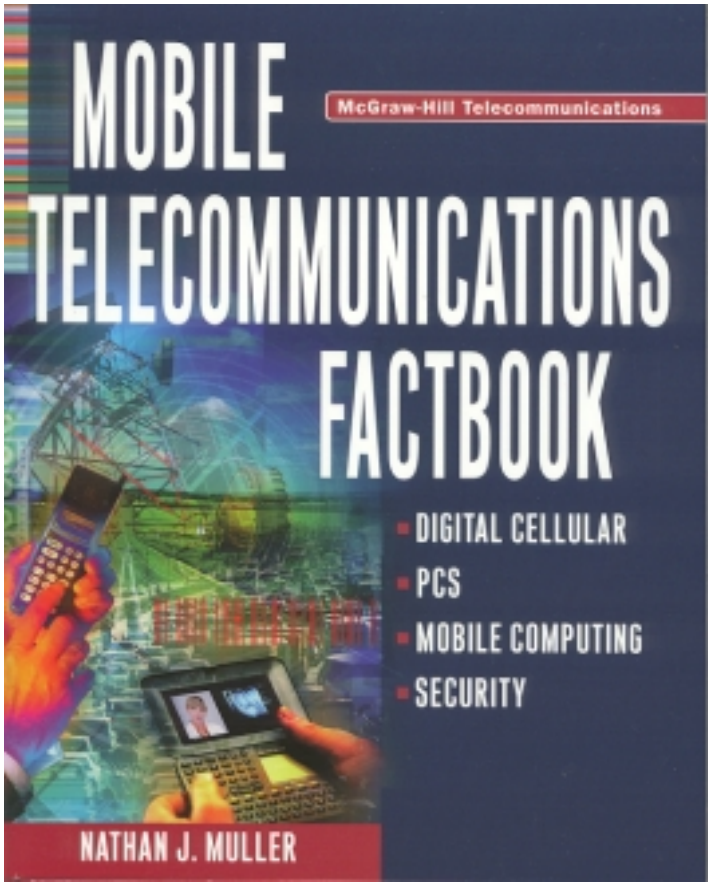
FURTHER READING:

As a preview for further reading, the following reference has been provided from the pages of the book below:

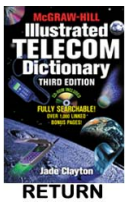
Title: Mobile Telecommunications Factbook
Author: Nathan J. Muller
Publisher: McGraw-Hill

ISBN: 0070444617



Matsushita's innovations in this field include the world's first cordless videophone system, the PHS Videophone System, which permits communication with both audio and color moving images; and the PHS Multimedia Communications System, which enables the transmission and reception of multimedia information, and access to the Internet via a PHS modem card.

Future of PHS



RETURN

Although the performance of PHS diminishes while traveling at high speeds—such as in a train or a car—at walking speeds, it provides seamless connections at home, outdoors and in the office. This seamless feature will become even more important in future applications, such as when it becomes possible to use PHS terminals as an electronic wallet.

While 32-Kbps transmission will become available in Japan soon, research is now underway to achieve a transmission rate of 64 Kbps through the use of two channels. With this much capacity, PHS can be extended to a variety of other services in the future, including full motion video.

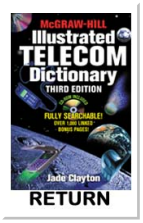
In combination with a small, lightweight portable data terminal, PHS might also be used to realize Oracle Corp.'s concept of "network computing," whereby users would access application software stored on the Internet for use when needed. With the limited memory and disk storage capacity of such network computers, the applications and associated programs would stay on the Internet, preventing the PHS devices from becoming overwhelmed. All this is possible with the Java programming language from Sun Microsystems.

Java was designed to provide a cleaner, simpler language that could be processed faster and more efficiently than C or C++ on nearly any microprocessor. Whereas C or C++ source code is optimized for a particular model of processor, Java source code is compiled into a universal format. It writes for a virtual machine in the form of simple binary instructions. Compiled byte code is executed by a Java run-time interpreter, such as a Web browser, performing all the usual activities of a real processor, but within a safe, virtual environment instead of a particular computer platform.

Java is being used as the foundation for developing interactive trading, insurance, investment planning, and stock-quote applications that can be accessed over the Web. Java applets are being used for implementing online banking, allowing customers to download their account information and interactively conduct bank business. Java is also being used by transportation companies to access shipping documents—bills of lading, container manifests, and shipment routings—from Web browsers. It is only a matter of time before Java is implemented on PHS terminals, perhaps being integrated into these devices at the chip level.

PCS 1900

PCS 1900 is an American National Standards Institute (ANSI) radio standard for 1.9-GHz Personal Communications Service (PCS) in the United States. As



such, it is compatible with the Global System for Mobile (GSM) telecommunications, the international standard. Adoption of the PCS 1900 standard in the United States is significant because it gives service providers a marketing advantage. Not only do customers reap the advantages of high-quality voice, integral text messaging, and security that GSM offers, but they can roam globally, limited only by the roaming agreements of the home service provider. Since most countries support GSM or a compatible variant, such as PHS, there is more connectivity potential than with other protocol standards.

Both GSM and PCS 1900 are based on TDMA technology. TDMA-based technology enjoys an initial cost advantage over rival technology CDMA equipment because suppliers making TDMA infrastructure equipment and handsets have already reached economies of scale. In contrast, CDMA equipment is still in its first generation and, therefore, is generally more expensive.

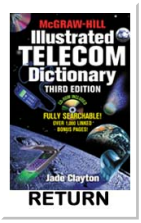
Services and features

Though similar to analog cellular service, digital PCS 1900 technology provides improved voice quality, better coverage, and a richer feature set. Not only is voice quality clearer, but fax and data transmissions are more reliable. Laptop computer users can connect to the handset with a PCMCIA card and send fax and data transmissions at higher speeds.

Like GSM, PCS 1900's digital orientation makes possible several advanced services and features that are not efficiently or economically supported in analog cellular networks. Among them are:

- *Short Message Service.* This service enables alphanumeric messages up to 160 characters to be sent to-and-from PCS 1900-compatible handsets. Short Message Service applications include two-way point-to-point messaging, confirmed message delivery, cell-based messaging, and voice mail alert. If the handset is not turned on and a text message page is sent, the recipient will not miss it. This is a key point of difference between short/text messaging and traditional paging. The short/text messaging network is smart enough to know when the page has been successfully delivered (received by the phone). If the page is not successfully delivered, the text messaging system will hold and re-try the page for up to 28 days.
- *Voice Mail.* The PCS 1900 network provides one central voice mail box for both wired and wireless service. In addition, the voice mail alert feature ensures that subscribers do not miss important messages.
- *Personal Call Management.* Subscribers are offered a single telephone number for all their physical telecommunication devices. For example, a single number can be assigned for home and mobile use, or office and mobile use. This allows subscribers to receive all calls regardless of their physical location.
- *Data Applications.* Wireless data applications that can be supported by PCS 1900 networks include Internet access, electronic commerce, and fax transmission.

Network architecture



PCS 1900 is a frequency-adapted version of GSM which is made necessary because the FCC assigned the 1.9-GHz frequency for broadband PCS. Otherwise, PCS 1900 and GSM are similar in all other respects, including the network architecture, discussed earlier.

GSM's SIM is often referred to as the Smart Card under PCS 1900. The card can be used in any compatible GSM/PCS 1900 handset. The Smart Card works the same as the SIM. By removing the Smart Card from one PCS 1900 phone and inserting it into another PCS 1900 phone, the user is able to receive calls at that phone, make calls from that phone, or receive other subscribed services such as wireless Internet access. The handsets cannot be used to place calls (except 911 emergency calls) until the subscriber inserts the Smart Card and enters a personal identification number (PIN).

The profile information stored in the Smart Card also enables international roaming. When traveling in the United States, international GSM customers will be able to rent handsets, insert their SIM, and access their services as if they are back home. Likewise, when U.S. subscribers travel internationally to cities with compatible networks and mutual roaming agreements, they only need to take their Smart Card with them to access the services they subscribed to back home via the local network.

Like SIMs, Smart Cards also provide storage for features such as frequently called numbers and short messages. The handset provides an indication of when the Smart Card's text messaging memory is full. Different handsets give different indications:

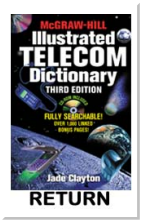
- Motorola Flip phone provides a blinking envelope icon, indicating the card is full.
- Ericsson CF 337 phone displays a text message in the format #stored(#available), as in 3(5).
- Nokia 2190 phone displays a text message such as "No Space: Messages Waiting," followed by a blinking envelope icon which indicates the card is full.

Smart Cards can also include the AT command set extensions which integrate computing applications with cellular data communications. In the future, Smart Cards and PCS 1900 technology will also link subscribers to applications in electronic commerce, banking, and health care.

There are other features available. For instance, the user can automatically call back a numeric page. Using the intelligence of the mobile handset, if a text message page has a telephone number embedded, it can be called using simple handset commands. The system automatically sends a Text Message alert for any new voice message. The alert is displayed on the mobile handset. If the user happens to listen to new messages from a landline phone, and are saved or deleted, the message alert will not appear for those messages when the mobile phone is turned on again. In such cases, the message alert will be canceled. However, if the user listens to a voice message from a landline phone

and does not have time to save or delete it, the voice message is still considered "new." In this case, the message alert will be delivered to the user when the mobile phone is turned on.

Conclusion



At present, the CDMA (IS-95) standard has been chosen by about half of all the PCS licensees in the United States, giving it a temporary lead in the total number of potential subscribers. The largest of these is Sprint PCS, which completed its nationwide rollout of CDMA-based PCS in 1997. Among the regional PCS service providers also using CDMA is GTE, which in 1997 completely upgraded its major-market cellular networks nationwide.

The first regional PCS networks based on the PCS 1900 standard became operational in 1996. Among the PCS auction winners that have regional PCS 1900 networks in place are APC Sprint Spectrum, American Portable Telecom, Bell South Personal Communications, Intercel, Omnipoint, Pacific Bell Mobile Services, DCR Communications, and Western Wireless.

Bell South chose PCS 1900 because it has extensive experience in building and operating GSM systems in five other countries, including Australia, Denmark, Germany, India and New Zealand. AT&T has chosen IS-136 because it supports dual-band 800/1900-MHz TDMA cellular/PCS systems.

Among the two largest PCS 1900 service providers are Omnipoint Corp. and Western Wireless. Omnipoint owns PCS licenses that cover more than 96.5 million people, making Omnipoint the fourth largest PCS operator in the United States. Western Wireless is a major service provider of wireless communications in the rural United States. The company owns and operates nonwireline cellular telephone systems in 70 markets, including 15 metropolitan statistical areas, making it the fifth largest PCS operator in the United States.

In terms of equipment, Nortel dominates the PCS 1900 market in the United States. In June 1995, Nortel became the first equipment provider to obtain full certification of 1.9-GHz PCS network equipment from the FCC and Underwriters Laboratories (UL). As of year-end 1996, Nortel was the market leader in the sale of PCS 1900 networks, with one of the six new digital wireless PCS networks in commercial service in the United States using Nortel equipment. Nortel has more than 1000 PCS radio base stations in service with operators serving six Major Trading Areas (MTAs) which reach more than 60 million potential subscribers. Nortel supplies PCS 1900 equipment to Bell South, Omnipoint, and Western Wireless, among others.

The number of PCS 1900 customers in North America reached 400,000 in May 1997. The national network of local service providers is adding more than 1600 customers in North America daily. Nine service providers offer service in 323 cities, reaching nearly 40 million potential subscribers with 4857 cell sites. PCS 1900 service is in operation in half of all U.S. states and two Canadian provinces.

An advantage U.S. carriers have in supporting the PCS 1900 standard is that it is compatible with the worldwide GSM standard, which means customers can roam globally, since most countries support GSM. There will be

strong continuing GSM growth in Europe and worldwide, particularly as the technology expands into new markets, including India, China, and Latin America. In these markets, GSM is cheaper to install, more readily available and more reliable than the existing copper wire infrastructure.

With so many standards to choose from, there is a fair amount of risk when PCS service providers make a commitment to one. A number of factors go into this decision, including economics, scalability, features supported, and interoperability. Perhaps the approach of AirNet Communications makes more sense. The company offers broadband wireless base station systems and products whose software-definable and all-digital architecture permit analog- and digital-protocol independence. That lets the operator control how new air protocols are phased in to the network without requiring the purchase of a new base of equipment.

AirNet's systems enable operators to define a specified number of channels to each protocol from a single hardware platform. Two distinct over-the-air protocols can be run simultaneously, such as TACS and GSM; GSM and DCS 1800; or AMPS and PCS 1900. Multiple protocols no longer require separate networks. In addition, AirNet's base stations are smaller (the size of a file cabinet, versus the tool-shed size of traditional base stations), have fewer components, and provide upgradable, modular channel capacity up to 96 channels, compared with the 48-channel standard capacity. That results in lower deployment and operating expenses and thus minimizes the cost per subscriber.

It is clear from the diversity of technology commitments that no single standard for PCS will dominate in the United States to the exclusion of any other.