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CHAPTER 6

CDMA Technology

Upon completion of this chapter, the student should be able to:

- Discuss the basic concepts and evolution of CDMA technology.
- Discuss the difference between the various access technologies; namely FDMA, TDMA, and CDMA.
- List the United States frequency bands used for CDMA technology.
- Discuss CDMA network and system architecture.
- Discuss network management.
- Discuss CDMA channel and frame concepts.
- Discuss the functions of the forward and reverse logical channels.
- Discuss CDMA system operations: initialization, call establishment, call handoff, and power control.
- Discuss the implementations of 3G cellular using CDMA technology.

This chapter introduces another cellular wireless air interface technology known as code division multiple access or CDMA. Because of the importance of CDMA as the air interface technology of the future and the amount of detail included in this chapter, it has been organized into three parts: CDMA system overview, CDMA basics, and 3G CDMA. First deployed commercially in 1995, CDMA is a relatively new technology. However, CDMA-based systems are overwhelmingly being counted on to provide the needed infrastructure to implement future 3G systems and beyond (4G). Part I of this chapter begins with an introduction to the first deployment of 2G CDMA systems and the subsequent evolution to 3G CDMA systems. Included in this introduction is an explanation of basic CDMA operation, the frequency allocations allowed for CDMA use in the United States, and CDMA frequency reuse issues. An overview of the present cdma2000 (the initial phase of 3G cellular) network and system architecture is presented next with short descriptions of the operation and functions of the network elements included in the overview. Since many of the common network elements have been previously discussed, the emphasis in this chapter is on new network elements and differences in the wireless network due to the use of CDMA technology. A detailed introduction to cellular network management techniques is included also.

In an effort to not overwhelm the reader, the second part of this chapter provides a detailed explanatior of the IS-95B CDMA channel concept and the actual implementation details of the air interface signals fo this 2G technology. Forward and reverse logical channels are described and their functionality within th system is explained. The CDMA frame format is also introduced and its significance within the systen explained for both forward and reverse logical channels. With the basic technical details fairly well coverec

Evolution of 3G CDMA

Cdma2000 is the term used for 3G CDMA systems. Cdma2000 was one of five proposals the ITU approved for IMT-2000 third-generation (3G) standards. As previously mentioned in Chapter 2, cdma2000 is the wideband enhanced version of CDMA. It is backward compatible with TIA/EIA-95-B and provides support for data services up to 2 mbps, multimedia services, and advanced radio technologies. The implementation of cdma2000 technology is to occur in planned phases with the first phase known as 1xRTT (1X radio transmission technology) happening over a standard 1.25-MHz CDMA channel. The next phase of implementation is known as cdma2000 1xEV (where EV stands for evolutionary). There are two versions of 1xEV: 1xEV-DO (data only) and 1xEV-DV (data and voice). 1xEV-DO can support asymmetrical peak data rates of 2.4 mbps in the downlink direction and 153 kbps in the uplink direction. 1xEV-DV can support integrated voice and data at speeds up to 3 mbps over an all-IP network architecture. The changeover from cdmaOne to cdma2000 1xRTT has been ongoing in the United States and the rest of North America since late in the year 2000. Currently, there are several cdma2000 1xEV-DO systems in operation worldwide with more in the planning stage. Again, see the CDMA Development Group's Web site for information about the worldwide deployment of 3G cdma2000 systems. Further information about cdma2000 and other 3G CDMA technologies will be presented later in this chapter.

CDMA Basics

CDMA is a multiple-access technology that is based on the use of wideband spread spectrum digital techniques that enable the separation of signals that are concurrent in both time and frequency. All signals in this system share the same frequency spectrum simultaneously. The signals transmitted by the mobile stations and the base stations within a cell are spread over the entire bandwidth of a radio channel and encoded in such a way as to appear as broadband noise signals to every other mobile or base station receiver. The identification and subsequent demodulation of individual signals occur at a receiver through the use of a copy of the code used to originally spread the signal at the transmitter. This process has the effect of demodulating the signal intended for the receiver while rejecting all other signals as broadband noise. Since a specific minimum level of signal-to-noise ratio is necessary to provide for a certain level of received signal quality, the level of background noise or interference from all system transmissions ultimately limits the number of users of the system and hence system capacity. Therefore, CDMA systems are carefully designed to limit the output power of each transmission to the least amount of power necessary for proper operation.

At this time, it will be helpful to compare the CDMA air interface scheme with the frequency division multiple access (FDMA) and time division multiple access (TDMA) air interfaces (see Figure 6–2). For FDMA, the available radio spectrum is divided into narrowband channels and each user is given a particular channel for his or her use. The user confines transmitted signal power within this channel, and selective filters are used at both ends of the radio link to distinguish transmissions that are occurring simultaneously on many different channels. The frequency allocations can only be reused at a distance far enough away that the resulting interference is negligible. The TDMA scheme goes one step further by dividing up the spectral allocation into timeslots. Now, each user must confine its transmitted spectral energy within the particular timeslot assigned to it. For this case, the mobile and the base station must employ some type of time synchronization. This technique increases spectral efficiency at the expense of each user's total data rate. In CDMA, each mobile has continuous use of the entire spectral allocation and spreads its transmitted energy out over the entire bandwidth of the allocation. Using a unique code for each transmitted signal, the mobiles and the base station are able to distinguish between signals transmitted simultaneously over the same frequency allocation. CDMA can also be combined with FDMA and TDMA technologies to increase system capacity.

capacity.

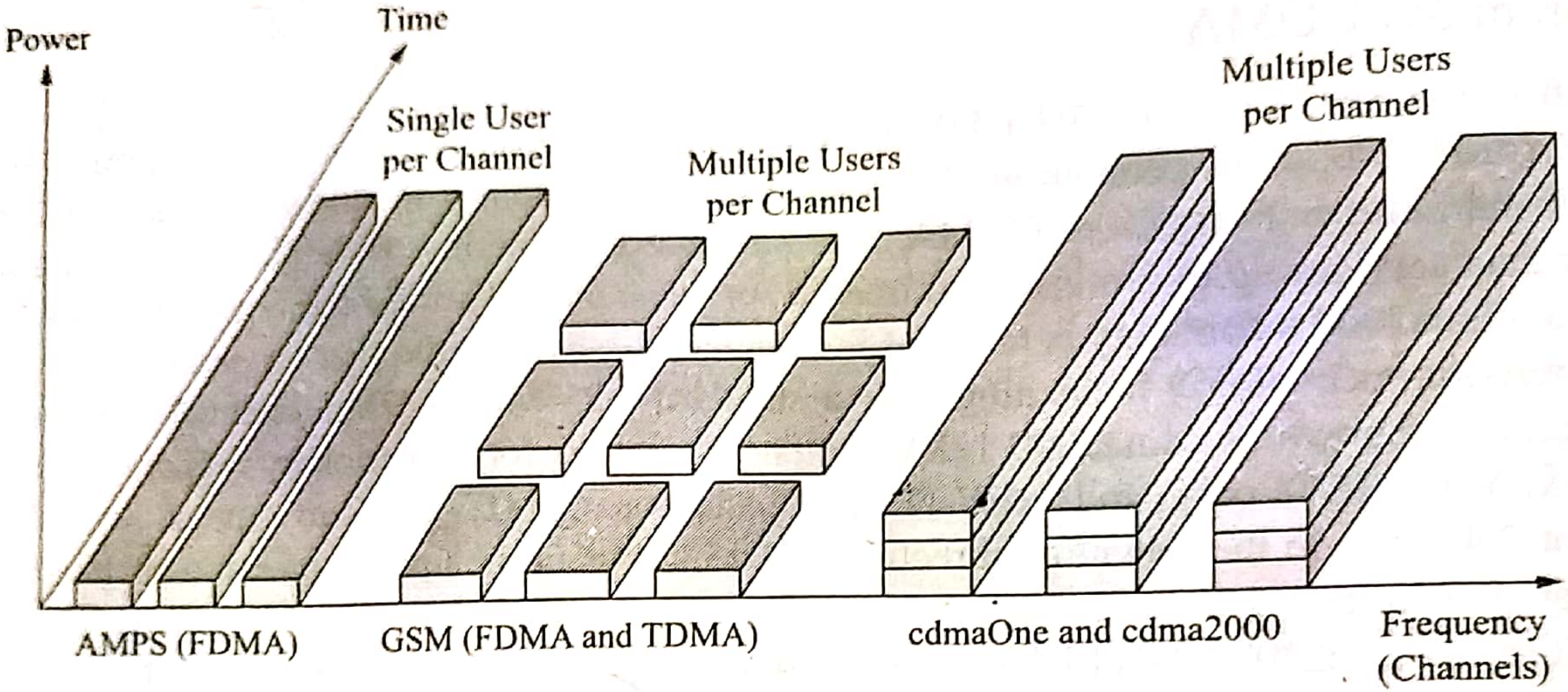

Figure 6–2 Comparison of FDMA, TDMA, and CDMA air interfaces.

For 2G CDMA systems, one might be inclined to state that the frequency separation between adjacent carriers or channels is 1.25 MHz. In CDMA standards, the terms *carrier* and *channel* are carefully distinguished from one another. A carrier frequency may be divided by means of codes into sixty-four different channels. Each of these channels may carry information related to a separate and distinct conversation or data connection in digital form. This distinction is also true of TDMA systems where each carrier is divided into timeslots and each timeslot serves as a channel. In older FDMA systems, the two terms are synonymous and hence a source of confusion when discussing these new technologies.

CDMA Frequency Bands

Presently, in the United States, CDMA systems can be deployed for use in the existing cellular frequency bands (Band Class 0) and the personal communications service (PCS) bands (Band Class 1). In the future, 3G CDMA systems will also be allowed in the newly released 1710–1755 MHz and 2110–2155 MHz advanced wireless services (AWS) bands (see the FCC Web site at www.fcc.gov for further details about the use of these bands). In other parts of the world there are various additional frequency bands (with band class designations given by the CDMA standards) available for CDMA use including a lower frequency band at 450 MHz. When used in the cellular bands, a frequency separation of 45 MHz between the forward and reverse channels is employed. The MS transmit frequency band is 824–849 MHz and the BS transmit frequency band is 869–894 MHz. In this band, not all of the frequencies are designated for use by CDMA cellular wireless networks. Recall that the FCC requires AMPS service to be supported until 2007, so some of the channels are reserved for this purpose. This dual use of the cellular frequency band gives rise to dual-mode CDMA phones.

The 1900-MHz PCS band may be used for either GSM, NA-TDMA, or CDMA technologies. Refer back to Figure 5–2 for details of the PCS bands and Table 5–3 for GSM carrier frequencies. Table 6–1 shows the corresponding CDMA and NA-TDMA PCS channel numbers and carrier frequencies. For CDMA, with a 50-kHz channel spacing, the chart indicates a total of 1200 CDMA channel numbers (carrier frequencies) over the 60 MHz of allocated frequency. The chart also indicates the NA-TDMA channel numbers. One can see that there is not a one-to-one correspondence between the CDMA and NA-TDMA channel numbering systems or between either of these systems and the GSM channel numbers shown in Table 5–3. Additionally, the CDMA spacing between transmit and receive frequencies is 80 MHz whereas for NA-TDMA it is 80.04 MHz and for GSM it is 90 MHz. All this means is that there are possible interference concerns between all of these systems on both the uplink and downlink frequencies where coexisting systems are located.

Table 6–1 CDMA and NA-TDMA channel numbers and frequency assignments for the PCS band (Band Class 1) (Courtesy of 3GPP2)

Transmitter	*CDMA PCS Channel Number (N)*	*Center Frequency for CDMA Channel (MHz)*	*TDMA PCS Channel Number (N)*	*TDMA PCS Channel Frequency (MHz)*
Mobile Station	$0 \le N \le 1199$	$1850.000 + 0.050\ N$	$1 \le N \le 1999$	$1849.980 + 0.030 \times N$
Base Station	$0 \le N \le 1199$	$1930 + 0.050\ N$	$1 \le N \le 1999$	$1930.020 + 0.030 \times N$

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6.2 CDMA NETWORK AND SYSTEM ARCHITECTURE

The reference architecture for wireless mobile systems deployed in North America is based upon standards developed by the TIA. The TIA Committee TR-45 develops system performance, compatibility, interoperability, and service standards for the cellular band, and committee TR-46 coordinates the same activities for the PCS band. The TR-45.3 subcommittee deals with NA-TDMA and the TR-45.5 subcommittee with CDMA. Furthermore, the TR-45 committee works closely with the 3GPP2 organization to specify the standards for cdma2000. For more information about these activities visit the TIA Web site at www.tiaonline.org.

The initial reference architecture for IS-95 CDMA is very similar to the GSM reference architecture presented in Chapter 5. The adoption of TIA/EIA-95 provided for additional network interfaces that exist between the various system elements. This reference model developed by TR-45/46 is depicted by Figure 6–3.

The new cdma2000 reference architecture (see Figure 6–4) has been enhanced to include even more additional network access interfaces. These interfaces are mainly concerned with the evolving structure of cdma2000 toward an all-IP core network.

As was discussed with GSM cellular, messaging between CDMA system network elements is carried out through the use of protocols very similar to SS7. TIA/EIA-634-B is an open interface standard that deals with signaling between the MSC and the BSC (over the A interface), and TIA/EIA-41-D describes

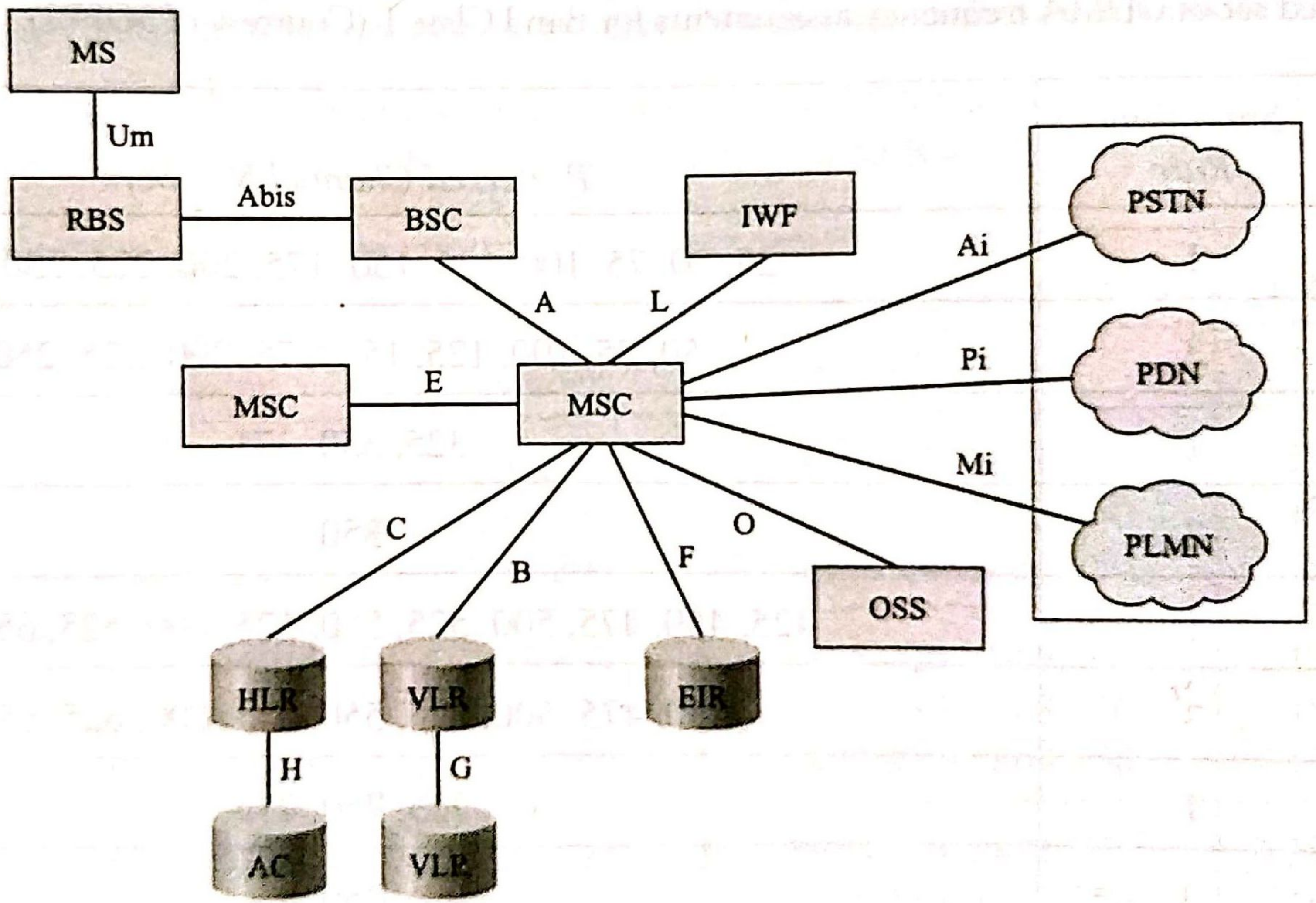


Figure 6–3 Initial CDMA (IS-95) reference architecture.

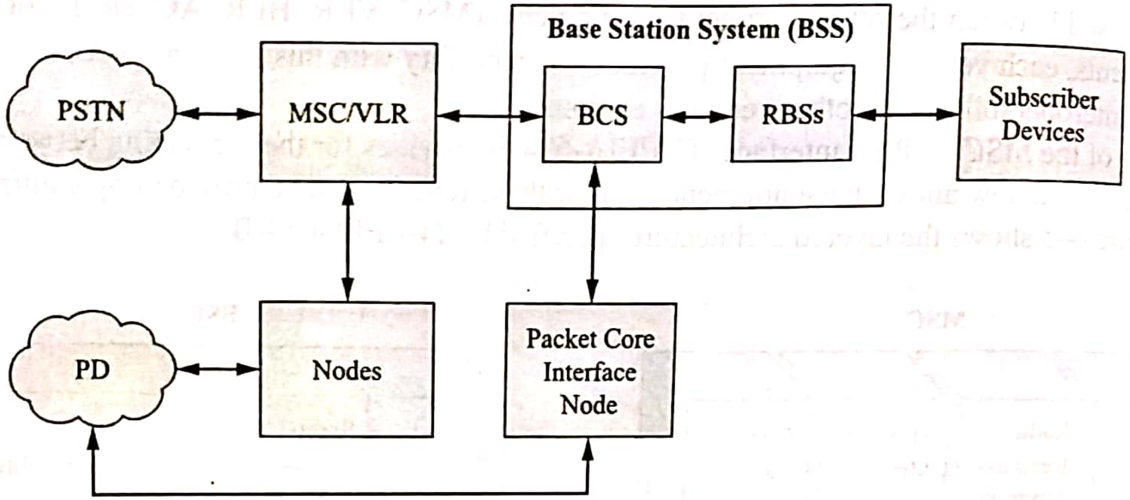
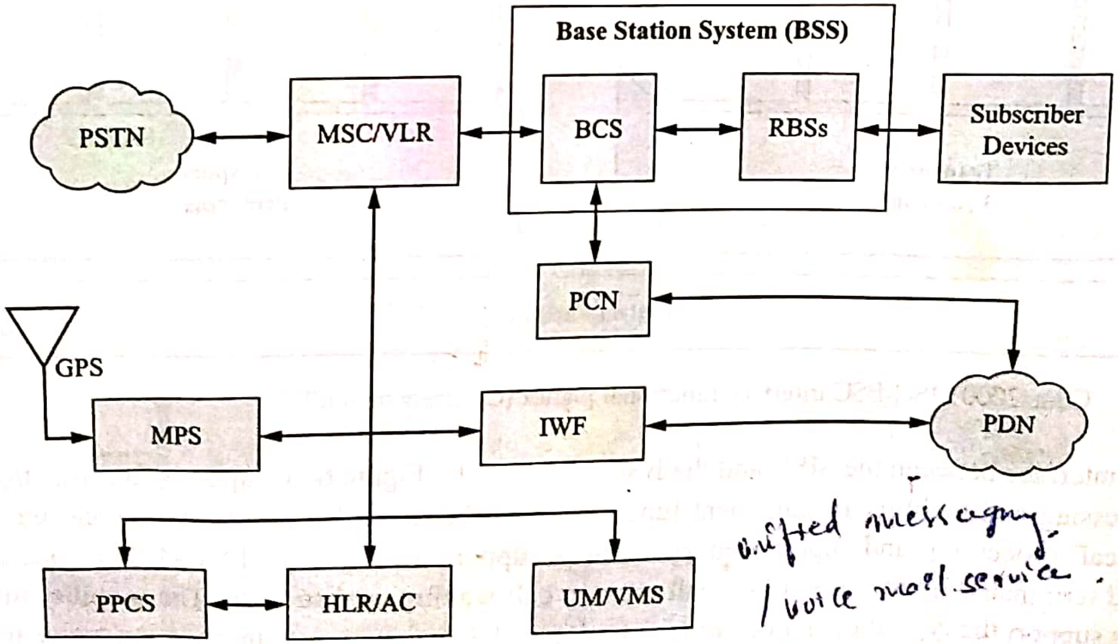


Figure 6–6 Major network components of a cdma2000 wireless system (Courtesy of Ericsson).



unified messaging
/ voice mail service.

Figure 6–7 Details of the network nodes found in a cdma2000 wireless system (Courtesy of Ericsson).

Mobile Services Switching Center and Visitor Location Register

... cdma2000 wireless system (Courtesy of Ericsson).

Mobile-Services Switching Center and Visitor Location Register

The CDMA mobile-services switching center (MSC) serves as the interface between the public switched telephone network (PSTN) and the base station subsystem (BSS). The MSC performs the functions necessary for the establishment of calls to and from the system's mobile subscribers. Additionally, the MSC, in conjunction with other network system elements, provides the functionality needed to permit subscriber mobility and roaming. Some of these operations include subscriber registration and authentication, location updating functions, call handoffs, and call routing for roaming subscribers.

Typically the visitor location register (VLR) function is colocated with the MSC. Its function is to provide a database containing temporary information about registered subscribers that may be needed by the MSC in the performance of call control operations and the provisioning of subscriber services for the mobiles currently registered in the MSVC/VLR service area.

Interworking Function

In the early (IS-95) CDMA systems, the interworking function (IWF) node is the only gateway between the wireless network and the packet data network (PDN). As such, it provides a direct connection to the PDN for packet data calls. Additionally, the IWF node supports circuit-switched data calls by providing internal modems for connections to dial-up Internet service providers (ISPs). These circuit-switched data calls are routed to the PSTN through the MSC. Today, the IWF typically uses Ethernet for the signaling between itself and the MSC and for the exchange of packet data between itself and the PDN. In cdma2000, the IWF's packet data transfer function is augmented by the packet core network (PCN) element.

Mobile Positioning System

In an ongoing program mandated by the FCC and designed to upgrade the United States' cellular systems, a location system is incorporated by the CDMA system that can determine the geographic position of a mobile subscriber. This **mobile positioning system** (MPS) is based on the Global Positioning System (GPS) and is to be used for emergency services. The ability to locate the caller is known as Enhanced 911 or E911. Other proposed uses of this system capability relate to what are known as "location-based services" or location-specific marketing tools.

For Phase 1 of the wireless E911 program, the cellular system must be able to tell a local public safety answering point (PSAP) the location of the cellular antenna that is handling the emergency call. In Phase 2 of the first implementations of this location determining system, the MPS uses a form of mobile-assisted GPS and triangulation to determine the latitude and longitude of the mobile within 50 to 100 meters. It is believed that later phases of this system will be able to lower the system uncertainty even further. The FCC has set a timetable for the rollout of this service with an expected implementation by cellular service providers by the end of 2005.

There has already been much discussion about the idea of "big brother" knowing one's location via one's cell phone and it remains to be seen where this technology will lead to over the coming years vis-à-vis the privacy issue. Additionally, unwanted spam over the Internet and unsolicited calls from telemarketers have recently become hot political topics and it remains to be seen whether location-based services will be accepted by the cellular subscriber or just become another form of telemarketing or wireless spam.

Unified Messaging/Voice Mail Service

Ericsson Corporation's new cdma2000 systems contain a unified messaging/voice mail service (UM/VMS) node that integrates e-mail and voice mail access. This node provides messaging waiting indication using short message service (SMS) and multiple message retrieval modes including the use of DTMF or either a Web or WAP browser. As shown in Figure 6–7, the UM/VMS node connects to the PDN and the MSC in Ericsson's system.

HLR/AC

The home location register (HLR) and authentication center (AC) are typically colocated in cdma2000 systems. The HLR holds subscriber information in a database format that is used by the system to manage the subscriber device (SD) activity. The type of information contained in the HLR includes the SD electronic serial number (ESN), details of the subscriber's service plan, any service restrictions (no overseas access, etc.), and the identification of the MSC where the mobile was last registered.

The AC provides a secure database for the authentication of mobile subscribers when they first register with the system and during call origination and call termination. The AC uses shared secret data (SSD) for authentication calculations. Both the AC and SD calculate SSD based on the authentication key or A-key, the ESN, and a random number provided by the AC and broadcast to the SD. The A-key is stored in the SD and also at the AC and never transmitted over the air. The AC or MSC/VLR compares the values calculated by the AC and the SD to determine the mobile's status with the system.

PPCS and Other Nodes

The prepaid calling service (PPCS) node provides a prepaid calling service using the subscriber's home location area MSC. This node provides the MSC with information about the subscriber's allocated minutes and provides the subscriber with account balance information. The PPCS node is usually associated with a prepaid administration computer system that provides the necessary database to store subscriber information and update it as needed. The prepaid administration system (PPAS) provides the subscriber account balance information to the PPCS system. The MSC sends information about subscriber time used to the PPAS for account updating. In the future, other additional nodes may be added to the system to provide increased system functionality like intersystem roaming.

Base Station Subsystem

A base station subsystem (BSS) consists of one base station controller (BSC) and all the radio base stations (RBSs) controlled by the BSC (refer back to Figure 6–6). The BSS provides the mobile subscriber with an interface to the circuit switched core network (PSTN) through the MSC and an interface to the public data network (PDN) through the packet core network (PCN). There can be more than one BSS in a cdma2000 system. Today, the combination of all the CDMA BSSs and the radio network management system that oversees their operation is known as the CDMA radio access network or C-RAN.

Base Station Controller

In a cdma2000 system, the base station controller (BSC) provides the following functionality. It is the interface between the MSC, the packet core network (PCN), other BSSs in the same system, and all of the radio base stations that it controls. As such, it provides routing of data packets between the PCN and the RBSs, radio resource allocation (the setting up and tearing down of both BSC and RBS call resources), system timing and synchronization, system power control, all handoff procedures, and the processing of both voice and data as needed.

Radio Base Station

The cdma2000 radio base station (RBS) provides the interface between the BSC and the subscriber devices via the common air interface. The functions provided by the RBS include CDMA encoding and decoding of the subscriber traffic and system overhead channels and the CDMA radio links to and from the subscribers. The typical RBS contains an integrated GPS antenna and receiver that is used to provide system timing and frequency references, a computer-based control system that monitors and manages the operations of the RBS and provides alarm indications as needed, communications links for the transmission of both system signals and subscriber traffic between itself and the BSC, and power supplies and environmental control units as needed.

PLMN Subnetwork

A cdma2000 public land mobile network (PLMN) (refer back to Figure 3–5) provides mobile wireless communication services to subscribers and typically consists of several functional subnetworks. These subnetworks are known as the circuit core network (CCN), the packet core network (PCN), the service node network (SNN), and the CDMA radio access network (C-RAN). The cdma2000 PLMN subscriber has access to the PSTN and the PDN through these subnetworks. The organization of the PLMN into subnetworks facilitates the management of the system.

Circuit Core Network

The circuit core network (CCN) provides the switching functions necessary to complete calls to and from the mobile subscriber to the PSTN. The major network element in the CCN is the MSC. This portion of the system is primarily concerned with the completion of voice calls between the subscriber and the PSTN. The MSC is basically an extension of the PSTN that services the various cells and the associated radio base stations within the cells. The MSC provides circuit switching and provides features such as call charging, subscriber roaming support, and maintenance of subscriber databases.

CDMA Radio Access Network

In cdma2000, the CDMA radio access network or **C-RAN** provides the interface between the wireless cellular subscriber and what is known as the circuit core network (CCN). The CCN consists of the MSC and other system components involved with connections to the PSTN for all circuit-switched voice and data calls. The C-RAN can consist of multiple base station subsystems (BSSs) and some form of radio network manager (RNM) system. The RNM system provides operation and management (O&M) support for multiple BSSs.

Packet Core Network

In cdma2000, the **packet core network** (PCN) provides a standard interface for wireless packet-switched data service between the C-RAN and the public data network (PDN). The PCN provides the necessary links to various IP networks to and from the C-RAN. The PCN typically consists of three main hardware nodes: the authentication, authorization, and accounting (AAA) server, the home agent (HA), and the packet data serving node (PDSN). Figure 6–8 depicts the elements of the PCN and their interconnection to each other and the relationship of the PCN to the PDN and the C-RAN.

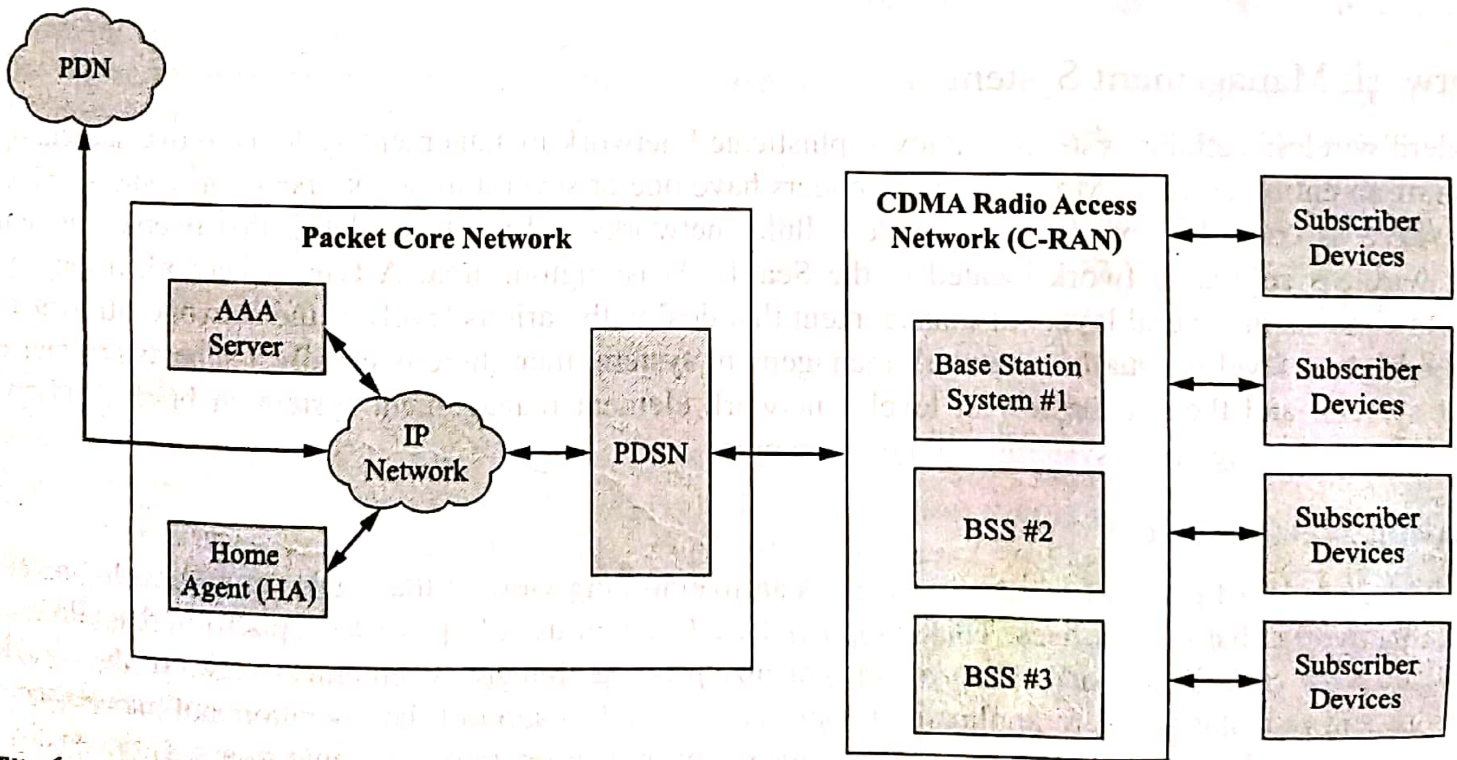


Figure 6–8 Elements of the cdma2000 packet core network (Courtesy of Ericsson).

In a cdma2000 cellular system, the packet data serving node (PDSN) provides the needed IP transport capability to connect the C-RAN and hence the subscriber to the public data network. The PDSN connects to the C-RAN through the A_{quater} interface (also known as the radio-packet (R-P) interface). The PDSN also interfaces the C-RAN with the home agent and the authentication, authorization, and accounting nodes. In such a capacity, it sets up, maintains, and terminates secure communications with the home agent and the authentication, authorization, and accounting nodes. It further serves as a point of connection to the radio network and the IP network and provides IP service management to offered IP traffic. Finally, to facilitate wireless mobile IP functionality, it also serves as a foreign agent to register network visitors (this topic will be discussed in more detail shortly).

The authentication, authorization, and accounting **(AAA) server** both authenticates and authorizes the subscriber device to employ the available network services and applications. To facilitate this operation, the AAA server manages a database that contains user profiles. The user profile information will also include information about quality of service (QoS) for the PDSN. The AAA server receives accounting information from the PDSN node that together with session information can be used for billing of the subscriber. An AAA server may be configured primarily for billing purposes. If that is the case, the PDSN may send accounting information to the billing AAA server and use a different AAA server for authentication and authorization.

In the cdma2000 system, the **home agent** (HA) has the task of forwarding all packets that are destined for the subscriber device (SD) to the PDSN over an IP network. The PDSN then sends the packets to the SD via the C-RAN and the common air interface. To be able to perform this operation the HA in conjunction with the PDSN authenticates mobile IP registrations from the mobile subscriber, performs SD registration, maintains current location information for the SD, and performs the necessary packet tunneling. Packet tunneling refers to the following operation: IP packets destined for a particular SD's permanent address are rerouted to the SD's temporary address. If the SD is registered in a foreign network (i.e., not its home network), then the SD has been assigned a temporary dynamic IP address by the **foreign agent** (this functionality is provided by the foreign network PDSN) and this temporary address is sent to the HA.

A relatively recent addition to the elements of the PCN is a wireless LAN serving node (WSN). This node provides IP transport capability and connectivity between the wireless network and wireless LAN-enabled subscriber devices through wireless LAN access points (APs). More will be said about this topic in a later chapter.

Network Management System

Modern wireless cellular systems employ sophisticated network management systems to oversee the operation of an entire network. Most service providers have one or several network operations centers or NOCs that serve as control points for nationwide cellular networks. AT&T has a NOC that oversees its entire U.S. wireless cellular network located in the Seattle, Washington, area. A typical network management system consists of several layers of management that deal with various levels of the network infrastructure. At the highest level is usually a network management system, then there is usually a subnetwork management system, and then at the lowest level a network element management system. A brief overview of each of these management systems will be given next.

Network Management

The highest level of network management gives an overarching view of the entire network including all of the subnetworks that it comprises. This computer-based system usually provides a platform that allows one to monitor the overall network. The system typically provides integrated graphical views of the complete network and modular software applications that may be used to support the operation and maintenance of the entire network, and it further provides the means by which operators are able to assess the quality of network service and to provide corrective action when network problems occur.

There are basically five functions that a wireless network management system will perform: network surveillance or fault management, performance management, trouble management, configuration management, and security management. Fault management is concerned with the detection, isolation, and repair of network problems to prevent network faults from causing unacceptable network degradation or downtime. Using the tools provided by the system, a human operator can attempt to repair the problem from the NOC. Performance management functions are concerned with the gathering and reporting of relevant network performance statistics that can be used to continuously analyze network operation. Trouble management functions allow for the display and subsequent description of occurrences that have affected the network and also provide the operator with the ability to communicate this information to other persons involved with the maintenance of the network. If the operator at the NOC is unable to clear a trouble or a fault and depending upon the type of problem, it must be escalated and communicated to someone in the field who will now have the responsibility of dealing with it. Configuration management functions are used to support the administration and configuration of the network. These functions support the installation of new network elements as well as the interconnection of network nodes. Finally, security management functions manage user accounts and provide the ability to control and set user-based access levels.

Subnetwork Management and Element Management

Subnetwork management platforms provide management of the circuit, packet, and radio networks that compose the typical CDMA system. The circuit core network management system is mainly concerned with the CDMA mobile-services switching center. It provides fault, performance, configuration, software, and hardware management functions that support the operation of this particular network element at the subnetwork level. The computer system used for this function provides an operator with access to one or more MSCs for the performance of the various functions listed earlier. The packet core network management system is concerned with the PCN node of the CDMA system. Besides the standard functions of fault and performance management, the PCN management platform can perform statistics administration, online documentation, backup and restore functions, and maintain dynamic network topology maps and databases for the PCN nodes. The CDMA radio access network (C-RAN) management system is concerned with CDMA base station subsystems. It provides the ability to configure the radio and network parameters of the system BSSs, monitor C-RAN alarms and performance, and install or upgrade software to any network element in the C-RAN. Additionally, it provides the capability to manage user security and the ability to back up and restore the configuration of any C-RAN element.

Element management refers to the ability to interface directly with a network element through a "craft" data port. Using element specific software, a technician on-site with a laptop computer or off-site through a remote connection is able to interface directly with the specific network element. This type of software-driven element management is usually performed at a cell site during the initial deployment, installation, and testing of a radio base station and during any necessary diagnostic testing and troubleshooting if an escalated alarm or hardware trouble develops with the system.

System Communication Links

Today, equipment vendors are still using legacy channelized T1/E1/J1 copper pairs for connectivity from the MSC to the PSTN. Recently, however, CDMA equipment vendors have started to add fiber-optic interfaces to deliver SONET signals at data rates of 155.52 mbps as shown by Figure 6–9. Channelized T1/E1/J1 with control information is used over the A interface between the MSC and the BSC. Between the BSC and the RBSs unchannelized T1/E1/J1 is used. Between the MSC and the various network elements such as HLR, AC, and so on, signaling protocol TIA/EIA-41-D is used over T1/E1/J1 timeslots. T1/E1/J1 is used to transport data between the nodes and the MSC. Data between the service nodes and the PDN is typically carried by Ethernet at 10/100 mbps. Between the BSC to the PCN, fiber-optic signals at 155.52 mbps are converted to Ethernet at 10/100 mbps. Lastly, from PCN to PDN, data is carried by Ethernet at 10/100 mbps rates.

Recently, most wireless equipment vendors are offering integrated network solutions to service providers by providing microwave links capable of T1/E1/J1 transport or higher data rates for backhaul of aggregated signals to the PSTN. Several vendors offer high-capacity microwave radio systems that offer OC3/STM-1 data rates with the ability to transport asynchronous transfer mode (ATM) traffic. As service providers upgrade their systems to offer 3G CDMA services with high-data-rate access, the C-RAN will need to be interconnected and serviced by data transport technologies that offer higher data rates than T-carrier transport technology. At this point, it appears that ATM has been selected to be the data transport technology around which the next generation of radio access networks for 3G CDMA systems will be designed.

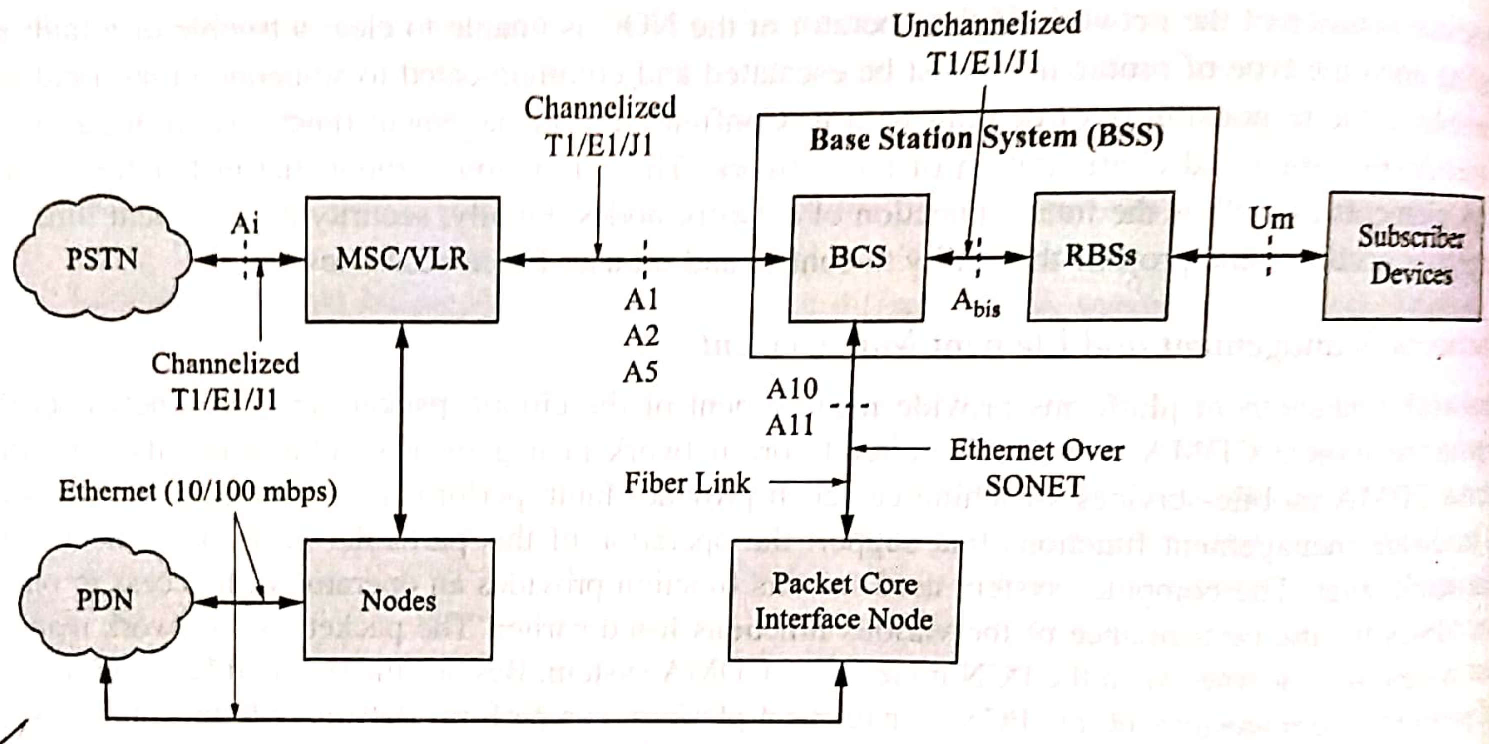


Figure 6–9 Network interfaces for CDMA systems (Courtesy of Ericsson).

Subscriber Devices

Subscriber device (SD) is a generic term used to describe several types of wireless phones and data devices that perform CDMA encoding/ decoding and vocoding operations for the transmission of voice or data in a wireless mobile environment. Each subscriber device has a band or set of radio bands over which it can operate and various modes of possible operation. Subscriber devices can be divided into two broad groups or categories depending upon their applications. Portable devices can operate in the cellular, PCS, or in both bands and can handle the transmission of voice, data, and other nonvoice applications. Typically, these types of SDs are used by people for mobile voice connectivity first, with the other data capabilities being of secondary importance. Wireless local loop (WLL) devices can handle the transmission of data over the CDMA system and typically are used with a laptop or personal digital assistant (PDA) type of device for high-speed Internet access. In the near future, the latter type of SD will probably be used to provide Voice over IP (VoIP) capabilities that will allow wireless video conferencing over either a laptop or tablet PC. In the coming years, the typical SD will include additional functionality for multimedia applications and the ability to use any additional frequency bands that might support CDMA services.

phones.

7.1 INTRODUCTION TO MOBILE WIRELESS DATA NETWORKS

The growth of the Internet and its daily use by the average person coupled with the public's desire for any-time, anywhere voice and data communications has been the driving force behind the growth and development of mobile wireless data networks. If one plots the number of Internet Web sites or Internet users versus time, the resulting upward curve is closely matched only by the growth in the number of worldwide wireless cellular subscribers. If desired, the reader may view any number of the previously listed Web sites (i.e., GSM, UMTS, CDMA forums or industry collaborations) that provide impressive, near real-time running totals of existing subscribers to a particular air interface technology and maps of worldwide deployment and coverage areas with detailed information about the service providers, frequency bands used, technology used, and so on. Most cellular industry predictions of future system expansion and total numbers of wireless subscribers are heavily optimistic, with double-digit growth predicted for at least this decade.

What is not so certain, however, are the predictions concerning the user take-up rate for mobile digital data services. Although the initial response for these services has been extremely encouraging in several applications areas (SMS, MMS, etc.), disruptive technologies like wireless local area networks (WLANs) and even newer initiatives like radio LANs (RLANs) and mobile wireless metropolitan area networks (WMANs) have started to cast some doubt as to the eventual shakeout that will occur in this industry. Another critical issue involves the subscriber's end device. The classic cellular telephone itself just does not provide the same experience when browsing the World Wide Web as does the traditional desktop PC or a notebook PC despite efforts to improve this situation through specialized software and mobile operating systems. It has been very difficult to get around the small display screen employed by most low-cost mobile phones. What this problem has spawned is the evolution of the end device. Personnel digital assistants (PDAs) have been around for a number of years and continue to evolve into what are now known as handhelds. Devices in this category are able to provide wireless connectivity either through WLAN hot spots or over nationwide wireless data networks and also provide acceptable-size, high-resolution color screens to improve the delivered data services experience to a more acceptable level. In some cases, PDA devices have incorporated cell phone functionality. At the same time, high-end cellular telephones have been morphing into multimedia infotainment/connectivity devices with the addition of larger, color, high-