CDMA network technologies: A decade of development and challenges - Part 1

The article briefly describes the origins of CDMA technology and the introduction of 3G versions such as CDMA2000 1X and CDMA2000 1x EV-DO. An overview of the network structure is presented with detailed explanations of the role of each component and interface in the network and protocol testing to change according to the needs of the network. The article will conclude with a discussion of some technical issues that may appear in CDMA networks and some proposed solutions.

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Code Division Multiple Access (CDMA) was born as an alternative to GSM cell architecture and contributed to the explosive growth in the wireless market over the past decade. CDMA, like GSM, has made continuous improvements throughout this period. Currently both networks are in the process of transitioning to worldwide 3G generation systems, allowing more storage and data services.

Digital revolution and development situation

While the mobile communications industry started with the transition from first generation Analog technology to second generation digital architecture, in Europe, GSM architecture became popular, while in the country America, part of Asia and elsewhere, spread-spectrum CDMA technology has a large market share. Because spread spectrum uses wide band, noise signals are often difficult to detect. They are also not easily blocked or demodulated. In addition, spread spectrum signals are often more difficult when jamming (jam) compared to narrow band signals. Low Probability of Intercept (LPI) and AJ (antijam) features are the main reason why the military has been using spread spectrum for years. Both GSM and CDMA network technologies are increasingly improved in terms of bandwidth, adding features and reliability at a lower cost to retain customers.

CDmaOne supports 2G mobile communication into oblivion

TIA / EIA CDMA IS-95 standard (published in July 1993) establishes the fundamental principles for end-to-end wireless communication systems. Commercial network system architecture based on this standard is known as CDmaOne. The TIA / EIA IS-95 and the revised version of the IS-95A (published in March 1995) form the basis for the majority of networks on CDMA 2G platforms deployed worldwide.

From the perspective of voice services, CdmaOne technology provides important features for mobile network operators such as:

The increase in voice capacity from 8X to 10X is more compelling when compared to Analog AMPS systems.

Network planning is simplified, with the same frequency used in each area of ??each cell (cell).

CDMA 2G infrastructure initially proved effective in delivering high quality, low-loss voice traffic. However, it did not last long because mobile users began to have demands for basic data services such as Internet and Intranet services, multimedia applications, or speedy commercial transactions. Elevation is added to simple voice services on their phones. The TIA / EIA IS-95A standard met this requirement with the introduction of broadband 1.25 MHz CDMA channels, source control, call handling, 'hand-off' techniques [3] and registration (registration) for system operation. The IS-95A TIA / EIA has provided the appropriate circuit switching data services for CDMA subscribers. However, these services are limited to a maximum speed of 14.4 Kbit / s per user.

The second phase of the revised version for the original specification has produced the IS-95B TIA / EIA standard. This standard provides subscribers with packet switching data services at speeds up to 64 Kbit / s for each subscriber in addition to the existing voice services. With increased data rates, IS-95B TIA / EIA-compatible networks are considered CDMA 2.5G technologies.

Cdma2000 replaces cdmaOne

The transition to 3G generation is still being implemented with a large number of new standards proposed. Some are designed based on GSM infrastructure and others are derived directly from CDMA technology. Finally, the ITU also defined an IMT-2000 standard comprising five different radio interfaces including CDMA2000. Note that all IMT-2000 protocols use 'spread-spectrum' technology [5] related to network installation, operation and maintenance.

ITU defines a 3G network as a communication network in which system capacity and spectrum performance are improved compared to 2G systems. 3G supports data services with a minimum transfer rate of 144 Kbit / s in mobile environments and 2 Mbit / s in fixed environments. The CDMA2000 architecture faces the above objectives and includes a number of additions that an operator can choose to cater to the existing infrastructure-based transition strategy, price and some another factor.

These include CDMA2000 1X and CDMA2000 1xEV:

CDMA2000 1X + doubles voice capacity compared to CdmaOne networks, allocating maximum data rates of 307 Kbit / s for each subscriber in a mobile environment.

+ CDMA2000 1xEV includes two variants, both backwards compatible with CDMA2000 1X and CdmaOne technologies.

CDMA2000 1xEV-DO (Data Only) is capable of allocating multimedia data services such as MP3 transmission, video conferencing with a maximum data rate of 2.4 Mbit / s for each internal subscriber. mobile environment.

CDMA2000 1xEV-DV (Data Voice - Data and Voice) provides simultaneous integrated multimedia and voice data services with a maximum data rate of 3.09 Mbit / s for each subscriber.

A network structure designed for packetized communications

Figure 1 illustrates a simplified CDMA2000 1X network, which shows both the telephone structure (ANSI-41, see the last abbreviation) and the data. Refer to Figure 1 to discuss the following issues.

Picture 1 of CDMA network technologies: A decade of development and challenges - Part 1

Figure 1: Structure of a CDMA network . (Note that all symbols, concepts in the figure are explained in the abbreviations or comments in part 2 of the article)

Mobile station (MS - Mobile Station)

In a CDMA2000 1X network, the MS mobile station - is the subscriber of CDMA subscriber or mobile network device - acting as a mobile IP client.

Mobile stations interacting with Access Network to acquire the appropriate radio resources to exchange packets and monitor the status of radio resources including 'active' (active), 'stand -by '(backup),' dormant '(inactive). It accepts buffer packets from mobile hosts when radio resources are not available or not enough to support network traffic.

Thanks to the power supply, the mobile station automatically registers with HLR (Home Location Register) to:

Verify that the mobile device is in the environment of the network being accessed. Give HLR the current location of the mobile device. Provided to MSC-S (Serving Mobile Switching Center) set of mobile device permissions.

After successful registration with HLR, the mobile device is ready to make data and voice calls. These calls can be in the form of CSD (circuit-switched data) or PSD (packet-switched data), depending on the compatibility of the mobile device itself. (or not compatible) with the IS-2000 standard. This document defines protocols for different CDMA interfaces related to the transmission of packets named A1, A7, A9 and A11.

MS mobile stations must comply with IS-2000 standards to initiate a packet data session when using 1xRTT1 network [4]. Mobile stations only have IS-95 capabilities limited by CSD, while IS-2000 terminals can be optional or PSD or CSD. Parameters forwarded by the terminal via spatial link (AL - air link) to the network will determine the type of service required.

Channel switching data has a maximum speed of 19.2 Kbit / s and is implemented via traditional TDM channels. This service allows users to select the point of attachment (point of attachment) to a data network using regular dialing.

The packet switching data service has a maximum data rate of 144 Kb / s. For each data session, a Point-to-Point Protocol (PPP) session is created between the mobile station and the PDSN (Packet Data Serving Node). The assignment of an IP address for each mobile device can be provided by PDSN or a Dynamic Host Configuration Protocol (DHCP) server via a HA (Home Agent) [2].

RAN (Radio Access Network)

RAN (Radio Access Network) is the entry point for mobile subscribers for data or voice communications including:

Space link (air link) Antenna / tower location (cell) and connect cable to BTS (Um) BTS (Base Station

Transceiver Subsystem) Communication line from BTS to BSC (Abis) BSC (Base Station Controller) PCF (Packet Control Function)

In particular, RAN has a number of responsibilities that influence the network's packet service provision. RAN must map to the mobile client identity referring to a single link-layer identity used to communicate with PDSN, validate mobile stations for access and maintain transmission links. established.

BTS (Base Station Transceiver Subsystem) controls the operation of the spatial link (air link) and functions as an interface between the network and the mobile device. RF resources such as frequency assignment, area division and transmission source control are managed by the BTS. In addition, BTS also manages the traffic from the cell position to the Base Station Controller to minimize any delay between these two components. Usually a BTS connects to the BSC via un-channelized T1 devices or directly cables in the same device. The protocols used within this medium are exclusively based on HDLC (High-level Data Link Control).

The Base Station Controller (***BSC***) routes voice messages and circuit switching data between the cell position and MSC. It also has the role of managing mobility as controlling and controlling 'hand-offs' [3] from a cell position to another location if necessary. The BSC connects to each MTX that uses channeled T1 lines for voice and circuit switching data and with non-channel T1 lines for signaling and controlling messages to the PDSN using the 10BaseT Ethernet protocol.

PCF (Packet Control Function) routes IP packet data between mobile stations within range of cell (cell) and PDSN (Packet Data Serving Node) locations. During packet data sessions, the PCF will allocate the available sub-channels if necessary to comply with the required services from the mobile device and prepay from the subscribers. The PCF maintains a 'reachable' state between the RN and the mobile station to ensure a persistent link to the packets, which buffers the packet coming from the PDSN while the radio resources are not available or insufficient to Support traffic from PDSN and forward packets between MS and PDSN.

The core network role in CDMA infrastructure

Foreign Packet Data Serving Node / Foreign Agent (PDSN / FA)

PDSN / FA is a gateway from RAN to public or private packet networks. In a simple IP network, PDSN acts as a standalone NSA (Network Access Server), while in a mobile IP network it can be configured as a Home Agent [2] or an FA. (Foreign Agent).

PDSN performs the following functions:

• Manage radio packet interface between BSS (Base Station Subsystem = BTS + BSC) and IP network by establishing, maintaining and connecting link layer to mobile client.

• Finish the PPP session created from the subscriber's home.
• Provide IP addresses for subscribers.
• Implement packet routing to external packet data networks or packet routing to the HA to become secure tunnels.
• Collect and forward data charging packets.
• Manage subscription services based on the profile information received from AAA server SCS server [1].
• Local user authentication or forwarding authentication requests for AAA server.

(Part I)