CDMA2000 Networks for Multimedia Service


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CDMA2000 Overview

3GPP2’s CDMA2000 1X, 1xEV-DO and 1xEV-DV.
CDMA2000 CAI Standard Family

Multimedia! High-Speed!

- **IS95-A**
  - 8/13kbps QCELP
  - SMS/VMS/IN
  - 9/14.4kbps

- **IS95-B**
  - 115.2 kbps
  - Improve capacity
  - Improve call quality

- **CDMA2000 1X**
  - Double capacity
  - 144/384kbps
  - Improve standby time (2 Times)

- **1xEV-DV**
  - Under Harmonization
  - More than 2.4Mbps

- **1xEV-DO**
  - 2.4 Mbps
  - Improve Packet Performance

Timeline:
- 1997
- 1999
- 2000
- 2001
- 2003
CDMA2000 Family History

- **CDMA2000 1X**
  - Under commercial service in South Korea from 2000.
  - Service will be open in Japan, US, China and so on in 2002.

- **CDMA2000 1xEV-DO**
  - Under trial service in South Korea from Dec. 2001.
  - Commercial service launched at Jan. 2002 in South Korea.
  - Service will be open in Japan in 2002.

- **CDMA2000 1xEV-DV**
  - Standard under construction.
  - Air and Signaling standard will be completed in Mid 2002.
CDMA2000 1X Benefits over IS95A/B

- High speed packet data service
  - Forward link: 9.6 ~ 153.6 (Rel.0), 307.2 (Rel.A) kbps.
  - Reverse link: 9.6 ~ 153.6 kbps.
- Air capacity increase by 1.5 ~ 1.7 times
  - Expected additional 2dB capacity increase.
  - Reverse pilot, Fast power control, Transmit diversity and so on.
- Handset standby time increases by 2 times
  - Almost 1.5 times due to color LCD’s power consumption.
- An others
  - Increased error correction capability by using Turbo code.
  - Hybrid PSK/QPSK (Reverse/Forward)
CDMA2000 1X Network Architecture

- IS-2000
- BTS1
- BSC1
- MSC
- WIN
- SCE/SMS
- Intelligent Peripheral
- HLR
- PSTN
- PLMN
- Internet
- PDA
- BTS64
- BTS1
- BSC12
- DCN
- PDSN
- PDGN
- AAA Server
- O&M Server
- Application Server
- Voice Path
- Data Path
- Signaling + Traffic
CDMA2000 1X Packet Data Service Overview

- MAC and RLP-Type3
  - MAC States: Active state, and Dormant state.
  - RLP-Type3: NAK based error recovery with up to 3 retransmission.

- RF-Scheduler
  - Efficient radio resource management scheme.
  - Assign radio resource according to available power, and user info.

- And others
  - Using high speed SCH.
  - Hard handoff preference for high speed SCH.
  - Mobile IP supported.
1X Evolution with Data Only Overview

- Official name is IS-856 HRPD (High Rate Packet Data)
- Good layering and modularity
  - Composed of independent specific protocols.
- High speed channels
  - Forward link
    - TDM’ed, full power, variable rate (38.4 kbps ~ 2.4576 Mbps).
    - Adaptive coding and modulation R=1/4-1/2, 4PSK, 8-PSK, 16-QAM).
    - Full power burst pilot.
    - No soft handoff.
    - Multi-user and multi-antenna receive diversity.
  - Reverse link
    - Pilot added coherent demodulation (9.6 ~ 153.6 kbps).
    - Rate control channel.
- Session management
  - The base-station and mobile negotiate the configuration of all protocols that will be used in the session.
1xEV-DO Network Architecture
1X Evolution with Data & Voice Overview

- Standard under construction
  - Under harmonization process of two technology.
    - L3QS own technology: Samsung, LG, Qualcomm, Lucent, LSI.
    - MNTiP 1Xtreme: Nokia, Motorola, TI, Philips.
  - Air and Signaling standard will be completed in mid 2002.

- Characteristics
  - Backward compatibility with CDMA2000 1X.
  - Both Voice and Data service are supported at the same carrier.
  - High speed data service (higher than 2.4 Mbps).
  - Forward link C/I measurement
    - CDM pilot based forward link C/I measurement.
  - Forward link rate determination on the packet data channel
    - BS decides the data-rates based on feedback from MS
  - Forward link cell site selection & switching
    - Based on C/I measurements by MS
Forward Link Peak Data Rate and Modulation
- L3QS: 2.4Mbps with 16QAM
- 1Xtreme: 4.8584Mbps with 64QAM
Forward Link Characteristics
- L3QS
  - 38.4/76.8/153.6/307.2/614.4/1228.8/2457.6 kbps
  - Up to 28 Walshes (Length 32)
  - 1.25/2.5/5/10ms unit transmission
- 1Xtreme
  - 76.8N/115.2N/153.6N/172.8N/230.4N/345.6N kbps
  - Where N is the number of codes 1~14.
  - Up to 14 Walshes (Length 16)
  - 5ms unit transmission
All-IP Network Architecture

Access Gateway (AGW)

- **IP Multimedia Domain Function**
  - Supports inter-AGW handoff.
  - Supports link layer handoffs between ANs in the same AGW.
  - Provides FA(IPv4) and/or Attendant(IPv6).
  - Link layer termination with MS such as PPP.
  - Provides interface to AN functions such as PCF.
  - Transport bear stream between MS and CN.
  - Provides access to network level registration and authentication to MS.
  - User authentication, access authorization with AAA.
  - Management of core QoS resources with CQM.
  - Maps NAI into MSID
  - Propagates appropriate policy decision information to AN.
  - Intercepts and processes QoS requests from the MS.
  - Polices traffic to and from MSs as per QoS profile.
  - May mark packets from MS as per QoS profile.
  - Enforces policy decisions for authorized services.
  - Accounting function with accounting information maintained by AGW.

- **Legacy MS Domain Function**
  - Supports packet data service for the legacy MS.
Authentication, Authorization, and Accounting (AAA)

- **Authentication**
  - Verify entity’s identity for network access, QoS request, multimedia resource request, or service request.
  - Provides authentication and/or encryption keys to establish dynamic security associations between network entities.

- **Authorization**
  - Authorization of requests for services and/or bandwidth, etc.

- **Accounting**
  - Gathers data concerning the services, QoS, and multimedia resources requested and used by individual subscribers.
  - Records session details
    - Requesting party, requested services, actual services used, date & time of requests, duration of usage, QoS used, terminal used.
  - Records mobility
    - Administrative domain location, date and time of attach, date and time of detach
  - Collects session details from various sources
    - SCM, Core QoS Manager, other Accounting Servers.
Session Control Manager (SCM)

- **Main Role**
  - Establishes, monitors, manages, releases Multimedia sessions, and manages the user's service interactions.
  - Managing the allocation of required resources such as MRF.
  - Managing session states and user's service precedence information.
  - Providing session state information to the Authorization Function.
  - Performing session processing tasks (e.g., network selection) required for session completion.

- **Home SCM (H-SCM; Home Service Provider)**
  - Interrogating-SCM (I-SCM) : Entry point to network, responsible for locating the S-SCM serving the user.
  - Serving-SCM (S-SCM) : Keeping the session state.

- **Visited SCM (Visited Service Provider)**
  - Proxy-SCM (P-SCM) : Proxy request/response between MS & H-SCM.
  - Local-SCM (L-SCM) : Allocates and/or provide access for local resources.
  - Emergency-SCM (E-SCM) : Used for emergency call.
Legacy MS Domain (LMSD)

- **Home Location Register Functionality (HLRF)**
  - Supports non-IP terminal.
  - Supports IP signaling interface.
  - Manages subscriber location and/or accessibility information.

- **Mobile Switching Center Functionality (MSCF)**
  - Provides trigger mechanisms to access WIN and other service application function.
  - Modifies call and connection processing functions under the control of service logic.

- **Service Control Point Functionality (SCPF)**
  - Interacts with the MSCF server.
  - Contains the logic and processing capability required to handle WIN provided service attempts.
  - Interacts with other SCPFs and Service Applications for secured data acquisition and manipulation, distributed service control and unsolicited service notifications.
  - Interacts with the databases for data acquisition and manipulation.

- **Trunk Signaling Gateway (T-SGW)**
- **Roaming Signaling Gateway (R-SGW)**
Border Router (BR)

- Connects CN with peer networks.
  - IP packet routing.
  - Exterior gateway routing protocols.
  - Policing of incoming and outgoing traffic.
  - Ensuring traffic complies with defined SLA established with peer networks.

- QoS signaling support.
  - Intercept any QoS allocation request.
  - Issue a request to the local Core QoS Manager for QoS availability.
  - Forward the bandwidth allocation request to its final destination at available QoS condition.
MGW, MRF

• Media Gateway (MGW)
  – Provides packet interface to CN.
  – May provides circuit interface to PSTN for bearer traffic.
  – May provides vocoding and/or transcoding to the bearer traffic.
  – May converts digital byte stream to/from audio modem tone.
  – May terminates PPP connection.
  – Provides policy enforcement relative to its activities and resources.
  – Further usage is open.

• Media Resource Function (MRF)
  – Provides useful resources in supporting services to subscribers.
  – Provides multi-way conference bridges, announcement playback services, tone playback services, etc.
  – SCM controls allocation, de-allocation, and modification of the usage of the MRF.
• Media Gateway Control Function (MGCF)
  – Controls MGW through standard interfaces.
  – Controls allocation, de-allocation, and modification of the usage of the MGW.

• Trunk Signaling Gateway (T-SGW)
  – Has interfaces to IP and SS7 transport network.
  – Relays PSTN signaling between the IP and the SS7 transport network.

• Roaming Signaling Gateway (R-SGW)
  – Conversion between SCCP/MTP and IP between legacy and IP networks.
  – Address translation between DPC/SSN/GTT and IP addresses.

• Network Capability Gateway (NCGW)
  – Provides access to network resources needed during service application execution.
SQM, CQM

• Subscription Quality of Service manager (SQM)
  – QoS resource management on a per subscription basis for users subscribed to the home network.
  – Makes policy decisions with regard to use of QoS resources for a given subscription based on policy rules for that subscription and current allocations already made with respect to that subscription.
  – Keeps track of core QoS allocations requested by each subscription in order to correctly authorize or deny future QoS requests by each subscription.

• Core Quality of Service Manager (CQM)
  – Management of CN QoS resources.
  – Management of resources of the BR and AGW.
Databases

- Equipment Identity Register (EIR)
  - Maintains DB of stolen equipments.

- Dynamic Subscriber Information (DSI)
  - Current session registration information such as serving SCM address.

- Network Policy Rules (NPR)
  - Maintains DB of the policy rules for subscription resource usage, expected QoS, valid time and routes, geographical service area definitions, policy rules for the applications serving a user, etc.

- Subscriber Profiles (SP)
  - Maintains DB of subscriber specific information such as authorized features, authorized services, authorized service area and credit worthiness.
Mobile-IP HA, PDE, PS, SA

• Mobile IP Home Agent (HA)
  – Registering the current point of attachment of the user.
  – Forwarding of IP packets to and from the current point of attachment of the user.

• Position Determining Entity (PDE)
  – Determine the precise geographic position of the MS based on input data provided by the Position Server.

• Position Server (PS)
  – Provides geographic position information to requesting entities.

• Service Application (SA)
  – Provides value-added network-based services for wireless subscribers.
  – Services may be accessed via the Network Capability Gateway or accessed directly from the user’s MS.
  – A service application is accessed using an Application Programming Interface (API) such as those defined by OSA.
Network Evolution to All-IP

From 3GPP2 TSG-S.All-IP,
Migration Goal

- Protection of investment in existing infrastructure.
- Continued support of existing users and MS within the legacy MS domain.
- The ability of Wireless Network Operators to migrate portions of their network functionality at a pace and in a manner that best meets their operational and economic goals.
- Support for green field deployments.
- The ability of a subscriber to carry forward the E.164 number assigned to a legacy MS to the All-IP MS.
- The ability to comply to regionally mandated features such as lawful intercept, emergency services.
Evolution Phase 0

Phase-0
(Today's Wireless Network)

- Legacy TIA/EIA-41 Network
  - TIA/EIA-41 Revision.E
  - MSC

- Packet Data Network
  - PDSN
  - Simple-IP, Mobile-IP(FA/HA)
  - AAA

- Radio Network
  - IOS Version 4.1
  - BS(BSC/BTS), PCF
  - CDMA2000 CAI
Evolution Phase 1

Phase-1
("1x", "IOS-v4.1" & "IP Signaling Transport")

- **Principles**
  - Separation of Sig. and Bearer.
  - IP transport for Signaling.

- **Legacy TIA/EIA-41 Network**
  - IP-Transport for TIA/EIA-41 signaling transport.
  - Legacy SS7/X.25 may be used.
  - TIA/EIA-41 over IP based WIN may replace IN.

- **Packet Data Network**
  - Legacy MS may be supported via Legacy MS Domain.

- **Radio Network**
  - IP based signaling transport.
  - IOS4.1 based Bearer.
  - CDMA2000 CAI.
Evolution Phase 2

Phase-2
(IP Core Network with Service Applications and Legacy MS Support)

Legacy TIA/EIA-41 Network with IP Transport

PN
(with Legacy MS Domain Support)

Legacy MS Domain Support

Mobile Station

EIR
DSI
Profile
Network
Policy
Rules
Service
Application
Network
Capability
Gateway
AAA
Position
Server
Position
Determining
Entity
BTS
MM
BSC/RNC
+ PCF
cdma2000 Access Network
Access
Gateway
FA / Attendan
Mobile IP
Home Agent
AAA
Media
Gateway
Border
Router
PSTN
Network

Legacy MS Domain Support

MAP
HLRF
MSCF
SCPF
T-SGW
R-SGW
CDM

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Evolution Phase 2

- **Principles**
  - Introduction of Legacy MS Domain (LMSD).
  - IP transport for Bearer.
  - LMSD supports legacy services. (Voice & Circuit Data)
  - LMSD supports packet data service for the legacy MS.
  - CN supports home system authorized and serving system supported domains for providing network based services.

- **Legacy TIA/EIA-41 Network**
  - Interoperability between LMSD and the legacy TIA/EIA-41 network.

- **Packet Data network**
  - LMSD supports new IP-based signaling/bearer interfaces.
  - MS can access new IP-based service via LMSD.

- **Radio Network**
  - LMSD supported.
  - Separated signaling link and bearer stream transport for LMSD.
  - IP-transport for signaling and bearer link.
  - CDMA2000 CAI.
Evolution Phase 3

Phase-3
(All-IP Network with Multimedia Streaming and Service Applications)
Evolution Phase 3

• Principles
  – Culmination of the evolution.
  – Extension of IP over the Radio.

• Legacy TIA/EIA-41 Network
  – Eliminated.

• Packet Data Network
  – IP Multimedia Domain as the dominant network technology.
  – Legacy MS may continue to be supported by a Phase-2 LMSD in conjunction with a Phase-3 IP Multimedia Domain.
  – IP transport for both signaling and bearer for LMSD.
  – IP Multimedia Domain supports enhanced services and QoS.

• Radio Network
  – IP transport of both signaling and transport.
Sequential Phase Evolution Scenario

Phase-0
- Phase-1 Access
- Phase-1 Core

Phase-1
- Core and Access
- Core and Access

Phase-2
- Phase-1 Core and Access

Phase-3

Time 0 Time 1 Time 2 Time 3 Time 4
'Mix & Match' Phase Evolution Scenario

Phase-0

Phase-1 Core

Phase-1 Core and Access

Phase-1 Core

Phase-1 Core and Access

Phase-2

Phase-2

Phase-3

Time 0

Time 1

Time 2
Example Service Flow
Originating Multimedia Call to PSTN from an All-IP MS in a Visited Multimedia Domain (1/3)
Incoming Call from Legacy PSTN to an All-IP MS Active in a Visited Multimedia Domain (1/3)
Incoming Call from Legacy PSTN to an All-IP MS
Active in a Visited Multimedia Domain (2/3)
Incoming Call from Legacy PSTN to an All-IP MS Active in a Visited Multimedia Domain (3/3)
Thank you.