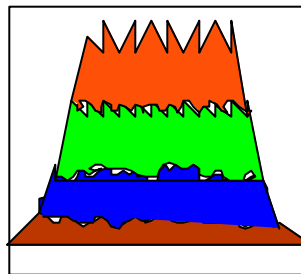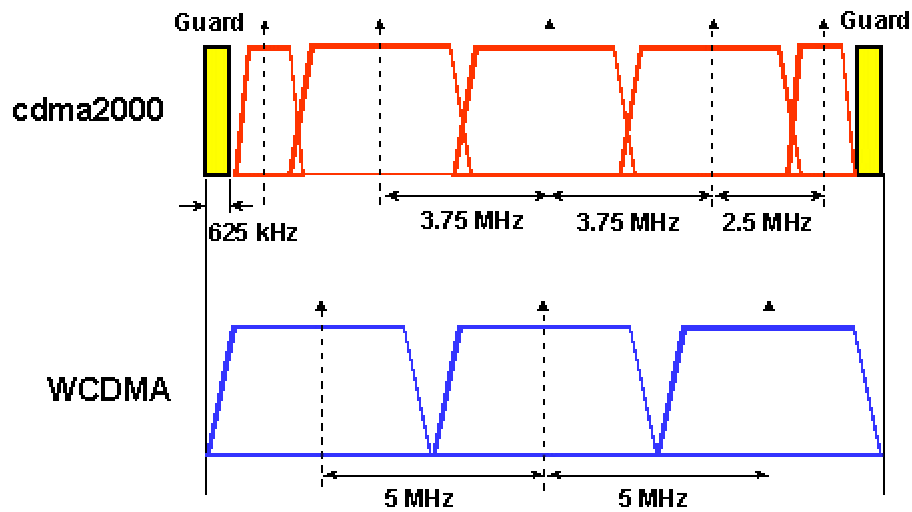# cdmaOne ™ & cdma2000 White Paper

Compiled & Edited by Loi McLoughlin

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Introduction:

There are a lot of information out there about CDMA and WCDMA and a person could easily get confused about the technology because of various names. This paper's goal is to help make it a little clearer on CDMA and 3G. The following information has been derived from many documents from the telecommunication industry.

General Information on CDMA

How does CDMA work?

CDMA uses codes to transmit and distinguish between multiple wireless subscribers. Voice and data signals are spread over a much broader bandwidth than the original signal. Since the connections are distinguished by digital codes, multiple users can share the same channel simultaneously. This greatly increases system capacity and allows wireless providers to transmit more information over the same frequency spectrum.

Which wireless operators deploy CDMA systems?

In the US, Verizon (Bell Atlantic, GTE, AirTouch, Primeco PCS) and Sprint PCS provide the largest CDMA footprint that covers most of the U.S. Regional CDMA carriers include Qwest Wireless and Alltel. Korean operators are among the largest CDMA carriers in the world. SK Telecom, KT Freetel and LG share more than 27 million CDMA subscribers in Korea.

What is the difference between cdmaOne and cdma2000?

cdmaOne ™ is the commercial term branded by CDMA Development group (CDG) for all IS-95 based CDMA systems.

cdma2000 is a name identifying the third generation technology that is an evolutionary outgrowth of cdmaOne offering operators who have deployed a second generation. cdmaOne system is a seamless migration path that economically supports upgrade to 3G features and services within existing spectrum allocations for both cellular and PCS operators.

cdma2000 has been divided into 2 phases. The first phase capabilities are defined in a standard known as 1X. Completed in the July 1999, this phase of cdma2000 carriers the TIA standard name of IS-2000 and the ITU standard name of MC-1X. 1X introduces 144 kbps packet data in a mobile environment and speeds beyond this in a fixed environment. Features available with 1X are a two-fold increase in both voice capacity and standby time, advanced packet data services, as well as greatly extended battery life and improved sleep mode technology. All of these capabilities will be available in an existing 1.25 MHz channel. The second release of 1X is being worked on in the TIA and will support faster data speeds with peak rates up to 614 KBPS.

cdma2000 phase two, known as 3X, incorporates the capabilities of 1X, supports all channel sizes (5 MHz, 10 MHz, etc.), provides circuit and packet data rates up to 2 Mbps, incorporates advanced multimedia capabilities, and includes a framework for advanced 3G voice services and vocoders, including voice over packet and circuit data.

As noted above, the 3G solution based on cdmaOne technology is known by many names that all relate to a single technology solution. The various names result from the naming conventions of different standards organizations or phases in the standards process.

- IMT-CDMA Multi Carrier 1X/3X (ITU standards name)
- MC-1X and MC-3X (abbreviation of ITU standards names)
- cdma2000 phase 1 (1X) and phase 2 (3X) · 1XRTT and 3XRTT

What is 1xEV?

1xEV is the next evolution of 1x. It is based on Qualcomm HDR (High Data Rate) technology. The following are the drivers for 1xEV:

- In the evolution timeline for cdma2000 1x, high-speed data capability to support existing and future Internet based services will become critically important.
- The data traffic will involve a significant amount of bursty data characteristic of Internet access traffic.
- Spectrum will continue to be a scarce resource, making 1.25 MHz systems significantly more attractive compared to 5 MHz systems (3X), so long as comparable performance can be achieved. Operators and subscribers will benefit from these systems via: - High speed and higher capacity Packet Data transport system
  - Higher Spectral efficiency for Packet Data
  - Voice with higher spectral efficiency
- The scalability and flexibility of cdma2000 1x systems are much better than 5 MHz systems for migrating existing 2G systems
- cdma2000 1x systems minimize impact on cell-site equipment and handheld devices in evolving to support high-speed packet data services

In order to meet cdma2000 Operator schedule requirements for deploying high-speed packet data services in a 1.25 MHz carrier, 1xEV will be defined in two phases. The CDG is outlining a phased approach because Operators believe that the industry can deliver an optimized packet air interface without real-time (e.g., voice) services on an accelerated schedule compared to an air interface which delivers both real-time and high-speed packet data services on the same carrier.

Phase 1: System Optimized for Non-Real Time, High-Speed Packet Data Services
The high-speed packet data service operates on one carrier. If the subscriber invokes voice or another real-time service, the 1xEV systems shall use cdma2000 1x to implement the service. The objective is to make this operation transparent to the user.

Phase 2: System to Concurrently Support High-Speed Packet Data and Real-Time Service
In an integrated approach, the objective is to integrate phase one capabilities on the same carrier, while retaining the ability to maintain packet data services on a separate carrier.

What is W-CDMA and how does it differ from cdmaOne and cdma2000?

cdmaOne and cdma2000 are based on the same standard where cdma2000 technologies represent the evolution of cdmaOne. W-CDMA or Wideband CDMA is also a CDMA technology that has different system parameters and implementation details. One of the differences is the chip rate (chip rate is used to spread the data). cdma2000 uses 3.6864 Mcps and WCDMA uses 4.096 Mcps.

WCDMA is optimized to allow very high-speed multimedia services such as voice, Internet access and videoconferencing, the technology will provide access speeds at up to 2Mbit/s in the local area and 384kbit/s wide area access with full mobility. These higher data rates require a wide radio frequency band, which is why WCDMA with 5MHz carrier has been selected; compared with 200kHz carrier for narrowband GSM. WCDMA can be added to existing GSM core network.

What is the difference between UMTS and WCDMA?

Universal Mobile Telecommunications System (UMTS) is a standard for delivering 3G services being developed under the auspices of ETSI (European Telecommunications Standards Institute). It builds on the world's most widely deployed mobile technology – GSM – and offers the prospect of a truly global wireless standard for personal multimedia communications. and it offers consumers a potential for a whole range of mobile multimedia services. Electronic postcards, web surfing, access to corporate LANs and intranets, and e-mail from a mobile terminal, to name but a few.

Wideband Code Division Multiple Access (WCDMA) is an air interface standard and it is the key technology for UMTS.

What is IMT-2000 Standard?

IMT-2000 Standard for 3rd Generation has three Modes:

Mode	Title	Origin	Supporters
1	WCDMA	Based on the first operational mode of ETSI's UTRA (3G Terrestrial Radio Access) RTT proposal.	Japan's ARIB (Association of Radio Industries and Businesses, the Japanese standards setting body) and GSM network operators and vendors. To be deployed in Japan and Europe.
2	cdma2000 Multi-Carrier FDD	Based on the cdma2000 RTT proposal from the US Telecommunications Industry Association (TIA). Consists of the 1XRTT and 3XRTT components	cdmaOne operators and members of the CDMA Development Group (CDG). Likely to be deployed in the USA.
3	IMT TCUTRA TDD (Time Division Duplex)	The second operational mode of ETSI's UTRA (3G Terrestrial Radio Access) RTT proposal. An unpaired band solution to better facilitate indoor cordless communications.	Harmonized with China's TD-SCDMA RTT proposal. Probably will be deployed in China.

3G Minimum Data Rate Definition:

Environment	Description	Data Rate
High Mobility	Speed >120 kmph, outdoor environment	144 kbps
Full Mobility	Speed < 120 kmph, outdoor environment	384 kbps
Limited Mobility	Speed < 10 kmph, stationary indoors and short range outdoor environment	At least 2 Mbps

Data Rate for different Standard:

Standard	Description	Data Rate
WCDMA	Wideband CDMA, Chip rate 4.096 Mbps, can be added to existing GSM core network	384 kbps for full mobility
1xRTT	Backward compatible to cdmaOne network. Works on 1.25Mhz bandwidth	Maximum 144Kbps
cdma2000 1xEV	Next evolution of 1X. Backward compatible to cdmaOne, Chip rate 3.6864 Mbps. Works on 1.25Mhz bandwidth	

Phase 1 (data only)	Phase 1, without voice	Rate 1: Forward – 1.25 Mbps
		                Reverse – 300 kbps
		Rate 2: Forward – 600 kbps
		                Reverse – 144 kbps

Phase 2 (Data and voice)	With voice	Rate 1: Forward – 1.25 Mbps
		                Reverse – 1.25 Mbps
		Rate 2: Forward – 600 kbps
		                Reverse – 600 kbps

A Comparison between GPRS and cdmaOne Packet Data

The path to high-speed packet data differs greatly between GSM and cdmaOne networks. GSM operators require a new data backbone, base station upgrades and new handsets to offer packet data services. Packet data in cdmaOne networks is standard and was built into the IS-95 standard from its inception. All cdmaOne handsets and base stations are packet data capable today, and the networks utilize standard Internet protocol (IP) based equipment.

Currently, mobile data rates are low on both GSM at 9.6 kbps with Circuit Switched Data and cdmaOne 95A networks at 14.4 kbps in either circuit or packet switched modes. These speeds are far lower than those available to a typical user of a PSTN wire-line network.

WCDMA Migration

Packet data Equipment requirements	GSM CSD (Circuit Switched Data)	GPRS (General PacketRadio Service)	EDGE (Enhanced Data rates for GSM Evolution)	IMT-2000 CDMADirect Spread (CDMA DS) (WCDMA)
Handset	No packet data capability -Single-Mode phones	New handsets GPRS-- enabled handsets will work on GPRS enabled networks and 9.6Kbps on GSM networks using CSD-Dual Mode phones	New handsets EDGE-- handsets will work at up to 384Kbps on EDGE enabled networks on GPRS enabled networks and 9.6Kbps on GSM networks using CSD-Tri-Mode phones	New handsets CDMA DS handsets will work at up to 2Mbps and only on 3G networks-Quad-Mode phones
Infrastructure	No packet data capability	New packet overlay/ backbone needed for circuit switched network	Further backbone modifications required	New infrastructure roll out with existing interconnect
Technology Platform	Current GSM TDMATechnology	GSM TDMA platform with additional packet overlay	Modulation changes required to GSM TDMA platform	New CDMA infrastructure

The GSM data evolution path will always require new network infrastructure and new phones. Every one of the future GSM data services from GPRS to EDGE to WCDMA (and High Speed Circuit Switched Data and Wireless Application Protocol) requires the purchase of a new mobile phone to take full advantage of the enhanced functionality, but all handsets will still be able to operate on the GSM network, allowing voice and CSD at 9.6Kbps. The GSM roadmap for handsets is not forward and backward compatible. This means that GPRS handsets will not work on EDGE or 3G CDMA DS base stations. A GSM carrier must make new investments in base stations for GPRS, EDGE and 3G CDMA DS, while the packet backbone may only need minor modifications after deploying GPRS. GSM also requires the implementation of IP based network elements to allow a packet overlay onto a circuit switched network. The links between the existing GSM network infrastructure entities and the IP backbone are comprised of proprietary hardware such as the Gateway GPRS Service Nodes (GGSNs) that link the Internet to the IP backbone. These are MODIFIED IP routers.

The cdmaOne packet-data implementation, on the other hand, utilizes standard routers, which are the same ones used in the landline Internet.

cdma2000 migration

Packet Data Equipment requirements	95A	95B	IMT-2000 CDMAMulti-carrier 1X(MC 1X)	IMT-2000 CDMAMulti-carrier 3X(MC 3X)
Handset	Standard 95A handsets will work on all future networks: 95B, 1X and 3Xat 14.4Kbps-Single-Mode phone *	Standard in chipsets 1999 95B handsets will work on 95A networks at 14.4Kbps and 95B, 1X and 3X systems at speeds up to 114 Kbps-Single-Mode phone	1X standard in chipsets in 2001 1X handsets will work on 95A networks at 14.4Kbps, 95B Networks at speeds up to 114 Kbps and 1X and 3X networks at speeds up to 307Kbps-Single-Mode phone	New handsets 3X handsets will work on 95A networks at 14.4Kbps, 95B networks at speeds up to 114Kbps and 1X networks at speeds up to 307 Kbps and 3X networks at 2Mbps-Single-Mode phone
Infrastructure	Standard	New software in BSC (Base Station Controller)	1X requires new software in backbone and new channel cards at base station	Backbone modifications New channel cards at base stations
Technology Platform	CDMA	CDMA	CDMA	CDMA

* Across the raw air link; assumes eight concatenated channels. With GPRS, the figures also assume no error correction on data transferred.
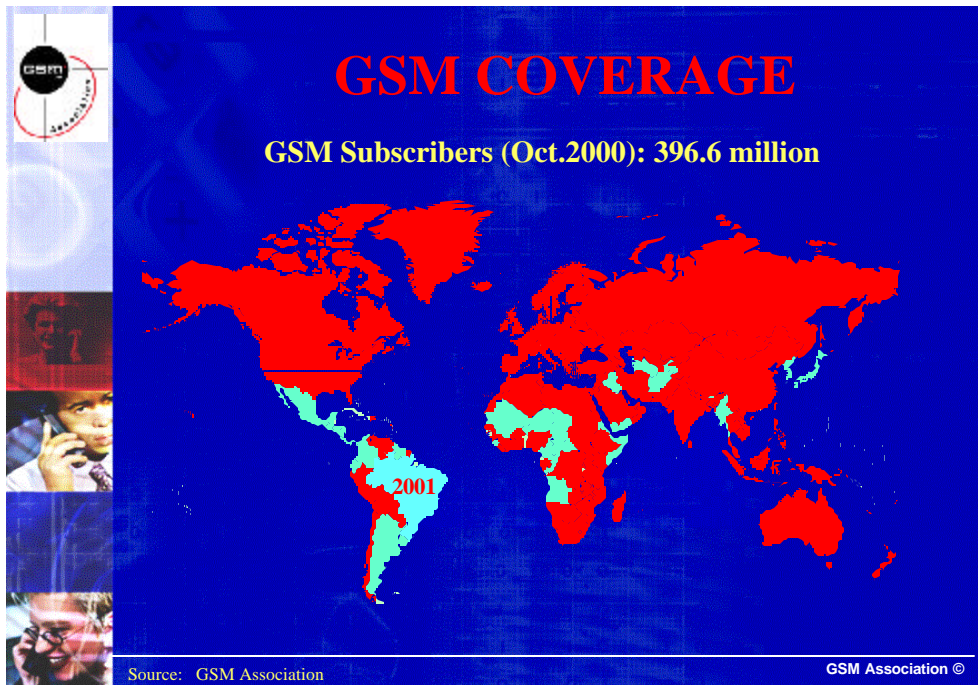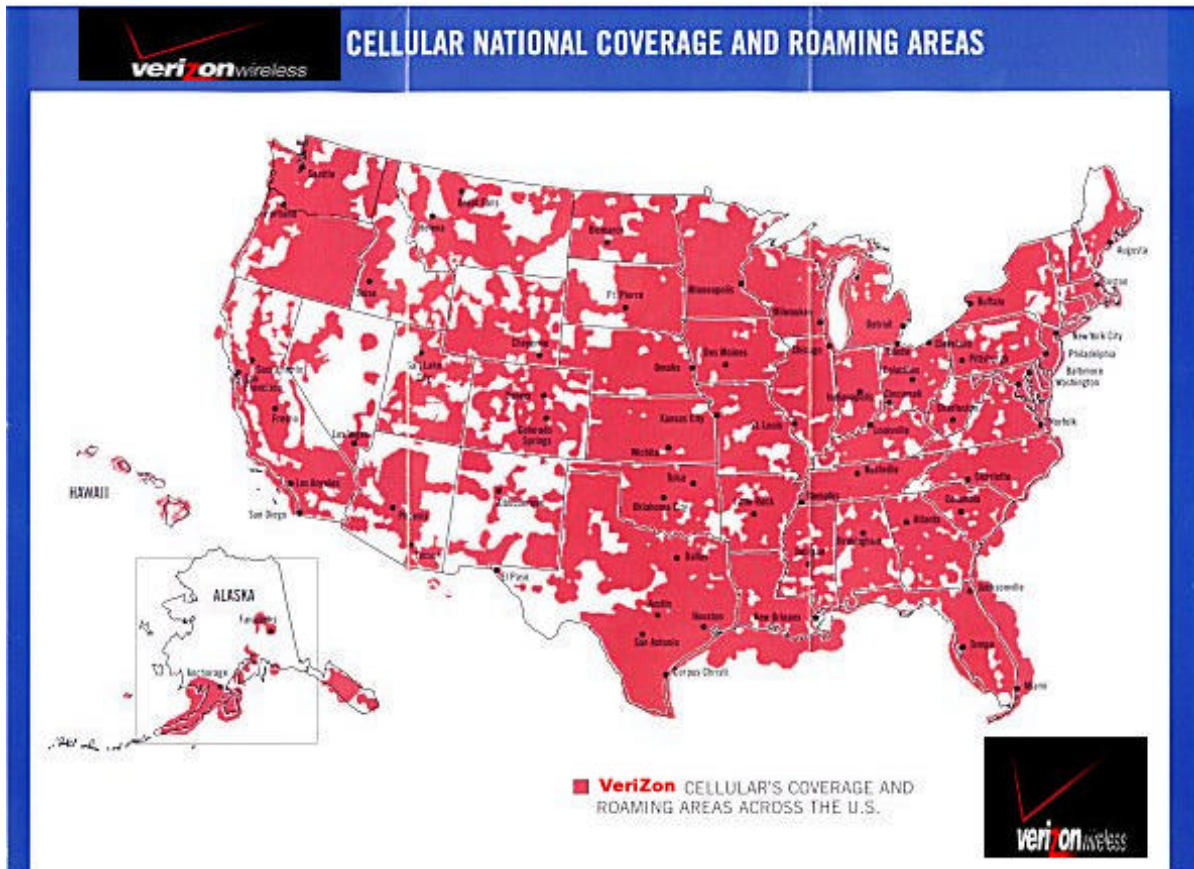
Coverage:

Countries with cdmaOne System:
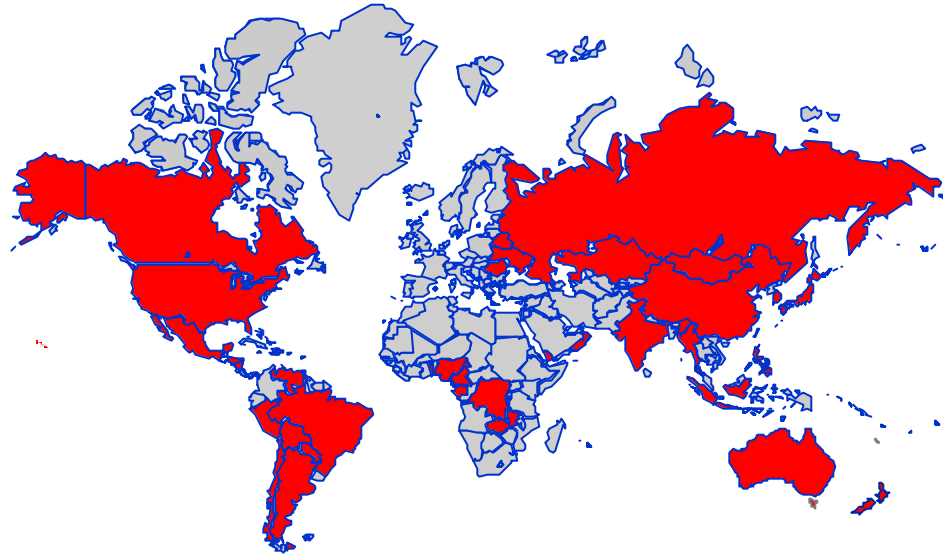
Source: CDG, April 2000

Countries with GSM System:

GSM Map above was provided by Martin Vetta

Verizon Wireless Coverage:

Note: This is for voice. The coverage is made up of analog and digital coverage (800MHz and 1900 MHz)

Sprint PCS Coverage:

Source: Nationwidewireless.net

Abbreviations:

1. IMT – International Mobile Telecomunication 2000
2. ITU – International Telecommunication Union
3. ETSI – European Telecommunications Standards Institute
4. ANSI – American National Standards Institutes
5. ARIB – Association of Radio Industries and Business (Japan)
6. TTA – Telecommunications Technology Association (Korea)
7. GPRS – General Packet Radio Service

Sources:

1. CDMA Development Group (CDG), 3G Papers
2. Mobile Lifestreams Limited, 3G White Paper
3. Slim Souissi, Advanced Research, Novatel Wireless, Inc.
4. Nationwidewireless.net