CDG Charter

Formed in 1993, a consortium of operator and vendor companies from around the world, involved in all aspects of CDMA and next generation wireless including advocacy, marketing, regulatory support, device availability and roaming.

To lead the rapid evolution and deployment of 3G and 4G systems, based on open standards and encompassing all core architectures, to meet the needs of markets around the world.

Operators
Subscriber Equipment
Value-Added Services
Network Infrastructure
Network Enhancement/Optimization
Network Interface & Access

Information Distribution
Technical Service Development
Deployment Assistance
Growth of CDMA is Strong

**Network Growth**
- 2007: 253
- 2009: 291

12 more networks being launched in 2009

**Subscriber Growth**
- 2008: 455 Million
- 2013: 597 Million

Over ½ billion subscribers as of June 2009

**Data Revenue Growth**
- 2007: $20 Billion
- 2008: $27 Billion

35 percent growth from top 3 CDMA carriers*

Source: CDG, August 2009


Source: Chetan Sharma, 2009

* Top 3 CDMA carriers in terms of data revenue: Verizon, KDDI and Sprint
CDMA: Strong Global Presence

CDMA2000 has built a strong ecosystem and enormous economies of scale

More than 315 operators in more than 109 countries/territories have deployed or are planning to deploy CDMA2000

502 million CDMA Subscribers

CDMA2000 will continue to be the core business offering for hundreds of operators well into the next decade

www.cdg.org
CDMA Global Operator Growth

*Number of CDMA2000 operators increased by nearly 30% in the past 3 years*

New CDMA2000 Operators per Year (Cumulative)

Most CDMA2000 operators will deploy EV-DO wireless broadband data services

www.cdg.org
Global CDMA2000 Device Shipments

CDMA2000 device shipments are expanding

As of December 2008

More than 2,110 CDMA200 devices have been commercialized by 120 suppliers

Sources: Average of ABI (Q4’08), Yankee (Q4’08), Gartner (Dec’08), IDC (Dec’08), IMS (Dec’08), iSuppli (Oct’08)
Global CDMA2000 Subscriber Forecast

CDMA2000 continues to grow at a rapid double-digit pace

CDMA2000 Subscribers Worldwide
(Cumulative)

Subscribers (Millions)

*Source: Actual CDMA Development Group
**Source: Net growth average of Strategy Analytics (Jun 2008), ABI (Aug 2008), Wireless Intelligence (Jul 2008), WCIS+ (Jul 2008), iGR (Mar 2008) and Yankee Group (Jun 2008) for subscriber forecasts (2008 and beyond) summed with CDG actual numbers of 2008
CDMA2000 Roadmap
What do operators want?

- Meet the growing demand for voice and data
- Offer an unsurpassed user experience
- Reduce the cost of delivering services
- Maximize the return on existing investments
CDMA2000 Roadmap

CDMA2000 offers a strong long-term path forward

1 Capacity increase is primarily due to new EVRC-B codec, handset interference cancellation (QLIC) and Quasi-Orthogonal Functions (QOF)
2 Capacity increase is primarily due to UL and DL interference cancellation, mobile receive diversity and several radio link enhancements.
3 Peak rate for 3 EV-DO carriers with software upgrade. Doubles network capacity or triples peak data speeds.
4 Peak rate for 3 EV-DO carriers with hardware upgrade supporting 64 QAM in the DL. Standard supports up to 15 aggregated 1.25 MHz carriers
5 DO Advanced includes smart network techniques, new device enhancements, 2x2 MIMO support, 64 QAM in the DL and 16 QAM in the UL
6 Operators have the option to only implement software upgrades
1X Advanced

Quadruples the voice capacity of today’s industry-leading CDMA2000 1X networks

CDMA2000 1X Advanced is a natural step for operators looking to lower their cost per call and free up channels for broadband data services.

Achievable Today

1X Today
- EVRC
- Single RX

1.5x Voice users

Relative capacity/sector (1.25 MHz)

New handset & channel card

4x Voice users

Without Mobile Rx Diversity

With Mobile Rx Diversity

Interference Cancellation
- BTS Interference Cancellation
- Advanced Device IC (QLIC)

Radio link Enhancements
- Efficient power control
- Early termination
- Smart blanking

1X Advanced
1X Advanced Benefits

Capacity gain enabled by 1X Advanced offers several benefits

Lower Cost per Call
Greater spectral efficiency

More Minutes of Usage
Enables increased voice offerings

More Efficient Use of Spectrum
Important for spectrum constrained markets

Meets Increased Data Demand
Frees up channels that can be used for EV-DO services
**EV-DO Evolution Path**

*EV-DO offers a practical solution to satisfy the real demand for broadband data*

**Rev. A:** High sector capacity, very good link budget and user-experience
- DL: 3.1 Mbps
- UL: 1.8 Mbps

**Multicarrier EV-DO:** A software upgrade that aggregates up to three Rev. A channels
- Triples peak data rates / Doubles network capacity

**Rev. B:** New channel card - more capacity
- DL: 14.7 Mbps
- UL: 5.4 Mbps

**DO Advanced:** More network capacity and speed
- DL: 32 Mbps
- UL: 12.4 Mbps

Operators can improve network capacity and user experience with incremental software upgrades and network optimizations
EV-DO Evolution Benefits
Selective and cost-effective software upgrades offer several benefits

- Improved User Experience
  Greater network capacity

- Investment Preservation
  Software upgrades to existing equipment

- Addresses Real-World Demand
  Incremental upgrades at site-specific locations

- Service Continuity
  Backward compatibility – No service interruptions

- Unified operation of Advanced Topology Networks
  Smart Network techniques

Note: 1. Operator demand for each enhancement varies. Some carriers may not adopt the complete set of enhancements.
Preservation of Existing Investments

Existing 3G CDMA networks are fulfilling the demand for an extensive selection of desired applications and services.
EV-DO is Driving Data Revenue Growth

Demand for EV-DO services is driving substantial data revenue per user

Verizon Wireless
Retail Data ARPU and
Data Revenue as a Percent of Service Revenue

Annual data revenues grew 33 percent over the prior year to $3.9 billion. 45.5 million of Verizon’s subscribers have 3G broadband EV-DO devices.

1 Commercial EV-DO market information based on Verizon press releases and other publicly available information, July 24, 2009
Interoperability with LTE
CDMA vs. OFDMA

CDMA and OFDMA are different technologies with different capabilities.

CDMA

- Codes are spread over the channel
  - 1.25MHz
  - 5 MHz

OFDM-Based Technologies

- Sub-carriers are independent over the channel and scale with additional bandwidth
  - 10 MHz
  - 15 MHz
  - 20 MHz

CDMA2000 1X and EV-DO are more efficient in bandwidths up to 5 MHz.

OFDMA-based solutions offers a simpler implementation in bandwidths greater than 10 MHz.

www.cdg.org
CDMA2000 and OFDM-Based Solutions

CDMA2000 is complemented with several OFDM-based solutions.

**CDMA2000 Evolution Path**

- CDMA2000 1X
- 1xEV-DO Rel. 0
- 1xEV-DO Rev. A
- H/W Upgrade
- Multicarrier Upgrade
- EV-DO Rev. B
- DO Advanced

**OFDMA-based Technologies**

- LTE
- Mobile WiMAX

LTE is part of the CDMA2000 technology roadmap.

www.cdg.org
Lessons Learned: Migration from 1G to 2G to 3G

• Takes longer, and is never as simple as it may seem
• Graceful evolutionary change is preferred
• Coverage is king
• Multimode devices are essential
• Economies of scale matters
• A mature ecosystem is desired

To sustain its exponential growth, the global mobile industry should continue strengthening and expanding its existing ecosystem, while it embraces and assimilates newer technologies and players within its fold

Source: IDC
CDMA Operators with Announced LTE plans

The following CDMA2000 operators have announced their plans to deploy LTE

Most other CDMA2000 operators do not have the requisite demand, spectrum or capital to deploy LTE
**LTE Interoperability: CDG Areas of Focus**

*Current CDG initiatives*

**Seamless Mobility:**
To ensure service continuity, inter-standard hand-offs between LTE and CDMA2000 networks is essential.

**System Determination:**
To maximize revenue, the appropriate system determination algorithms must exist in every CDMA2000/LTE device.

**Device Certification:**
To ensure full compliance, device certification from an independent third-party is sanctioned.

**Inter-Standard Global Roaming:**
To enable global roaming, inter-standard roaming between LTE and CDMA2000 networks is essential.
CDMA2000 Manufacturers Working on LTE

The following CDG members are developing LTE devices and equipment.

Infrastructure Vendors

- Alcatel-Lucent
- LG
- Huawei
- Motorola
- Nortel Networks
- Starent Networks
- ZTE

Chipset and Device Vendors

- LG
- Nokia
- Samsung
- Qualcomm

Test Vendors

- Anritsu
- SGS
- Spirent Communications

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CDMA: Efficient and Flexible Spectrum Utilization

CDMA2000’s 1.25 MHz bandwidth facilitates subscriber traffic management

Minimizes “stranded” spectrum assets required to support embedded user equipment while moving between technologies

CDMA offers greater flexibility to implement LTE
Several vendors support LTE in existing CDMA2000 base stations, with common radios & antennas
OFDMA Broadband Overlay Timeline

OFDM-based solutions will be built-out over time as demand grows and spectrum becomes available

Today

- 3G CDMA WAN Coverage

Next 10 years (Coexistence)

- OFDM Urban-zone
- 3G CDMA
- OFDM Urban-zone
- 3G CDMA
- OFDM Urban-zone

Beyond 10 years (Migration)

- OFDMA WAN Coverage

3G CDMA WAN networks will coexist with OFDM-based solutions until next generation broadband networks are fully capable of delivering:

1) Ubiquitous coverage
2) Carrier-grade VoIP
3) Low-cost devices *
4) Global roaming *

* Harmonization of spectrum for OFDM-based solutions will be necessary to build economies of scale and enable global roaming

www.cdg.org
EV-DO Evolution Periods

- Ubiquitous EV-DO Service
- Additional Capacity Femtocells VoIP
- Mature VoIP; Concurrent VoIP/Data; High-Definition Multimedia; Integration w/LTE
- Seamless LTE Handoff

% of Addressable Market

Today
2010-2011
2012
2015
2017

Source: Airvana

www.cdg.org
CDMA2000 WorldMode™ Devices
More than 200 WorldMode devices from more than 57 vendors

CDMA2000 1X + GSM + GPRS
- Nokia 2865

CDMA2000 1X + EV-DO Rev. A + GSM + GPRS
- RIM BlackBerry 8830

EV-DO Rev. A + HSPA
- Dell Precision Series

CDMA2000 1X + EV-DO Rev. A + HSPA
- LG SH-100

What Comes Next?

CDMA2000 1X + EV-DO Rev. A/B + LTE

Coming!

Samples shown, LTE WorldMode is concept only
World’s First 3G/4G WorldMode™ Device

Enables Mobile WiMAX devices to roam onto EV-DO Rev. A networks

EV-DO Rev. A + Mobile WiMAX

Franklin U300

Several CDMA2000/LTE multimode and multiband devices are being developed
Next Generation Multimode Devices

Next generation mobile broadband devices will leverage the learning curve of CDMA2000 WorldMode™ devices.

Radio Frequency Links:

- LTE
- WiMAX*
- EV-DO Rev. B
- EV-DO Rev. A
- EV-DO Rel. 0
- GPS
- 1X

Radio frequency selection is carrier-dependent.

* WiMAX is enabled using a separate chipset
** MDM 9800 and MDM 9600 chipsets will support FDD and TDD duplex modes and different carrier bandwidths.
Initial WorldMode LTE Device Availability

CDMA industry is developing CDMA2000 / LTE multimode/multiband devices

Multimode LTE
Commercial Device Availability

Modes:
- LTE
- CDMA2000 1X
- EV-DO Rev. A
- EV-DO Rev. B
- UMTS
- HSPA+

LTE Peak Data Rates (20 MHz):
- DL: 50 Mbps
- UL: 25 Mbps

PC Card
- Q4 2010

Handset
- Q2 2011
What about LTE voice communications

Most CDMA2000 operators will rely on their CDMA2000 1X network to deliver voice

LTE only for voice and data?
Or, LTE for data and 1X for traditional voice?

Factors to consider:
How important is simultaneous voice & data?
How important is an all-IP service model?
Should voice capacity be maximized?
CAPEX spending priorities?
Handset complexity?
Roaming Partners?
Timing?
Migration Timeline

With an increasing number of subscribers the migration process is lengthening

Migration of Subscribers

Putting things into perspective.
The generational migration process will take many years.
Voice will remain the most important application

For more information...

www.CDG.org
DO Advanced

Substantially improves network capacity and user experience using software upgrades, new devices and an optional hardware upgrade.

- **Software Upgrade**
  - Smart Networks
    - Smart network techniques that optimize network utilization:
      - Smart interference management and smart load balancing that exploits partial network loads

- **Software Upgrade**
  - Advanced Topology Networks
    - Smart network techniques applied to advanced topology networks: microcells, picocells, femtocells and remote radio heads

- **Infra/Standards Independent**
  - Advanced Devices
    - New device enhancements:
      - Enhanced equalizer, Reverse link transmit diversity, and Higher-order receive diversity

- **Optional H/W Upgrade**
  - Advanced Antenna Techniques
    - MIMO
    - ~15% improvement in spectral efficiency

[Link to CDG website](www.cdg.org)
Improved Performance with Advanced Topology Networks

Smart network techniques applied to pico, femto cell deployments

Network Capacity (DL) (Macro + Pico)

4.5X

EV-DO Rev. A

DO Advanced (with smart network techniques)

Source: Qualcomm simulations. Assumes 1 single carrier macro, with 2 double carrier picocells. Pico-cells are placed in high demand areas of the network. Typical loading assumed on the macro BTS. MIMO not considered.