3rd Generation Mobile Wireless

A Presentation on the Opportunities and Challenges of Delivering Advanced Mobile Communications Services

Warsaw, Poland

October 2, 2001
Contents

CDMA Development Group
3G Market Summary
3G Drivers and Key Considerations
Summary
To lead the rapid evolution and deployment of CDMA-based systems, based on open standards and encompassing all core architectures, to meet the needs of markets around the world in an emerging, information-intensive environment.
The CDG is a consortium of 110 member companies from around the world. Members are involved in many aspects of CDMA system deployment and support.
3rd Generation Mobile Wireless
Market Summary
A number of factors are driving the wireless Internet and wireless information...

Societal trends
• Emerging computer literate society
• Increasing travel and mobility
• Desire for entertainment
• Need for enhanced productivity

Technology enablers
• High speed, cost effective mobile systems
• Integrated multimedia applications
• Small, powerful, application-rich user devices

Market trends
• Rapid growth in mobile
• Rapid Internet adoption
• Accelerating pace of electronic commerce (aka M-commerce)
• Rapid growth of portable and palmtop computers
...enabling exciting vertical and horizontal applications

<table>
<thead>
<tr>
<th>Enterprise Workgroup</th>
<th>Mobile Professional</th>
<th>Consumer</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Specific IT Applications</td>
<td>• Business General</td>
<td>• Personal Interest</td>
</tr>
<tr>
<td>• Business Verticals</td>
<td>• Horizontal Business</td>
<td>• Horizontal Consumer</td>
</tr>
<tr>
<td>• Group Chat, Email, Instant Messaging</td>
<td>• Internet / Intranet</td>
<td>• Internet</td>
</tr>
<tr>
<td>• Wide Area Intranet</td>
<td>• Email, Chat, Instant Messaging</td>
<td>• Entertainment, Infotainment, Lottery, Sports</td>
</tr>
<tr>
<td>• Mobile Workforce Management (dispatch), Telematics</td>
<td>• Personal Information Management</td>
<td>• Navigation, Map Search</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Electronic Cash (M-Commerce)</td>
</tr>
</tbody>
</table>

Email, Intranet Access, Legacy Applications
Access, Vertical Applications

Weather, Travel, News, Gaming, Stock Quotes
Access to the Internet creates enormous opportunity for the wireless industry

Millions

0 200 400 600 800 1000 1200 1400 1600 1800

1999 2000 2001 2002 2003 2004 2005

Worldwide Wireless Subscribers

Wireless Data Users

Worldwide Wireless Subscribers Source: The ARC Group, Wireless Internet Report
Wireless Data Users Source: EMC Database, 2001
cdmaOne Subscriber Growth History

Worldwide total: 96,313,000

Note: prior to March 1998 the Caribbean and Mexico are included in North America; after March 1998 they are included in Caribbean & Latin America.
Looking more closely at wireless technologies, CDMA continues to grow share and is becoming a key enabler of the wireless Internet.

CDMA in the Americas accounted for 30% of the wireless marketplace while GSM was just 7%.

Worldwide, CDMA will account for 22% of the wireless marketplace.

Source: EMC Database, June 2001

CDMA (2G and 3G) will very likely be the predominant global wireless technology.
Going forward, addressable population will be a key driver of technology market share

Countries able to deploy CDMA2000 in existing cdmaOne networks represent over 4.18 billion pops

Sources: CIA World Factbook, EMC World Cellular Database June 2001, CDG 2001, Public Announcements
CDMA Development Group Confidential
Going forward, addressable population will be a key driver of technology market share.

Countries able to deploy CDMA2000 in existing cdmaOne networks represent over 4.18 billion pops.

Countries announcing CDMA2000 deployments represent 806.5 million pops.

Sources: CIA World Factbook, EMC World Cellular Database June 2001, CDG 2001, Public Announcements
CDMA Development Group Confidential
Going forward, addressable population will be a key driver of technology market share.

Countries able to deploy CDMA2000 in existing cdmaOne networks represent **over 4.18 billion** pops.

Countries announcing CDMA2000 deployments represent **806.5 million** pops.

Countries that have awarded UMTS spectrum represent only 607 Million pops:

- **J-WCDMA = 175 million**
  (Japan, Korea)
- **UMTS = 432 million**
  (Western Europe/Asia)

**Sources:** CIA World Factbook, EMC World Cellular Database June 2001, CDG 2001, Public Announcements
CDMA Development Group Confidential
3G Drivers and Key Considerations
Certain factors are critical for making 3G a success

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>✔</td>
<td>Solutions that are globally recognized and meet adopted, international standards</td>
</tr>
<tr>
<td>✔</td>
<td>Solutions that work, enable quick time-to-market and meet industry expectations</td>
</tr>
<tr>
<td>✔</td>
<td>Spectrum flexibility, efficiency and cost</td>
</tr>
<tr>
<td>✔</td>
<td>Capacity to meet future demand</td>
</tr>
<tr>
<td>✔</td>
<td>Seamless and cost effective migration from today’s systems</td>
</tr>
<tr>
<td>✔</td>
<td>Broad range of competitively-priced devices for end users (consumers, enterprises)</td>
</tr>
<tr>
<td>✔</td>
<td>Broad range of applications for end users</td>
</tr>
</tbody>
</table>

This section addresses each of these success factors
The ITU formed the IMT-2000 program to coordinate standards to meet these needs.

**IMT-2000 Terrestrial Radio Interfaces**

- **CDMA Development Group Confidential**
- **WCDMA (UMTS)**
- **CDMA2000**
- **UTRA TDD & TD-SCDMA**
- **UWC-136/EDGE**
- **DECT**

Although there are five terrestrial standards, most of the attention and energy in the industry has been toward the CDMA standards.
More importantly, 3G services are available today with CDMA2000

<table>
<thead>
<tr>
<th>Operator</th>
<th>Commercial Availability</th>
<th>CDMA2000 1X</th>
</tr>
</thead>
<tbody>
<tr>
<td>Telstra (Australia)</td>
<td>Trial 3Q 2000</td>
<td></td>
</tr>
<tr>
<td>Telus Mobility (Canada, incl. Clearnet)</td>
<td>Trial 3Q 2000</td>
<td></td>
</tr>
<tr>
<td>SK Telecom (Korea, incl. Shinsegi)</td>
<td>Oct. 1, 2000</td>
<td></td>
</tr>
<tr>
<td>Telcel (Venezuela)</td>
<td>Trial 1H 2001</td>
<td></td>
</tr>
<tr>
<td>LG Telecom (Korea)</td>
<td>May 1, 2001</td>
<td></td>
</tr>
<tr>
<td>KT Freetel (Korea, incl. Hansol PCS)</td>
<td>May 2, 2001</td>
<td></td>
</tr>
<tr>
<td>Verizon Wireless (USA)</td>
<td>2H 2001</td>
<td></td>
</tr>
<tr>
<td>ALLTEL (USA)</td>
<td>2H 2001</td>
<td></td>
</tr>
<tr>
<td>Sprint PCS (USA)</td>
<td>4Q 2001</td>
<td></td>
</tr>
<tr>
<td>KDDI (Japan)</td>
<td>4Q 2001</td>
<td></td>
</tr>
<tr>
<td>Bell Mobility (Canada)</td>
<td>4Q 2001</td>
<td></td>
</tr>
<tr>
<td>Global Telecom (Brazil)</td>
<td>4Q 2001</td>
<td></td>
</tr>
<tr>
<td>Telesp (Brazil)</td>
<td>4Q 2001</td>
<td></td>
</tr>
<tr>
<td>Vesper (WLL, Brazil)</td>
<td>4Q 2001</td>
<td></td>
</tr>
<tr>
<td>Pegaso PCS (Mexico)</td>
<td>4Q 2001</td>
<td></td>
</tr>
<tr>
<td>Telecom Mobile Limited (New Zealand)</td>
<td>4Q 2001</td>
<td></td>
</tr>
</tbody>
</table>

Sources: Company Press Releases and Statements, News Articles and Analyst Reports

Three commercial networks
More than 1 million subscribers
5,000 base stations
Data speeds 150 Kbps
Thirteen additional networks in Asia, North and South America will be launched in 2001

CDMA Development Group Confidential
Migration to 3G in Central and Eastern Europe

There are over 13 countries in Central and Eastern Europe that have operational analogue NMT 450 systems in the 450-470 MHz band. Since 1999, the NMT Association has conducted studies of the technology options available to NMT 450 operators to evolve their systems from analogue to digital, and has recommended both GSM 400 and cdma450 solutions.

To date, several NMT operators have announced trials and/or deployment of cdma450 systems:

- In Romania, Telemobil is in the process of upgrading its NMT 450 network to cdma450, and has announced plans to offer commercial services by the end of 2001.
- In Russia, Moscow Cellular (MCC) is in the process of conducting a trial of cdma450 equipment on its NMT 450 network.
- Operators in numerous other Central and Eastern European countries are in discussions with equipment providers to digitize their networks using cdma450 equipment.
- These cdma450 trials and deployments are being supported by CDMA equipment vendors Lucent Technologies and Curitel (formerly Hyundai).
Spectrum flexibility is a key consideration for any technology...

**CDMA2000 3G services operate in a small amount of spectrum**
- Effective use of spectrum, significant to ALL operators
- Effective both in overlay or greenfield deployments

CDMA2000 is not constrained to only the IMT-2000 band. Defined to operate in existing and IMT spectrum:
- 450 MHz
- 700 MHz
- 800 MHz
- 900 MHz
- 1700 MHz
- 1800 MHz
- 1900 MHz
- 2100 MHz

Spectrum flexibility, efficiency and cost
Capacity to meet future demand
Solutions that are globally recognized and meet adopted, international standards
Solutions that work, enable quick time-to-market and meet industry expectations
Solutions that are effective in existing and IMT spectrum
Solutions that provide increased capacity and cost-effective migration from today’s systems
Broad range of competitive, price-competitive and value
Broad range of applications for end users

Current Spectrum
- Analog
- cdmaOne
- TDMA
- GSM/GPRS

Or New Spectrum
- 1x
- 1x
- 1x

5 MHz
The CDMA2000 evolution path is flexible and future-proof

- Voice
- Data up to 14.4 kbps
- 2x increases in voice capacity
- Optimized, very high-speed data (Phase 1)
- Integrated voice and data (Phase 2); up to 4.8 Mbps

- Voice
- Data up to 115 kbps
- Up to 307 kbps packet data on a single (1.25 MHz) carrier
- First 3G system for any technology worldwide
- Up to 2.4 Mbps packet data on a single (1.25 MHz) carrier
- Broad range of applications for end users
Operators are faced with a few migration alternatives to 3G

1G /2G

- cdmaOne (IS-95A) (IS-95B)
- AMPS/Analog
- TDMA (IS-136)
- GSM
- NMT

New 3G Operator

3G

- Japan WCDMA
- CDMA2000
- EDGE
- Europe WCDMA (UTMS)

Best Approach to 3G

The next few slides will illustrate why the path to CDMA2000 is most beneficial for analog, TDMA, GSM and new (3G) operators by addressing:
- Basic network architecture
- Ease of migration
The architecture for CDMA2000 is quite clean.
Whereas that for GSM/GPRS/EDGE/WCDMA requires a parallel network of service nodes.
Evolving cdmaOne to CDMA2000 1X is a logical proposition

- Solutions that are globally recognized and meet adopted, international standards
- Solutions that work, enable quick time-to-market and meet industry expectations
- Spectrum flexibility, efficiency and cost
- Capacity to meet future demand
- Seamless and cost-effective migration from today’s systems
- Broad range of competitively-priced devices for end-users and enterprises
- Broad range of applications for end-users

**cdmaOne** → **CDMA2000**

- New Terminals (backward compatible)
- Software Upgrade
- New 1X Channel Card
- New Software
- PSTN
- MSC
- BSC
- BTS
- IWF
- PDSN
- IP Backbone
- WWW
- VPN
- Enterprise Network

CDMA Development Group Confidential
Evolving cdmaOne to CDMA2000 1X is a logical proposition

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- Capacity to meet future demand
- Seamless and cost-effective migration from today’s systems
- Broad range of competitively-priced devices for end users
- Broad range of applications for end users

Evolving to CDMA2000

New 1X Channel Card
New Software

New Terminals (backward compatible)
AMPS and TDMA to 3G: Practical solution to CDMA2000

AMPS to CDMA2000 1X

This path is particularly compelling due to:
- Re-use of the core network
- Ability to deploy 3G in-band, without the cost of buying new spectrum
- Ability to deploy 3G in only a small amount of spectrum

* Usually co-located with AMPS equipment, requires separate interface protocols
AMPS and TDMA to 3G: Practical solution to CDMA2000

AMPS to CDMA2000 1X

Software Update

PSTN

MSC

BTS

CDMA2000 BTS*

BSC

New Equipment

PDSN

IP Backbone

WWWW

Enterprise Network

VPN

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New Equipment with 1X Channel Card

New Off-the-shelf CDMA2000/AMPS Terminals

Solutions that are globally recognized and meet adopted, international standards

Solutions that work, enable quick time-to-market and meet industry expectations

Spectrum flexibility, efficiency and cost

Capacity to meet future demand

Savings and cost effective migration from today’s systems

Broad range of competitively priced devices for end users

AMPS and TDMA to 3G: Practical solution to CDMA2000

AMPS to CDMA2000 1X

Software Update

PSTN

MSC

BTS

CDMA2000 BTS*

BSC

New Equipment

PDSN

IP Backbone

WWWW

Enterprise Network

VPN

This path is particularly compelling due to:
• Re-use of the core network
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* Usually co-located with AMPS equipment, requires separate interface protocols
GSM to 3G: Practical solution to CDMA2000

Adding CDMA2000 1X

New Terminals
(GSM/GPRS)

GSM/ GPRS BTS

Upgrade

GSM/ GPRS BSC

Upgrade

A/lu Interface

CDMA2000 BTS*

 Upgrade to GPRS

New Equipment

CDMA2000 BSC*

GPRS and CDMA2000 are Complementary

New Terminals
(CDMA2000 1X or multimode
GSM/GPRS/CDMA2000 1X)

SGSN

New Equipment

GPRS

Backbone

Non-standard router

GGSN

Commercial IP
Router Packaged
by Vendor

Modem Pool

Commercial IP
Router by Vendor

PDSN

RADIUS
Server

IP
Backbone

WWW

VPN

Enterprise Network

* Usually co-located with 2G/2.5G equipment, requires separate interface protocols

CDMA Development Group Confidential
Solutions that are globally recognized and meet adopted, international standards

Solutions that work, enable quick time-to-market and meet industry expectations

Spectrum flexibility, efficiency and cost

Capacity to meet future demand

Seamless and cost effective migration from today's systems

Broad range of competitively-priced devices for end users (consumers, enterprises)

Broad range of applications for end users

GSM to 3G: Practical solution to CDMA2000

Adding CDMA2000 1X

New Terminals (GSM/GPRS)

GSM/GPRS BTS

Upgrade

GSM/ GPRS BSC

Upgrade

A/lu Interface

CDMA2000 BSC*

1X Channel Card

CDMA2000 BTS*

New Equipment

GPRS and CDMA2000 are Complementary

New Terminals (CDMA2000 1X or multimode GSM/GPRS/CDMA2000 1X)

SGSN

New Equipment

GPRS Backbone

Non-standard router

GGSN

Commercial IP Router Packaged by Vendor

PDSN

RADIUS Server

MSC

Commercial Server

Upgrade

CDMA2000 BSC*

A/lu Interface

Modem Pool

PSTN

Commercial IP

IP Backbone

WWW

VPN

Enterprise Network

* Usually co-located with 2G/2.5G equipment, requires separate interface protocols

CDMA Development Group Confidential
GSM to 3G: Practical solution to CDMA2000

Adding CDMA2000 1X

New Terminals (GSM/GPRS)

GSM/ GPRS BTS

Upgrade

CDMA2000 BTS*

1X Channel Card

New Equipment

GPRS and CDMA2000 are Complementary

New Terminals
(CDMA2000 1X or multimode GSM/GPRS/CDMA2000 1X)

MSC

Upgrade

A/lu Interface

CDMA2000 BSC*

PDSN

RADIUS Server

Commercial Server

IP Backbone

GPRS Backbone

SGSN

Non-standard router

GGSN

New Equipment

Commercial IP Router Packaged by Vendor

Modem Pool

PSTN

Commercial IP

WWW

VPN

Enterprise Network

* Usually co-located with 2G/2.5G equipment, requires separate interface protocols

CDMA Development Group Confidential
Multiple CDMA2000 terminal products are already available in the market

Solutions that are globally recognized and meet adopted, international standards
Solutions that work, enable quick time-to-market and meet industry expectations
Spectrum flexibility, efficiency and cost
Capacity to meet future demand
Smooth and cost-effective migration from today’s systems
Broad range of competitively-priced devices for end users
Broad range of applications for end users
CDMA terminals are reaching price parity with GSM

In a recent study comparing phones from the top tier vendors, CDMA is reaching price parity with GSM and achieving lower prices in some price tiers.

Sub-$100 phones are available for cdmaOne and GSM

cdmaOne cost curves and economies of scale directly benefit CDMA2000

Tier 1 vendors: Perceived by the market as supplying the best overall quality for a specified product at a particular price point. The most important characteristic of a Tier 1 vendor is market share. Since Tier 1 vendors normally have a strong brand, they are typically able to levy a premium for their products.

Tier 2 vendors: Regarded as providing average quality for a specified product at a particular price point. Tier 2 vendors do not obtain a premium for their products and will sell them for a price less than that charged by a Tier 1 vendor, even if product specification were similar.

Comparison of average unsubsidized wholesale terminal prices from Tier One and Tier Two manufacturers. Grouped by product tier.

<table>
<thead>
<tr>
<th>Tier1-Low</th>
<th>Tier2-Low</th>
<th>Tier1-Mid</th>
<th>Tier2-Mid</th>
<th>Tier1-High</th>
<th>Tier2-High</th>
</tr>
</thead>
<tbody>
<tr>
<td>GSM</td>
<td>$186</td>
<td></td>
<td></td>
<td>$200</td>
<td></td>
</tr>
<tr>
<td>CDMA</td>
<td>$188</td>
<td></td>
<td></td>
<td>$200</td>
<td></td>
</tr>
</tbody>
</table>


*Average Price - Source: Nokia

CDMA Development Group Confidential

**Retail Price - Source: Orange: http://www.the_order.co.uk/orange_contract/Orange_nokia_9210_contract.asp

***Retail Price - Source: Verizon Wireless
CDMA2000 terminals have a time-to-market advantage that will translate to better economies and pricing

Notes:
1. Average Q4 wholesale pricing for CDMA2000 is based on 300,000 unit shipments.
2. WCDMA pricing is based on smaller volume shipments since Gartner does not expect volume order for WCDMA until after 2003.
3. WCDMA pricing represents single mode 2.1 GHz and multimode dual band terminals for W. Europe and Asia.
4. GSM/GPRS pricing represents 900 MHz and 900/800 MHz terminals for W. Europe and Asia, plus GSM 1900 MHz terminals for N. America.
5. CDMA2000 1X pricing represents 800 MHz and 1.9 GHz, single mode, dual mode and tri-mode handsets for Asia and N. America.

Source: Gartner Group, April 2001
CDMA Development Group Confidential
CDMA enables the kind of capabilities needed to realize significant advancements in services...

- Solutions that are globally recognized and meet adopted, international standards
- Solutions that are cost effective for operators and meet industry expectations
- Spectrum flexibility, efficiency and cost
- Capacity to meet future demand
- Readiness and cost-effective migration from today’s systems
- Broad range of competitively priced solutions for end users
- Broad range of applications for end users
CDMA enables the kind of capabilities needed to realize significant advancements in services (cont.)

- Voice
- Fax
- E-Mail
- Electronic Newspaper
- Mobile Radio
- Text Messaging
- Audio Streaming
- Voicemail

Data Transmission Speed - kbps

1G Analog | 2G CDMA | 3G CDMA

- Weather, Traffic, News, Sports, Stock updates
- Electronic Publishing

Solutions that are globally recognized and meet adopted, international standards
Solutions that work, enable quick time-to-market and meet industry expectations
Spectrum flexibility, efficiency and cost
Capacity to meet future demand
Freedom and cost-effective migration from today's systems
Broad range of competitively-priced devices for end users
Broad range of applications for end users
CDMA enables the kind of capabilities needed to realize significant advancements in services (cont.)

- Text Messaging
- Audio Streaming
- Video Streaming
- High-speed Internet
- Remote Medical Service (Medical image)
- Video Conference (High quality)
- M-Commerce
- Video Surveillance, Video Mail, Travel
- Weather, Traffic, News, Sports, Stock updates
- Data Transmission Speed - kbps

1G Analog
- Voice
- Voice Mail
- Fax
- Electronic Newspaper
- Telephone (Voice)

2G CDMA
- Text Messaging
- Audio Streaming
- Mobile Radio
- Mobile TV
- Electronic Publishing

3G CDMA
- Video Streaming
- High-speed Internet
- Remote Medical Service (Medical image)
- Video Conference (High quality)
- M-Commerce
- Video Surveillance, Video Mail, Travel
...and significantly enhances the user’s wireless experience

Approximate transfer times for a 3 minute MP3 song file

<table>
<thead>
<tr>
<th>Tx Standard</th>
<th>Data Rate</th>
<th>Download Time</th>
<th>Commercial</th>
</tr>
</thead>
<tbody>
<tr>
<td>GSM</td>
<td>9.6 kbps</td>
<td>2466 (41 minutes)</td>
<td>Commercial</td>
</tr>
<tr>
<td><strong>cdmaOne</strong> (IS-95A)</td>
<td>14.4 kbps</td>
<td>1852 (31 minutes)</td>
<td>Commercial</td>
</tr>
<tr>
<td>GPRS</td>
<td>45 kbps</td>
<td>526 (8.8 minutes)</td>
<td>Commercial</td>
</tr>
<tr>
<td><strong>cdmaOne</strong> (IS-95B)</td>
<td>56 kbps</td>
<td>417 (7 minutes)</td>
<td>Commercial</td>
</tr>
<tr>
<td>WCDMA phase 1</td>
<td>56 kbps</td>
<td>417 (7 minutes)</td>
<td>??</td>
</tr>
<tr>
<td>CDMA2000 1X</td>
<td>307 kbps</td>
<td>77 (1.3 minutes)</td>
<td>Commercial</td>
</tr>
<tr>
<td>WCDMA phase 2</td>
<td>306 kbps</td>
<td>77 (1.3 minutes)</td>
<td>2004+</td>
</tr>
<tr>
<td>CDMA2000 1xEV</td>
<td>2-5 Mbps</td>
<td>13-6 (0.2-0.1 minutes)</td>
<td>2002</td>
</tr>
</tbody>
</table>

Solutions that are globally recognized and meet adopted, international standards
Solutions that work, enable quick time-to-market and meet industry expectations
Spectrum flexibility, efficiency and cost
Capacity to meet future demand
Simplicity and cost effective migration from today’s systems
Broad range of competitive, price-competitive and cost-effective solutions
Broad range of applications for end users
Summary
CDMA2000 delivers on 3G now

Commercial for one year

Over 1 million subscribers, 75% of handset sales

Handsets are available in large quantities. Color display drive sales.

Thousands of personalized services including information, entertainment, m-banking and multimedia services such as video downloads, advertisement, MP3 file transfer

Average data rates 120Kbps

Capacity increase 1.5 to 1.7 times

Handset standby time increase by 2 times

175% higher data ARPU

Video at 130 Kbps
Summary

The wireless industry is on the verge of enabling applications and services never before imagined.

Operators are faced with different alternatives for enabling these capabilities with 3G systems.

In the end, certain factors are critical to determining which alternative is most beneficial, including:

- Global recognition of the technology
- Viability of the technology, and ability to deliver
- Flexibility in solutions
- Cost competitive solutions
- Broad range of products and applications

CDMA2000 is delivering on 3G, and addresses these factors.