NTT DoCoMo WCDMA Commercial Service

- Finally Oct. 1, 2001
- Sold 4000 terminals the 1st day in Tokyo
- $400 standard
- $566 video
- $233 laptop PC card
- Game just started
We are Uniquely Positioned as a 3G Technology Enabler

- Partnership Alliance
  - Microsoft, AMD, ZTE, Capitel, Mobilecom,…

- Hold patents future (3G) wireless systems

- Development focus on WCDMA Terminal Chipsets
## Wiscom Major Milestones

<table>
<thead>
<tr>
<th>Year</th>
<th>Month</th>
<th>Events</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>5</td>
<td>Established in New Jersey, US.</td>
</tr>
<tr>
<td>2000</td>
<td>6</td>
<td>First round funding closed.</td>
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<tr>
<td>2001</td>
<td>3</td>
<td>Voice call and file transfer demo, 7 patents submitted</td>
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<tr>
<td>2001</td>
<td>4</td>
<td>Wiscom China Established in Beijing.</td>
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<tr>
<td>2001</td>
<td>5</td>
<td>Signed MOI with Mobicom for WCDMA mobile co-development.</td>
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<tr>
<td>2001</td>
<td>7</td>
<td>Signed MOI with Capitel for WCDMA L2/L3 co-development.</td>
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<tr>
<td>2001</td>
<td>8</td>
<td>Signed MOU with ZTE for WCDMA mobile development &amp; interop. test</td>
</tr>
<tr>
<td>2001</td>
<td>8</td>
<td>Signed MOU with AMD for WCDMA mobile develop. &amp; chip/stacked memory</td>
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<tr>
<td>2001</td>
<td>10</td>
<td>Signed MOU with Microsoft for 3G applications on platform &amp; standard collaboration</td>
</tr>
<tr>
<td>2001</td>
<td>10</td>
<td>True 3G high bandwidth demo over the air: Video conf, Streaming Video &amp; Web browsing on WCDMA platform</td>
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</table>
Where Are We Today?

- Analog networks have migrated to digital
- Handset volume growth outstrips PCs almost 4:1
- Subscriber base has grown to almost 700 million
- Connectivity is a major part of emerging devices—Including handsets
  - *Always connected—internet everywhere*
- Still a voice-centric network operation today, but data capabilities are emerging
  - 2.5G interim evolution: GSM (GPRS), CDMA (IS-95B, 1x),
    - TDMA (IS-136+)
  - 3G revolution will occur in multiple stages
- **We are just at the starting line.**
Mobile Devices Market
Segmentation

Modules -
Embedded Apps
Telematics /
Telemetry

Add-On
Devices

Data Devices
w/ Integral
Wireless

Business / Smart
Phones

Basic
Phones

Nokia 3330
PDQ Smart Phone
Ericsson R380
Blackberry
Palm

HandSpring Visor,
Spring Board Modules

Greater Multi-Media Capability
Larger Displays / Touch-Screens and Keyboards
Multi Wireless Modes
& Generally Higher Data Rates

Wiscom Technologies
3G Mobile Multimedia Devices

Portable Electronics Devices + Cellular Terminal = Mobile Multimedia Devices

Mobile Multimedia Devices
Inflection Points – Bandwidth

- Rare Internet use, only in text modes (9.6 kbps)
- First useful speed for graphics (28.8 kbps)
- Web more accessible, full web pages, some file downloads (56 kbps)
- Speed enables large downloads and multimedia (128 kbps)
- Close to office LAN experience; almost full network transparency (384 kbps)
Mobile Data Drives ARPU higher in Europe & US

“Killer Cocktail” emerging (3000+ applications – SMS/Email/Fax/Voice Mail, Banking/Payments, Location Based Internet Access/Info. Services Mobile Office, Telemetry/Telematics, Interactive Gaming)

Source: Qualcomm Estimates
Wireless Applications

Mail 33%
Others (eg banking) 8%
Personal homepages 6%
Gourmet/recipes 6%
Travel 6%
Ticketing/living 6%
Town information 7%
News 12%
Entertainment 16%

Source: DoCoMo survey
The Promise of 3G

- Higher bandwidth capability
  - 144-384 Kbps at mobile speeds
  - 2 Mbps at fixed locations (ITU spec)
  - 10-20 Mbps using HSDPA (3.5G)
- Future broadband applications/services
  - Internet browsing (WML, HTML)
  - Audio/video streaming multimedia (MP3, MPEG, H.3XX)
  - Location based services (GPS), e-commerce, push software technologies (ASP), and much more...
- Migration path from 2G and 2.5G technologies
- Voice/data convergence will shake up the market as wireless world merges with IP and computing world
- Worldwide coverage eventually
- 4G will be for 100 Mbps after 2010
2G to 3G Evolution Path

- TDMA (IS-136)
- GSM
- PDC
- CDMA (IS-95A)
- CDMA (IS-95B)
- GPRS
- cdma2000-1X
- cdma2000-3X
- WCDMA HSDPA
- TDD-CDMA
- Cdma2000 1X-EV

AT&T Wireless switch to GSM/GPRS

Current View

Original Plan

Wiscom Technologies
Global Telecom Market

By 2003, Wireless Voice and Internet will surpass Wired Voice and Internet

Subscribers (M)

<table>
<thead>
<tr>
<th>Year</th>
<th>Wired Voice</th>
<th>Wireless Voice</th>
<th>Wired Internet</th>
<th>Wireless Internet</th>
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</thead>
<tbody>
<tr>
<td>1997</td>
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</tbody>
</table>

Source: Salomon Smith Barney Estimates.
Wireless Expansion

Wireless explosion continues – Global subscribers to double between 2001 and 2005

Subscribers by Market (000)

Source: EMC World Cellular Database; June 2001 forecast based on actual figures to end March 2001
Western markets approaching saturation. Opportunities in emerging markets remain high.

Penetration by Market (%)

Source: EMC World Cellular Database; June 2001 forecast based on actual figures to end March 2001
China Market

China on track to becoming the world’s largest mobile market

Mobile Subscribers in China (M)

New Handset Sales in China (M)

Source: the Yankee Group
3G multimedia services will increase ARPU from $450 to $540

Keys for high ARPU strongly depend on availability of 3G technology and multimedia applications

Source: Wiscom Estimate
Market Drivers for 3G

- 2G mobile systems are reaching capacity limit
- Revenue per user for voice is declining
- New value-added services need high speed, packet data

Source: EMC statistics for 2000
Market Drivers - key decision Criteria

» Price, Price, Price. (data rates are an enabler, not a value!)

Source: Yankee Group

Affordable Service 38%
Affordable Equipment 29%
Better Coverage 9%
Ease of Use 9%
Network Reliability 9%
Content Services Other 4%
Other 2%
Affordable Service 38%

Source: Yankee Group
TDMA and PDS will phase out

IS95/cdma2000 market may have slow growth

GSM/GPRS market will reach peak during 2004 - 2005

WCDMA will gain more than 40% of market share by 2007

Source: Wiscom Estimate
Chip Vendor Success Factors

- Balanced solution: low power, high performance, low cost, targeted at several consumer form factors
- Tier-1 OEMs still drive the market, but tier-2/3 and start-up OEMs building momentum
- Drive Standardization:
  - Offer interoperability with other offload chips (GPS, Bluetooth, etc.) and multimedia application processors
  - Offer feature-rich and easy-to-use software development environment and tools
  - Offer several packages to different OEMs
- Partnerships and collaboration critical to success
- Branding activities become common
WCDMA dominates in IMT-2000 (3G)

- **WCDMA**
  - Pushed by Japanese players and GSM players
  - Will dominate based on GSM current footprint (~65%)

- **Cdma2000**
  - A natural path for IS-95 CDMA players
  - Limited growth due to current limited IS-95 footprint (~12%)

- **TD-SCDMA**
  - One option of TDD mode (1.28Mcps)
  - “home-grown” and with strong political support in China
  - Less interest outside China

- **EDGE**
  - Original GSM interim step, barely meets 3G need, viewed as 2.5G
  - Diminishing support from TDMA (IS-136) players (~ 8%)
Major PHY Differences between WCDMA and cdma2000

- Synchronization Between Base Stations
  - WCDMA uses asynch BTS → need cell search for initial synch and soft handover

- Operating Bandwidth and Chip Rate
  - WCDMA operates at 3.84Mcps over 5MHz

- Channel Structure and Rate Flexibility
  - WCDMA introduces TrCH concept for varieties of rate and QoS flexibilities
  - WCDMA rate information can be obtained via TFCI

- High Speed Packet Data
Core Product Diagram

Functional Layers

Application Layers
WAP, i-mode, TCP/IP, PDA
User Interface, Window CE, Palm OS

Layer 2/Layer 3
Medium Access Control, Radio Link Control,
Radio Resource Control,
Call Control, Mobility Management

Layer 1
Spreading, Modulation, Channel Coding,
Synchronization, Rake receiver, Searcher,
Tracker, Power control, Transport CH Processing

Associated Hardware

Micro-Controller
DSP
Special Circuit
RF

Wiscom Products
WCDMA L1 Design

RF/IF
- Pulse shaping
- RF Control
  - AGC
  - AFC
  - Power Control
    - Power management
    - timing
  - Pulse shaping
- Power setting
- Gain setting
- I-Q mux

Cell/Multipath Search
- Rake Receiver
  - De-spreading
  - Channel Estimation
  - tracking
  - Max Ratio Combining
  - Finger management
- Tx chain
  - Gain setting
  - spreading
- Interleaving

TrCH Processing
- PHY mapping
- Interleaving
- Rate matching
- Convolutional en/decoder
- Turbo en/decoder
- Compressed mode
- Vocoder

L2/L3
- UE Controller

4/25/2003
Wiscom Technologies
Wiscom Technologies

WCDMA L2/L3 Protocols

- Wiscom develops Access Stratum based on its expertise in WCDMA
- NAS will partner with GSM L2/L3 vendors where most parts can be re-used

Non-Access Stratum (NAS)

Access Stratum (AS)

L1 Chipset
WCDMA Baseband Design Process

Standards

Requirements

Architecture

Algorithms

µ-architecture

Floating point system simulation

Fixed point system simulation

Function simulation

Synthesis

VHDL programming

DSP programming

Driver & integration

Platform

Function Partition

MIPS/memory budgeting

Reference system (RF & peripherals)

ASIC-ready FPGA Prototype
Touchdown to Final Products & Systems

- ASIC-ready FPGA Prototype
  - Place & Route
  - Synthesis
  - Foundry
  - Package
  - Test
  - Test vectors
  - Evaluation board

- ASIC Reference System
  - whole phone system design support
  - whole phone system test/integration support
  - Interoperability test and field trial support

- Mobile device

Requires tremendous system know how
FPGA to ASIC vs. Straight to ASIC

- **If straight to ASIC,**
  - Functional simulation & verification can not realistically cover all the real cases or will take an unrealistic time to finish
  - Back annotation simulation will also be very slow and take a lot of resources

- **Via FPGA**
  - Design easily testable and modifiable in actual hardware
  - VHDL code is portable for most of the design
  - Parallel software development via on circuit board external DSP and Micro-processor
  - Make early lab test and field trial possible for design proof and optimization
Thank You!

Wiscom Technologies, Inc.

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