Mobile Broadband for Rural and Remote Areas
The CDMA450 Solution

Hamdi Breik
Snr Manager, Mobility Solutions, MEA
hbreik@lucent.com
22, November, 2005
Presentation Outline

1. Wireless technology evolution:
   - 3G Today & standards evolution

2. Comparative benefits of CDMA450
   - Coverage
   - Voice capacity
   - Data throughput
   - Latency
   - Key Benefits

3. Lucent’s CDMA450 solution
   - N. Architecture
   - CDMA450 products
   - Evolution to IMS

4. Business Modeling

5. Summary
History of Wireless Innovations

- 1891 John J. Carty - an early AT&T engineer “A system of telephony without wires seems one of the interesting possibilities ... the ether will transmit speech”

- Carty is regarded as the founder of the scientific tradition that led to the formation of Bell Laboratories.

- 1924: AT&T supplied mobile communications to NYC police cars.

- 1947 the concept of Cellular networks was invented in Bell Labs

First Mobile Radio Telephone
History of Wireless in Lucent

**Technology**

- 2005: Launch of UMTS
- 2004: Launch of 3G-1X EV DO Networks
- 2002: Introduction of HSPDA Trials
- 2001: Introduction of 3G-1X EV DO and UMTS Trials
- 2001: First Commercialized CDMA450 Network in Romania
- 1998: First Demonstration of Microcellular Technology
- 1995: Introduction of CDMA PCS and Cellular Systems and Airloop™ Wireless Local Loop
- 1995: Introduction of CDPD System
- 1994: AT&T Collaborator in CDMA Demonstration System
- 1993: Introduction of GSM Systems
- 1992: First Validation of TDMA
- 1992: Introduction of Intelligent Digital Base Station Technology
- 1992: First Demonstration of Microcellular Technology
- 1991: First Commercial Service on AT&T System
- 1988: First Commercial Service on AT&T System
- 1983: Bell Labs Demonstrates First Cellular System
- 1971: AT&T Proposal for Cellular Service
- 1962: Bell Labs Demonstrates First Cellular System
- 1947: Bell Labs Proposes Cellular Concept

Lucent Technologies – Proprietary - Use pursuant to company instruction

22, November, 2005
Mass Market Data Services

1G
Analog voice, L. speed data

2G
Voice, M. speed data

3G
Voice, VOIP
H. Speed packet

4G
3G+interactive video, push to view

System Impact
- Data centric
- Lower cost
- Increase data rate
- Decrease latency
- Improve uplink
Current Commercial Status of IMT-2000 Operators

CDMA is the dominant platform for IMT-2000: CDMA2000® and WCDMA

CDMA2000:
- Operators–1X: 91
- 1X-EVDO: 18

WCDMA: 68

Source: 3GToday at www.3gtoday.com as of July 31, 2005

159 Operators in 71 Countries
196 million reported* 3G CDMA subscribers
660 Devices, 56 Vendors

Lucent Technologies – Proprietary - Use pursuant to company instruction
This Will Lead to a Redefinition of the Market for Broadband Subscribers...

By 2008, end users will begin to access their chosen blended lifestyle services across these technologies, moving toward seamless converged access.

Source: Yankee Group
## Comparison of Peak and Typical Forward Link (Downlink) Data Rates

<table>
<thead>
<tr>
<th>Technology</th>
<th>Operating Environment</th>
<th>Typical Forward Link (Downlink) Speeds</th>
<th>Min Expect Throughput (NAR Study) 64 Kbps</th>
<th>384 Kbps Desired Throughput Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dial-Up*</td>
<td>Landline</td>
<td>56 kbps</td>
<td>30-50k</td>
<td>Possible Peak</td>
</tr>
<tr>
<td>Public 802.11b/g</td>
<td>Unlicensed</td>
<td>11/54 Mbps</td>
<td>20-350k</td>
<td>Typical Operating Range</td>
</tr>
<tr>
<td>GSM</td>
<td>2nd Gen</td>
<td>9.6kb</td>
<td>60-100k</td>
<td></td>
</tr>
<tr>
<td>CDMA</td>
<td>2nd Gen</td>
<td>14.4 kbps</td>
<td>60-80k</td>
<td></td>
</tr>
<tr>
<td>CDPD</td>
<td>2nd Gen</td>
<td>19.2 kbps</td>
<td>60-100k</td>
<td></td>
</tr>
<tr>
<td>GPRS</td>
<td>2nd Gen</td>
<td>114 kbps</td>
<td>30-50k</td>
<td></td>
</tr>
<tr>
<td>EDGE</td>
<td>2nd Gen</td>
<td>384 kbps</td>
<td>60-80k</td>
<td></td>
</tr>
<tr>
<td>CDMA2000 1X</td>
<td>3rd Gen</td>
<td>153.6 kbps</td>
<td>60-100k</td>
<td></td>
</tr>
<tr>
<td>1x-EV-DO Rev 0*</td>
<td>3rd Gen</td>
<td>2.4 Mbps</td>
<td>600k – 1M</td>
<td></td>
</tr>
<tr>
<td>1x-EV-DO Rev A*</td>
<td>3rd Gen</td>
<td>3.1 Mbps</td>
<td>600k – 1M</td>
<td></td>
</tr>
<tr>
<td>UMTS / WCDMA*</td>
<td>3rd Gen</td>
<td>2 Mbps</td>
<td>300 – 1M</td>
<td></td>
</tr>
<tr>
<td>HSDPA*</td>
<td>3rd Gen</td>
<td>14.4 Mbps</td>
<td>300 – 1M</td>
<td></td>
</tr>
</tbody>
</table>

*Technologies are Asymmetric i.e., Reverse link (Uplink) is less

**Text**: Messages
**Basic**: Web
**Gaming**: Moderate Audio Low Quality Video Small-medium File Transfer Common "Dial-up"
**Enhanced**: Web Hi-fi Audio Large File Transfer Data Networking
**Net Meeting**: Multi-media Messaging
**Video**: conference Mid-Res Video Streaming
**MPEG-2 Video**: High-Res Video Stream

Source: Industry reports & Lucent Analysis
Average throughput in 5 MHz (per sector per carrier)

- **cdmaOne/CDMA2000**
  - 3G1x = Third Generation CDMA System
  - TD = Transmit Diversity
  - Rel.A = Release A
  - RxD = Receiver Diversity
  - IA = Intelligent Antenna

- **GPRS/EGPRS/EDGE**
  - CS1-CS4 = GPRS Modulation Scheme
  - IR = Incremental Redundancy
  - IA = Intelligent Antenna
  - EDGE = Enhanced Data for GSM Evolution

- **UMTS/HSPDA**
  - TD = Transmit Diversity
  - HSDPA = High Speed Downlink Packet Access
  - MIMO = Multiple Input Multiple Output
Technology comparison, Erlang Capacity in 5 MHz

<table>
<thead>
<tr>
<th>Year</th>
<th>GSM</th>
<th>cdmaOne/CDMA2000</th>
<th>UMTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1995</td>
<td>9</td>
<td>9</td>
<td>47.5</td>
</tr>
<tr>
<td>1996</td>
<td>9</td>
<td>9</td>
<td>93</td>
</tr>
<tr>
<td>1997</td>
<td>9</td>
<td>17.5</td>
<td>107</td>
</tr>
<tr>
<td>1998</td>
<td>9</td>
<td>17.5</td>
<td>163</td>
</tr>
<tr>
<td>1999</td>
<td>9</td>
<td>26.4</td>
<td>163</td>
</tr>
<tr>
<td>2000</td>
<td>9</td>
<td>26.4</td>
<td></td>
</tr>
<tr>
<td>2001</td>
<td>9</td>
<td>45.9</td>
<td></td>
</tr>
<tr>
<td>2002</td>
<td>9</td>
<td>58.2</td>
<td></td>
</tr>
<tr>
<td>2003</td>
<td>9</td>
<td>99</td>
<td></td>
</tr>
<tr>
<td>2004</td>
<td>22.2</td>
<td>106.5</td>
<td></td>
</tr>
<tr>
<td>2005</td>
<td>22.2</td>
<td>106.5</td>
<td></td>
</tr>
<tr>
<td>2006</td>
<td>22.2</td>
<td>168.9</td>
<td></td>
</tr>
</tbody>
</table>

Lucent Technologies – Proprietary - Use pursuant to company instruction

22, November, 2005
Wireless Systems Latency Comparison

Low latency will enable wireless systems carry delay-sensitive Applications such as voice, interactive gaming, TV video…

![Average UDP Latency](chart.jpg)

Source: Rysavy Research, September 2004 and Qualcomm simulations
Cost per Megabyte Comparison

<table>
<thead>
<tr>
<th>Technology</th>
<th>Cost per Megabyte</th>
</tr>
</thead>
<tbody>
<tr>
<td>EV-DO (Platinum)</td>
<td>$0.005</td>
</tr>
<tr>
<td>1xEV-DO</td>
<td>$0.02</td>
</tr>
<tr>
<td>1X</td>
<td>$0.06</td>
</tr>
<tr>
<td>WCDMA</td>
<td>$0.07</td>
</tr>
<tr>
<td>EDGE</td>
<td>0.11</td>
</tr>
<tr>
<td>GPRS</td>
<td>$0.42</td>
</tr>
</tbody>
</table>

Spectral efficiency affects cost

Cost = “Greenfield” Network Operations Expenses + Depreciation on Capital

Operators Prefer Mobile Broadband Technologies that are Affordable & Evolutionary

CDMA2000 Standards Technology Evolution

- 1xEV-DO Rev A - Standards Status
  - IS-856-A, Air Interface, Complete
- QoS, VoIP Support – Standards Status
  - IS-856-A, Air Interface, Complete

Lucent Technologies – Proprietary - Use pursuant to company instruction

22, November, 2005
CDMA2000 1x – Key Benefits
CDMA2000 Key Benefits (1/3)

Technology – Low Risk.

- CDMA2000 is a superior technology that provides:
  - Third Generation Compliant according to ITU IMT-2000 standards
  - Mature, stable and proven technology, commercialized in 2000
  - Compatible with 2G/3G services, applications and interoperability
  - High Capacity, Economical Technology
    - *Average Cost per MB 2¢ and voice per Minute 0.01¢
  - High Speed Data - Peak Rate 2.4MB,
  - Excellent Voice quality, better or comparable to landline
  - Smooth evolution to future CDMA2000 releases, investment protection.
    - Forward and Backward compatible, infrastructure and handsets/devices
  - Many choices of spectrum,
    - 450Mhz, 800Mhz, 1800Mhz, 1900Mhz and 2.1Ghz
CDMA2000 Key Benefits cont (2/3).

Services and Applications.

- All GSM supplementary and telemetry services are supported including SMS, MMS, and roaming.

- High speed data service at peak rate of 2.4 Mbps can be laid over existing CDMA2000 1x sharing infra and BTS equipment.

- Due to CDMA low cost structure; Existing Operator static Services and Applications can evolve into Dynamic rich content multi-media applications.
  
  - Existing MMS and java applications work with CDMA2000
  
  - Also allowing new and innovative services applications to be deployed today to further enhance Operator differentiation.

- Operator can use CDMA2000 capacity and speed advantage for offensive or defensive strategies, example;
  
  - Enables Operator to compete much more aggressively on price.
CDMA2000 Key Benefits cont. (3/3)

Handset and Devices

– More than 650 devices are available on the market with colour displays, cameras and GPS capabilities.
– CDMA2000 handsets and devices are mature, proven and stable.
– CDMA2000 handsets are completely programmable by Operator.
  • Providing complete control to Operator on User Interface and Over The Air activation and downloading.
– Single Mode, Quad/Tri/Dual band handset for roaming between CDMA spectrum available
– Much cheaper then EDGE and UMTS with lot more choices available today.
– Small form factor, long battery life and attractive looking – come in many styles and models addressing all market segments.
  • PCMCIA type for laptops
  • Fixed Wireless terminals
  • Embedded industrial devices
Lucent’s CDMA Value Proposition

- **Unrivalled Global Market Leader in Spread Spectrum CDMA Technology**
  - Most Experienced CDMA Vendor
  - First to Support CDMA; First in North America with CDMA2000 1X
  - Extensive Contributions to Standards
  - Extensive Intellectual Property

- **Lucent .... A CDMA Leader**
  - Lucent Has Deployed Over 148,000 CDMA Base Stations (1995 to October 2005)
  - Lucent has deployed Over 98,000 3G CDMA Base Stations (October 2005)
  - Lucent is No. 1 with over 42% Global CDMA subscribers share (Jan 2005)
  - Over 70 customers in 22 countries
    - Customers includes: Verizon Wireless, Sprint PCS, Telecom NZ, Telcel, KTF, China Unicom, Reliance India, Tata India, Telecard Pakistan

Over 98,000 of 148,000 Deployed Base Stations Are Equipped with CDMA2000 1X Technology Today
CDMA Wireless Revenue Share

<table>
<thead>
<tr>
<th>Company</th>
<th>4 Qtrs Ending 2Q03</th>
<th>4 Qtrs Ending 2Q04</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nortel</td>
<td>23.6%</td>
<td>21.2%</td>
</tr>
<tr>
<td>Samsung</td>
<td>11.9%</td>
<td>8.4%</td>
</tr>
<tr>
<td>Motorola</td>
<td>14.4%</td>
<td>18.7%</td>
</tr>
<tr>
<td>Ericsson</td>
<td>5.2%</td>
<td>4.2%</td>
</tr>
<tr>
<td>Alcatel</td>
<td>3.0%</td>
<td>3.7%</td>
</tr>
<tr>
<td>Others</td>
<td>3.3%</td>
<td>2.5%</td>
</tr>
<tr>
<td>Lucent</td>
<td>38.6%</td>
<td>41.3%</td>
</tr>
</tbody>
</table>

Source: Dell’Oro, 2Q 2004

Lucent continues to maintain #1 position

Lucent Technologies – Proprietary - Use pursuant to company instruction

22, November, 2005
CDMA450 – Theoretical Cell Sizes

CDMA450 provides larger cell sizes when compared to cell sizes in other bands.

<table>
<thead>
<tr>
<th>Frequency (MHz)</th>
<th>Cell Radius (Km)</th>
<th>Cell Area (Km²)</th>
<th>Normalized Cell Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>450</td>
<td>48.9</td>
<td>7521</td>
<td>1</td>
</tr>
<tr>
<td>850</td>
<td>29.4</td>
<td>2712</td>
<td>2.8</td>
</tr>
<tr>
<td>1900</td>
<td>13.3</td>
<td>553</td>
<td>13.6</td>
</tr>
<tr>
<td>2500</td>
<td>10</td>
<td>312</td>
<td>24.1</td>
</tr>
</tbody>
</table>

*NOTE: The above ‘theoretical’ cell sizes may not be able to achieve in certain morphologies and are based on simplistic assumptions.*
CDMA450, 1xEV-DO, Very High Speed Data

- Laid over 3G1X
- Data speed up to 153 KBPs on reverse and up to 2.4 MBPs for Forward links
- Future evolution to EV-DV, i.e.

Lucent Technologies – Proprietary - Use pursuant to company instruction

22, November, 2005
# Flexent CDMA450 BTS Products

<table>
<thead>
<tr>
<th></th>
<th>Modcell 2.0</th>
<th>Compact 3.0</th>
<th>Modcell ES</th>
<th>Modcell 4.0 Compact</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Footprint</strong></td>
<td>910x1010x1800mm (36x40x72in)</td>
<td>600x600x1200mm (24x24x50in)</td>
<td>600x600x1800mm (24x24x72in)</td>
<td>650X600X1200 (31X24X50)</td>
</tr>
<tr>
<td><strong>Weight (kg)</strong></td>
<td>410</td>
<td>260</td>
<td>300</td>
<td>260</td>
</tr>
<tr>
<td></td>
<td>For maximum capacity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Sectors</strong></td>
<td>1-3</td>
<td>1-3</td>
<td>1-3</td>
<td>1-3</td>
</tr>
<tr>
<td><strong>Carriers</strong></td>
<td>1-2 (w/ growth to 3)</td>
<td>1</td>
<td>1-3</td>
<td>1-3</td>
</tr>
<tr>
<td><strong>1xEV-DO</strong></td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>T1/E1</strong></td>
<td>12</td>
<td>4</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td><strong>Illustration</strong></td>
<td><img src="image1" alt="Modcell 2.0" /></td>
<td><img src="image2" alt="Compact 3.0" /></td>
<td><img src="image3" alt="Modcell ES" /></td>
<td><img src="image4" alt="Modcell 4.0 Compact" /></td>
</tr>
</tbody>
</table>
### “Footprint” Key to 4G

<table>
<thead>
<tr>
<th></th>
<th>CDMA2000</th>
<th>UMTS W-CDMA</th>
</tr>
</thead>
<tbody>
<tr>
<td>EV-DO</td>
<td>802.11/16 Interop.</td>
<td>802.11/16 Interop</td>
</tr>
<tr>
<td>Revision A EV-DO</td>
<td>HSDPA-EUDCH</td>
<td></td>
</tr>
<tr>
<td>SoftSwitch/MG</td>
<td>SoftSwitch/MG</td>
<td>VoIP/QoS/MPLS</td>
</tr>
<tr>
<td>VoIP/QoS/MPLS</td>
<td>BLAST/MIMO</td>
<td>BLAST/MIMO</td>
</tr>
<tr>
<td>Base Station Routers</td>
<td>Base Station Routers</td>
<td>BASE STATION ROUTERS</td>
</tr>
</tbody>
</table>

---

Lucent Technologies – Proprietary - Use pursuant to company instruction

22, November, 2005
Packetize the Core Network

1. Packet Tandem/Gateway
2. IP backhaul
3. TrFO/RTO on FPS

High Speed Data – enterprise & mass market

2. Data transfer speeds comparable to DSL, cable
   - Bring the office experience to road warrior
   - Cost effective alternative to DSL, cable in remote situation

IMS for new services

3. Access independent network – same services anywhere
   - Centralized servers speed deployment and provide common user experience
   - Multimedia services to end users

Voice over IP (VoIP)

4. Capacity greater than circuit voice
   - Voice integrated with Operatorer media in new services
   - Common infrastructure, lower cost

Lucent Technologies – Proprietary - Use pursuant to company instruction
Access Independent IMS Network

Convergence!
Nice but still horribly complicated

Lucent Technologies – Proprietary - Use pursuant to company instruction
Network of networks

Service Provider “Home” Network

Billing

Mobility

Authentication

Common backend infrastructure for 802.11, 3G, and MobileHotSpot

Core IP Network

3G Access Network

802.11 Access Network

Loosely coupled architecture allows independent deployment of 802.11 and 3G networks into IP core network

3G Wide-Area Wireless Coverage

3G Wireless Backhaul to MobileHotSpot

Handoff

User Terminals w/ 802.11 & 3G dual-mode capability & Mobile Client software

802.11 Local Area Wireless Hotspot Coverage

802.11 Hotspot on train, bus

Lucent Technologies – Proprietary - Use pursuant to company instruction
CDMA2000 Devices

Voice Centric
- Mono tone
- Camera
- MMS
- 100K pixel

Messaging
- Camera
- MMS
- 100K pixel

Interactive Multimedia
- Camcorder
- VoD/MOD
- Games phone
- 100K pixel

Digital Convergence
- Video telephone
- Digital TV
- WiFi
- Smartphone
- 300K-mega pixel CCD
- Voice recognition
Business Modeling Framework

**Business Model**

- **Revenues**
  - Market Size
  - Market Share
  - Churn
  - Services Mix
  - MOU/Mb
  - ARPU
  - Interconnection

- **Total Cost of Ownership**
  - CAPEX
    - Architecture
    - Network Design
    - Hardware
    - Software
    - Installation
    - Construction
  - OPEX
    - Maintenance
    - Training
    - Utilities
    - Backhaul Lease
    - Site Rental
    - Interconnect
  - SG&A/Others
    - G&A
    - Handset/PC card
    - Cust. Acquisition
    - Customer Care
    - Billing
    - Insurance
    - Fraud

**Financials**

- Tax Rate, Interest Rate, Discount Rate, Depreciation, Amortization, Study period

Lucent Technologies – Proprietary - Use pursuant to company instruction

22, November, 2005
Advanced Business Modeling

**Inputs**
- Technical
  - Network Specifications
  - Operational Data
  - Traffic Models
  - Engineering Rules
- Economic
  - Subscriber Forecast
  - Ground Rules & Constraints
  - Product Information
  - Competitive Environment

**Outputs**
- -- Analysis --
  - Traffic Data Analysis
  - Network Growth Configuration
  - Multi-year Product Mix
  - Total Cost of Ownership
  - Revenue Modeling
  - End User Segmentation
  - Financial Modeling and Analysis
- -- Results --
  - Cash flow
  - Break-even points
  - Total Revenue
  - Total Cost of Ownership
  - Sensitivity Analysis

Lucent Technologies – Proprietary - Use pursuant to company instruction

22, November, 2005
## Business Case Results

**5 Year NPV = S$64M**

**Breakeven Point at 2.5 Years**

<table>
<thead>
<tr>
<th></th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Revenues</strong></td>
<td>$35</td>
<td>$70</td>
<td>$86</td>
<td>$113</td>
<td>$136</td>
</tr>
<tr>
<td><strong>Capex</strong></td>
<td>$(36)</td>
<td>$(13)</td>
<td>$(11)</td>
<td>$(10)</td>
<td>$(10)</td>
</tr>
<tr>
<td><strong>Opex</strong></td>
<td>$(18)</td>
<td>$(26)</td>
<td>$(31)</td>
<td>$(37)</td>
<td>$(42)</td>
</tr>
<tr>
<td><strong>EBITDA</strong></td>
<td>$17</td>
<td>$44</td>
<td>$55</td>
<td>$76</td>
<td>$94</td>
</tr>
<tr>
<td><strong>FCF</strong></td>
<td>$(25)</td>
<td>$15</td>
<td>$(26)</td>
<td>$40</td>
<td>$53</td>
</tr>
<tr>
<td><strong>Cumulative NPV</strong></td>
<td>$(23)</td>
<td>$(11)</td>
<td>$8</td>
<td>$34</td>
<td>$64</td>
</tr>
</tbody>
</table>

Note: Cash flows occur at the end of year for NPV calculations.
Summary

- CDMA2000 1x is Mature, stable and proven technology
- Lucent is a CDMA leader #1 with over 148,000 BTS deployed worldwide
- CDMA2000 1x can offer wireless broadband services with mobile environment up to 153 Kbps and up to peak of 2.4 Mbps with an over-laid EV-DO
- CDMA2000 1x provides the capacity, coverage and quality needed for urban and rural applications plus future proof Compatible with future developments and evolution path to VOIP, IMS…
- CDMA450 is widely used for WLL applications which allows operators to:
  - supplement cable network in urban areas and
  - provide quickly and cost effectively Telephone service to needy rural areas
  - More suppliers keep entering the CDMA450 market
- In addition to 450 MHZ, CDMA 1x can be deployed on many different frequency bands. e.g. 850, 1900, 700 MHZ……..
Thank you