Giving Voice to the World

Pushing the Envelope on Handset Integration to Support Emerging Markets for Ultra-Low Cost Phones

Bill Krenik, PhD
Manager, Advanced Architectures
Wireless Terminals Business Unit
Wireless Meets Africa

Humanitarian and Business Benefits

- Reduction of poverty
- Social development
- Market development
- Access to healthcare

Farmers used to walk around for hours looking for working pay phones to call markets and find the best prices for their fruit – with mobile phones they can now easily link up with customers, brokers and the market.
Ultra-Low Cost Handsets Enable Growth in Emerging Markets

- **GSM Association:** Handset cost is a critical barrier
  - Mobile networks cover 80% of the world’s population
  - ~5 billion people are in cellular range; only 25% use cellular
  - Next billion customers to come from emerging markets
  - GSMA set initial tender for $40 handset price point; now at <$30 handset

- **Several hundred million ultra-low cost handsets expected by 2010**

Source: GSMA

Emerging Markets Growth

<table>
<thead>
<tr>
<th>Region</th>
<th>2004 Shipments</th>
<th>2008 Shipments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eastern Europe</td>
<td>66%</td>
<td>59%</td>
</tr>
<tr>
<td>China</td>
<td>26%</td>
<td>98%</td>
</tr>
<tr>
<td>India</td>
<td>36%</td>
<td></td>
</tr>
<tr>
<td>Undeveloped Asia/ME</td>
<td></td>
<td></td>
</tr>
<tr>
<td>South America</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Forward Concepts, Global Cellular Handset & Chip Markets, April 2005
Expanding Global Reach

**Phase 1**
Handsets delivered to operators in:
- India
- South Africa
- Nigeria
- Democratic Republic of Congo
- Egypt
- Algeria
- Tunisia
- Bangladesh
- Turkey
- Thailand
- Philippines
- Malaysia
- Indonesia
- Pakistan
- Yemen
- Sri Lanka
- Kenya

**Phase 2**
Handsets will be delivered to operators in:
- Rwanda
- Uganda
- Swaziland
- Cameroon
- Zambia
- Cote d'Ivoire
- Kazakhstan
- Pakistan
- Russia
- Ukraine
- Algeria
- Iraq
- Lesotho
- Mozambique
- Tanzania

Source: GSMA
Phase 1: Sub $40

- Participants are operators in countries with GNP per capita below the World Bank average and mobile penetration below 60%
- Other hurdles to be addressed include taxation, payment mechanisms, and regulatory issues
- Handsets delivered to operators in 17 countries representing 1.8 billion people

Phase 2: Sub $30

<table>
<thead>
<tr>
<th>Specs</th>
<th></th>
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<tbody>
<tr>
<td>Handset form</td>
<td>Candy bar</td>
</tr>
<tr>
<td>Weight</td>
<td>3.04 oz (86 g)</td>
</tr>
<tr>
<td>Talk time</td>
<td>450 minutes</td>
</tr>
<tr>
<td>Stand-by time</td>
<td>330 hours</td>
</tr>
<tr>
<td>Availability</td>
<td>Early 2006</td>
</tr>
<tr>
<td>Features</td>
<td>SMS, pre-loaded games, alarm, calculator, stopwatch, currency converter</td>
</tr>
</tbody>
</table>

Source: GSMA
Silicon Cost is a Major Factor in Overall Phone BOM

Portelligent estimates that silicon accounts for 31% of phone cost

SG Cowen estimates that silicon for a typical GSM phone is 26% of phone cost
Typical Cell Phone Block Diagram

LNA → RX Synth → TX
PA

Radio CODEC → Digital Baseband Logic
Memory

User Interface

Power Management

Passives

Audio → Display

SiGe BICMOS
Hi Voltage
Analog CMOS
Deep Submicron Digital
FLASH EEPROM
Discrete Passives: SAW Filters, Inductors

Technology for Innovators™

Texas Instruments
TI Digital RF Processor Technology

TI DRP™ technology integrates major cell phone functions into single-chip

1/2 the silicon
1/2 the power
1/2 the board area

Lower-priced handsets
Increased system performance
Improved battery life
Sleeker form factor
Moore's Law

- Feature size shrinks by 70% each generation
- Generations occur about every 2 years

34 Years of Scaling History

Modern CMOS
Beginning of Submicron CMOS
Deep UV Litho
90 nm in 2004
1st 65 nm in 2005
Presumed Limit to Scaling
SOC Technology – Not an Easy Task

System Design & Algorithms

DRP™ Technology – RF, Analog, and Digital Circuit Design (LNA, PLL, DAC, ADC)

Wafer Process Technology (90nm, 65nm, 45nm Digital RF process)

Single-Chip System

Manufacturing Expertise (300mm, test flow)

Applications Processing & MCS Technology

65nm transistor

Technology for Innovators™

Texas Instruments
Single-Chip Solution
Key Milestones

- 1997 – TI initiates DRP™ Technology research
- June 2001 – World’s first single-chip solution, TI’s BRF 6100
- February 2004 – 1st phone call on DRP test chip
- March 2005 – 1st phone call on fully functional single-chip solution
- August 2005 – 1st phone call on a commercial network (from India to Europe)
Integrating to Deliver the Most Competitive and Flexible Product Portfolio

Technology Legacy

<table>
<thead>
<tr>
<th>130nm</th>
<th>2003</th>
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<tbody>
<tr>
<td>GPS</td>
<td>BT</td>
</tr>
<tr>
<td>BB</td>
<td>BB&amp;RF</td>
</tr>
<tr>
<td>GPS</td>
<td>BB</td>
</tr>
<tr>
<td>RF</td>
<td>BB&amp;RF</td>
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<tr>
<td>GPS</td>
<td>BB</td>
</tr>
<tr>
<td>BT</td>
<td>BB&amp;RF</td>
</tr>
<tr>
<td>WLAN</td>
<td>BB</td>
</tr>
<tr>
<td>RF</td>
<td>BB&amp;RF</td>
</tr>
<tr>
<td>BB&amp;RF</td>
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<tr>
<td>GT</td>
<td>RF</td>
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<table>
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<td>BB&amp;RF</td>
<td>BB&amp;RF</td>
</tr>
<tr>
<td>GSM/GPRS</td>
<td>GSM/GPRS</td>
</tr>
<tr>
<td>BB</td>
<td>BB&amp;RF</td>
</tr>
<tr>
<td>DTV</td>
<td>BB&amp;RF</td>
</tr>
<tr>
<td>BB&amp;RF</td>
<td>WLAN</td>
</tr>
<tr>
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<td>BB</td>
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<tr>
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<table>
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<th>2006</th>
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<tbody>
<tr>
<td>GPS</td>
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<td>BB&amp;RF</td>
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<tr>
<td>BPR</td>
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<td>GSM/GPRS</td>
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<tr>
<td>SDR</td>
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<td>BT</td>
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<table>
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<th>2007</th>
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<tr>
<td>2008</td>
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Technology for Innovators™

Texas Instruments
SoC Integration Extends Growth of Wireless

Moore’s Law Predicted to stagnate in the next decade

... but SoC Integration can continue IC cost reduction and perpetuate growth of Wireless
Giving Voice to the World

- Low cost strategy has both humanitarian and business benefits

- DRP™ SoC technology and aggressive deep sub-micron node scaling (65nm today!) are essential to the ultra low cost market

- Technology from the low cost market is finding its way into other market segments