WTC 2012
Challenges and Innovations in LTE Deployment

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• InterDigital Overview
• Key Trends
• Key Challenges in LTE
• Innovative Solutions for LTE Deployment
• Summary
4G

As a long-standing contributor to the wireless industry, we solve many of the most critical and complex technical challenges years ahead of market deployment.

InterDigital develops fundamental wireless technologies that are at the core of mobile devices, networks, and services worldwide.

Our advanced solutions support more efficient wireless networks, a richer multimedia experience, and new mobile broadband capabilities.
• ~ 180 engineers developing technology used in every cellular wireless device
• Portfolio of 18,500 issued patents and applications at year-end 2010
  – Covering a wide range of technologies, including 2G, 3G, 4G / LTE and IEEE 802
  – 50% of 3G market under license at year-end 2010; 80% of 2G market licensed historically
  – Strong 4G / LTE portfolio
• Cash and short-term investments of $690 million\(^1\); third quarter 2011 revenues $76.5 million
• Approximately $2 billion market cap\(^2\)

1. As of September 30, 2011
2. As of November 22, 2011

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Tomorrow’s Network of Networks

Billions of subscribers  ●  Trillions of connections  ●  Seamlessly connected and fully integrated
KEY TRENDS
• Mobile ecosystem exists to drive LTE Adoption:
  – Applications drivers: Web access, HD video streaming, TV Everywhere
  – LTE lowers the cost/bit compared to previous generations
  – Consumers are willing to pay
  – Availability of devices (Smartphones, Tablets, PCs and CE)
  – Device & application ease of use for consumer

• LTE adoption ramp is faster than 3G
• Several networks have been deployed
• LTE offers cost and spectrum efficiencies
Mobile Ecosystem will Fuel LTE Growth

Mobile video traffic will exceed 50% of the total for the first time in 2011.

Last year’s mobile data traffic was 3x the size of the entire global Internet in 2000. Global mobile data traffic grew 2.6-fold in 2010, nearly tripling for 3rd year in a row.

In 2010, 3 million tablets and 94 million laptops were connected to the mobile network. Each tablet generated 5x and each laptop generated 22x more traffic than the average smartphone.

Growing availability of easy-to-use tablet, e-reader and smartphone devices

Lower backhaul costs and increased spectral efficiency means LTE has significant cost savings over prior technologies.

<table>
<thead>
<tr>
<th></th>
<th>2G</th>
<th>3G</th>
<th>3.5G</th>
<th>4G (LTE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Backhaul Cost per GB</td>
<td>$12.00</td>
<td>$4.00</td>
<td>$3.00</td>
<td>~$2.50</td>
</tr>
<tr>
<td>Cost Savings (vs. previous iteration)</td>
<td>-</td>
<td>3.0x</td>
<td>1.3x</td>
<td>1.2x</td>
</tr>
<tr>
<td>Max Link Spectral Efficiency (bit/s/Hz)</td>
<td>0.52</td>
<td>2.50</td>
<td>3.44</td>
<td>16.32</td>
</tr>
<tr>
<td>Efficiency Gain (vs. previous iteration)</td>
<td>-</td>
<td>4.8x</td>
<td>3.4x</td>
<td>1.9x</td>
</tr>
</tbody>
</table>

Source: Company data, Goldman Sachs Research estimates.
LTE Adoption Happening Faster than 3G

• In its 1st 5 years, LTE adoption is expected to grow at 2x the rate of 3G in its first 5 years

• Deployments are happening across the globe at a rapid rate
LTE cost-per-bit represents a 4-10x improvement compared to 3.5G technologies

Source: Motorola Whitepaper, “Motorola LTE, Beyond Mobile Broadband”
LTE Will Enable Larger Broadband Adoption

Source: Telco 2.0 New Mobile, Fixed and Wholesale Broadband Business Models Report
CHALLENGES STILL REMAIN...
Key Challenges

- Bandwidth crunch
  - Existing bands will not be enough for IMT services after year 2015
  - Video will be the dominant traffic source

- CAPEX/OPEX Crunch
  - Mobile voice era business model does not work anymore in face of Declining voice revenue, Exponential data growth, OTT service competition and New regulations

- Support of emerging cloud architectures

- Asymmetric networks cannot support two-way communications.

- Non uniform coverage and user experience

- Spectrum fragmentation – High number of LTE bands
FRAGMENTED AND COSTLY SPECTRUM
“Spectrum fragmentation has the potential to hinder global LTE roaming…”

“The lack of spectrum harmonization represents a key challenge for the emerging LTE ecosystem…”
OUR TECHNOLOGY SOLUTIONS TO THE CHALLENGE
Bandwidth Management and Dynamic Spectrum Management
Addresses BW Crunch, Reduces CAPEX/OPEX, Improves Coverage & User Experience

- Expanded Wi-Fi with Dynamic Spectrum
- Direct Link with Dynamic Spectrum
- Mitigating Macro cell interference and increasing capacity with Dynamic Spectrum
- Expanding cell capacity with Unlicensed + Dynamic Spectrum
- Network A
  - Spectrum Management Client
  - PHY & MAC level aggregation across licensed, unlicensed, and white space in one radio technology
- Network B
- Network C
- Expanding Wi-Fi with Dynamic Spectrum
- Cellular
- Dynamic Spectrum Management
  - Extending Cellular coverage with Dynamic Spectrum
  - Repeated signals
  -Licensed spectrum
  -Dynamic Spectrum (DS)
  -Unlicensed Spectrum

Bandwidth Management
- Bandwidth switching, aggregation, segregation, and mobility across networks at the IP level
VIDEO AWARE WIRELESS NETWORK AND WIRELESS AWARE VIDEO NETWORKS IMPROVES POWER, COST AND QOE
Cross-layer optimization for video over wireless

Addresses Bandwidth Crunch, Improves User Experience and Reduces Terminal Power Consumption - >3X
NETWORK VIRTUALIZATION REDUCES OPEX AND CAPEX
Network Virtualization - Move the Mobile Network into the Cloud

Significantly reduce deployment and operation costs by virtualizing the physical wireless network infrastructure and creating a customizable virtual network slice abstraction (75% CAPEX cost reduction).

Common Mobile Network interfaces across all operators
Segregated between bulk service, and per user transaction interfaces

Operators share the CNs to form the “Global Mobile Cloud”
Operators share the RAN

New Generation of Virtualized Service Providers (independent from the traditional Mobile Operators)
COVERAGE AND CAPACITY ENHANCEMENTS
Coverage and Capacity Improvements

**Cellular Controlled Device to Device**

- **BS Power Distribution**
  - BS1: 1, 2, 3
  - BS2: 1, 2, 3

**Advanced Multi-Site Carrier Aggregation**

- 45% cell edge gain*
- 35% cell average gain*

2X Cell Edge Capacity Gains for both Uplink and Downlink
5X Reduction in required Base station density for 95% coverage
Summary

• LTE Ecosystem of devices, networks and services are thriving, but challenges still remain.
• Key challenges: Opex, Capex, power consumption, business model and growing demand for bandwidth.
• We have developed solutions to these challenges and are taking it to standards body for mass market deployment.
• We are open for collaboration
THANK YOU