Overview on mobile broadband technologies

EBU workshop on mobile broadband technologies
12th May 2011
Qualcomm
About our role and convergence
Outline

Technology vision

- Mobile bands and air interface evolution
  - What’s next?
  - HSPA, HSPA+, HSPA Advanced, LTE, LTE Advanced, LTE TDD

- Spectrum mapping

- MBB for the delivery of mobile multimedia
  - Supplemental downlink
  - eMBMS
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Mobile: Biggest Platform in History of Mankind

Wireless Subscribers

3G Subscriptions Now

>1B

3G Subscriptions by 2014

~2.8B

Operators Committed to LTE

~196

Countries

75

LTE Networks Launched

23

Note: 3G includes CDMA2000, WCDMA and TD-SCDMA. Source: Wireless Intelligence estimates as of Nov. 2, 2010 for the quarter ending Sep 30, 2010; *number of unique wireless connections. Sources: Global Mobile Suppliers Association (GSA) (April 16, 2010)/UMTS Forum
2G to 3G migration is happening

Western Europe handsets sales (m)

Western Europe subscribers (m)

Consolidated analyst views
Worldwide Mobile Broadband Spectrum

**Bandwidth Deployment Options**

<table>
<thead>
<tr>
<th>FDD Blocks/ Spectrum band</th>
<th>5 MHz</th>
<th>10 MHz</th>
<th>20 MHz</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.5/2.6 GHz</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>2.1 GHz</td>
<td></td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>(1.7 or 1.9 uplink)</td>
<td></td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>1.5, 1.7, 1.8, 1.9 GHz</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>900 MHz</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>800/850 MHz</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Digital Dividend</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>(700 to 800 MHz)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1Usable spectrum blocks for product implementation. 2IMT extension 2500 to 2690 MHz, 70 MHz+70 MHz FDD in most countries. 3Digital dividend; Region 1 (Europe, Middle East and Africa) 790-862 MHz, Region 2 (Americas) 698-806 MHz. Region 3 (Asia) – some 698-790 MHz (e.g. China, India, Japan, Bangladesh, Korea, New Zealand, Papua New Guinea, Philippines and Singapore) others 790-806 MHz
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Radio Link Improvement is Slowing, What is Next?

- **HSPA+** (Evolved 3G)
- **HSPA** (Data optimized 3G)
- **3G (IMT-2000): WCDMA** (Voice & Data)
- **2G: GSM** (Digital Voice)
- **1G: Voice** (Analog Voice)

Approaching the theoretical limit
Network Topology Gain

The Next Significant Performance Leap
Increasing spectral efficiency per coverage area
Multiple Antennas Gain

- Complements beamforming
  - Higher gain typically closer to NodeB
- Small changes to beamforming
  - Both features standardized in R11

1 Source: Qualcomm simulation for closed loop beamforming. 3GPP framework PA3, 4UEs per cell, 2.8km ISD. Shows data throughput gain for the median and the 5% worst (Cell edge) users. Gain depends on propagation environment and the UE speed with lower gain for faster moving users. The open loop gain would be slightly less.
**Smart Networks/Het Nets**

**Extends benefits to 5 MHz deployments**

- **F1: 5MHz**
- Dual-Carrier Device

**Benefits multiple carrier deployments**

- **F1: 5MHz**, **F2: 5MHz**
- 2x to 4x Multicarrier Device

**Range expansion—more users benefit from small cells**

- **Added small cells**
- More overlapping coverage with small cells—Multipoint effectively expands its range¹

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¹Benefits HetNets (mix of macro networks with added small cells like picocells) due to more overlapping coverage with small cells.
Carrier Aggregation

Spectrum Examples:

- **2.1 GHz** (Band I)
- **1900 MHz** (Band II)
- **1800 MHz** (band III)
- **1700 MHz** (Band IV)
- **900 MHz** (Band VIII)
- **850 MHz** (Band V)

Aggregated Data Pipe

Up to 40 MHz

Across bands R9
4x DL in R10¹
8x DL in R11

Additional spectrum bands and band combinations continuously defined in 3GPP²

¹With 4x multicarrier in R10 (and 8x in R11), carriers within the same band need to be adjacent and inter-band aggregation can span two different bands.
²E.g., support for band XI (1500MHz Japan) combinations has been added and band III (1800MHz) is being added, beyond 4X combinations expected to be added in R11.
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HSPA+: The Natural Evolution at a Lower Cost

Incremental and cost-effective upgrade

Large and Growing Device Ecosystem
HSPA  >3071 device models with more than 262 suppliers

Deployed Worldwide on a Large Scale
WCDMA >400 networks,  > 632 million subs
HSPA  >398 networks,  > 342 million subs in over 130 countries

HSPA+ leverages existing investments and large ecosystem

Source: Global Mobile Suppliers Association (GSA) www.gsacom.com, April 2011, WCDMA subs include HSPA. HSPA and WCDMA as of Q4 2009
LTE Boosts Data Capacity in Dense Urban Areas

- 3G provides ubiquitous data coverage and voice
- Seamless service continuity with 3G from day one
- 3G/LTE multimode devices required

3G Coverage

Evolved 3G ensures similar user experience outside LTE coverage
LTE Leverages New and Wider Spectrum

Available in smaller bandwidths

Best suited to leverage new and wider bandwidths

LTE relative performance decreases with bandwidth due to higher overhead; 40% overhead in 1.4 MHz vs. 25% in 20 MHz results in 25% better relative performance in 20 MHz vs. 1.4 MHz.

LTE-TDD Optimal Technology for Unpaired Spectrum

TDD 2:1 shown as an example. LTE also supports half-duplex.
Parallel Evolution Paths of HSPA and LTE

- **Rel-99** (WCDMA) - 1.8-14.4 Mbps DL, 5.7 Mbps UL
- **Rel-5** (HSDPA) - 28 Mbps DL, 11 Mbps UL
- **Rel-6** (HSUPA) - 42 Mbps DL, 11 Mbps UL
- **Rel-7** - 84 Mbps DL, 23 Mbps UL (10 MHz)
- **Rel-8** - 168 Mbps DL, 23 Mbps UL (20 MHz)
- **Rel-9**
- **Rel-10** - 168 Mbps DL, 23 Mbps UL (20 MHz)

**Note:** Estimated commercial dates. LTE launch assumes multimode devices.
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European Mobile Spectrum

All potential future bands

- **800 MHz**: 791 - 821 MHz
- **900 MHz**: 880 - 960 MHz
  - **FDD**: 880 - 915 - 925 MHz
  - **TDD**: 1710 - 1785 MHz
- **1.8 GHz**: 1805 - 1880 MHz
- **2.1 GHz**: 1920 - 2110 MHz
- **2.6 GHz**: 2500 - 2690 MHz
- **1.4 GHz** (DL): 1452 - 1492 MHz
- **1.9 GHz**
- **2 GHz** (TDD): 2010 - 2025 MHz
- **2.6 GHz** (TDD): 2570 - 2620 MHz
- **3.5 GHz** (Uplink): 3400 - 3600 MHz

Legend:
- **Uplink**
- **TDD**
- **Downlink**
- **Undefined**
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Mobile Traffic Typically Downlink Centric

NEED MORE DOWNLINK CAPACITY

MAJORITY OF TRAFFIC ON DOWNLINK (DL)¹

MORE DOWNLOAD, MORE VIDEO AND RICH MEDIA TO NEW DEVICE SEGMENTS

¹ Based on measurements in live networks. Median shown. ²Uplink is also important, not only for capacity reasons: downlink improvement can be used to extend coverage. Faster TCP/IP feedback on the uplink means faster downlink. Applications like social networking will drive more uplink data.
Supplemental Downlink Addresses Traffic Asymmetry

- Leverage unpaired spectrum for more downlink capacity
- Carrier Aggregation (CA) is enabled in: HSPA+ R9\(^1\) (and beyond) or LTE R10\(^1\) (and beyond)

L-Band\(^3\) (1.4/1.5 GHz) key opportunity
- Harmonization possible in Europe and beyond, with up to 40 MHz of unpaired spectrum
- Other opportunities, such as 700MHz in the US, depend upon country-specific spectrum situations

\(^1\)Aggregation across bands is supported in HSPA+ R9 (and beyond) and LTE R10 (and beyond), but each specific band combination, e.g. combination of band 1 and L-band, has to be defined in 3GPP.
\(^3\)L-Band in Europe: 1452 MHz to 1492 MHz, sometimes referred to as 1.4GHz or 1.5GHz spectrum
LTE and HSPA+ support Supplemental Downlink

1 Carriers must be adjacent to each other
2 Support for aggregation across specific bands must be defined by 3GPP but is release-independent
3 Supported DL carriers combinations (Anchor+SDL) are (1+2), (1+3), (2+2)
4 Supported DL carriers combinations are not defined yet

Note: Estimated commercial dates.
LTE R10 capabilities for SDL
Aggregation 40 MHz to 100 MHz, across frequency bands

- Increased data rates and lower latencies for all users in the cell
- Data rates scale with bandwidth—Up to 1 Gbps peak data rate
  - Aggregating 40 MHz to 100 MHz provide peak data rates of 300 Mbps to 750 Mbps\(^1\) (2x2 MIMO) and over 1 Gbps (4x4 MIMO)

\(^1\)LTE R8 supports 4x4 MIMO, which enables 300 Mbps in 20 Mhz. Theoretically, LTE Advanced can support over 1Gbps peak data rates by aggregating at least 4 20 MHz carriers (up to 100 MHz of spectrum) using 4x4 MIMO.
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eMBMS Enables “Broadcasting” on LTE

- evolved Multimedia Broadcast Multicast Service
- Delivers multicast/broadcast capacity to mass audiences for rich media and video content
- 3G/LTE provide ubiquitous data coverage and voice
Overview of eMBMS for LTE

TDM of unicast/Multicast-broadcast

up to 60% subframes for multicast/broadcast
Conclusion

A lot more than convergence
Conclusion

A lot more than convergence

Convergences?
Conclusion

A lot more than convergence

Synergies?
Questions

QUESTIONS?