Solving the Global LTE Multimode and Multiband Challenge

4G World
October 2012
Global LTE Devices Start with Cellular Multimode

Gobi Multimode Integration Enables Global Reach and Seamless Mobility

17 LTE Voice Modes

100% Gobi Support

Source: Qualcomm Technologies, Inc
Leading LTE Technology Portfolio
Already on Third Generation of LTE

**First Generation**
World’s First Integrated LTE/3G Modem Chips
- MDM9200
- MDM9600
- 6 modes supported

**Second Generation**
World’s First Mobile Platform (8960) with integrated LTE/3G Multimode
- MDM9x15
- MSM8960
- Supports all 7 global standards

**Third Generation**
World’s First Integrated LTE/3G Modem with Cat4 and Carrier Aggregation
- MDM9x25

**Support of All Modes, All Bands, Performance Evolution**

Source: Qualcomm Technologies, Inc.
### High Level Multimode Options for LTE Voice Support

<table>
<thead>
<tr>
<th>Initial Launches</th>
<th>Initial Voice Solution</th>
<th>Long Term Voice Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data Devices</td>
<td>LTE Data Handsets</td>
<td>LTE VoIP Handsets</td>
</tr>
<tr>
<td><strong>LTE for Data Only</strong></td>
<td><strong>LTE for data 2G/3G for voice</strong></td>
<td><strong>Simultaneous LTE VoIP and rich data services</strong></td>
</tr>
<tr>
<td>LTE / 3G / 2G Multimode</td>
<td>Dual Radio 1x Voice + 3G/4G Data</td>
<td>VoLTE with Single Radio Voice Call Continuity</td>
</tr>
<tr>
<td>(Redirection, PS Handover)</td>
<td>Circuit Switched Fallback to 2G/3G CS Voice and Data</td>
<td>VT and RCS Enabled Services and Apps</td>
</tr>
<tr>
<td></td>
<td></td>
<td>+ CSFB for Roaming</td>
</tr>
</tbody>
</table>

2G/3G Coverage Continuity and Roaming
4G LTE Voice Capabilities

Snapshot of Global LTE Voice Support

- Dual Radio
  - 1x SVLTE
    - CSFB
      - FDD
        - 1x
      - TDD
    - 1x
    - GSM
    - UMTS
  - 1x
    - GSM
    - UMTS
    - TDS

- VoLTE
  - FDD
    - Single Mode
    - 1x SRVCC
    - GSM SRVCC
    - UMTS SRVCC
  - TDD
    - Single Mode
    - 1x SRVCC
    - GSM SRVCC
    - UMTS SRVCC
    - TDS SRVCC

- = Commercially released feature
- = In planning, development or under consideration

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Handset Radio Frequency Band Trends
Supported by Qualcomm Single Chip RF Solutions

Number of Bands in Handsets

- 2G
- Early 3G
- 3G Today
- 4G Multimode

- 2G
- 3G
- 4G
Leading RF solutions from QTI

RF Integration and Footprint Reduction
UMTS/GERAN → UMTS/GERAN/1x/DO/LTE → All 7 cellular Standards including TD-SCDMA

- Single chip **multimode/multiband** with integrated RxD and GPS
- **RTR8600**
- **MDM 9x00**
- **MDM 9x15**
- **WTR1605L**
- Single chip **world mode** with integrated RxD and GPS

- **RTR6285**
- Single chip **multiband/multimode** with integrated RxD and GPS

- **2007**
- **2010**
- **2012**
Global LTE Multimode ~40 Bands Required (some examples)

**North America**
- UMTS/CDMA AWS
- UMTS/CDMA1900
- UMTS/CDMA850
- Extended AWS
- LTE700
- TD-LTE2600 (B41)
- MSS2100 (S-band)

**South America**
- UMTS2100
- UMTS1800
- UMTS1900
- UMTS850

**Europe**
- UMTS2100
- UMTS900
- CDMA450
- LTE1800
- UMTS1800
- UMTS2600
- LTE800
- LTE2600-FDD
- TD-LTE2100 (B34)

**China**
- UMTS/CDMA2100
- CDMA850
- CDMA450
- TD-SCDMA1900
- TD-LTE2300
- TD-LTE 2600 (B38)

**India**
- CDMA850
- UMTS2100
- UMTS900
- TD-LTE2300

**Japan**
- CDMA/UMTS850
- UMTS/CDMA2100
- UMTS1700
- UMTS/LTE1500 (B11)
- LTE1500(B21)
- LTE850
- LTE900
- TD-LTE2600 (Bxx)

**Australia**
- UMTS850
- LTE850
- UMTS900
- LTE1800
- LTE2600

**South Korea**
- UMTS850
- UMTS2100
- CDMA1700

Example combinations shown above. Source: Qualcomm Technologies, Inc.
LTE Modes for Data and Voice Services (regional examples)

North America
- LTE FDD/UMTS/GERAN
- LTE FDD/CDMA2000
- LTE TDD/CDMA2000
- Dual Radio (1xSVLTE)
- FDD CSFB (UMTS, GSM)
- FDD/TDD CSFB (1x)
- VoLTE
- VoLTE/SRVCC (UMTS)
- VoLTE/SRVCC (1x)

Europe
- LTE FDD/UMTS/GERAN
- CSFB (UMTS, GSM)
- LTE TDD/UMTS/GERAN
- VoLTE/SRVCC (UMTS, GSM)

China
- LTE TDD/FDD/TD-SCDMA/GERAN
- LTE FDD/UMTS/GERAN
- LTE/CDMA2000
- Dual Radio (SGLTE)
- TDD CSFB (GSM, TD-SCDMA)
- FDD CSFB (UMTS, GSM)
- FDD CSFB (1x) or 1xSVLTE
- FDD/TDD VoLTE/SRVCC

Japan
- LTE FDD/UMTS
- LTE FDD/CDMA2000
- LTE TDD/UMTS
- CSFB (UMTS)
- Dual Radio (1xSVLTE)
- CSFB (1x)
- VoLTE/SRVCC (UMTS)
- VoLTE/SRVCC (1x)

South Korea
- LTE FDD/UMTS
- LTE FDD/CDMA2000
- CSFB (UMTS)
- Dual Radio (1xSVLTE)
- VoLTE
- VoLTE/SRVCC (UMTS)

Australia
- FDD LTE/UMTS
- CSFB (UMTS/GSM)
- VoLTE/SRVCC (UMTS)

India
- LTE TDD/UMTS/GERAN
- FDD LTE/UMTS/GERAN
- FDD LTE/EV-DO
- CSFB (UMTS)

South America
- LTE TDD/UMTS/GERAN
- FDD LTE/UMTS/GERAN
- TDD CSFB (UMTS/GSM)
- TDD CSFB (1x)

Legend:
Black text: Known Configurations
Purple text: Anticipated Configurations

Example combinations shown above. Source: Qualcomm Technologies, Inc.
LTE Advanced: Carrier Aggregation Overview

- Cat4 150 Mbps requires contiguous 20 MHz
- Very few operators have this LTE spectrum asset
- Carrier Aggregation combines fragmented spectrum
- Accelerates LTE migration to 150 Mbps
- Higher peak and average user data rates
- 30+ combinations considered in 3GPP

- Lead chipset (third gen LTE):
## LTE Advanced: Carrier Aggregation Combinations

### Interband Configurations

<table>
<thead>
<tr>
<th>Interband Configurations</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Band 1 + Band 5</td>
<td>Completed</td>
</tr>
<tr>
<td>Band 3 + Band 7</td>
<td>ongoing</td>
</tr>
<tr>
<td>Band 4 + Band 13</td>
<td>ongoing</td>
</tr>
<tr>
<td>Band 4 + Band 17</td>
<td>ongoing</td>
</tr>
<tr>
<td>Band 20 + Band 7</td>
<td>ongoing</td>
</tr>
<tr>
<td>Band 5 + Band 12</td>
<td>ongoing</td>
</tr>
<tr>
<td>Band 4 + Band 12</td>
<td>ongoing</td>
</tr>
<tr>
<td>SDL + Band 2</td>
<td>ongoing</td>
</tr>
<tr>
<td>Band 2 + Band 17</td>
<td>ongoing</td>
</tr>
<tr>
<td>Band 4 + Band 5</td>
<td>ongoing</td>
</tr>
<tr>
<td>Band 5 + Band 17</td>
<td>ongoing</td>
</tr>
<tr>
<td>Band 1 + Band 7</td>
<td>ongoing</td>
</tr>
<tr>
<td>Band 3 + Band 5 (DL only)</td>
<td>ongoing</td>
</tr>
<tr>
<td>Band 3 + Band 5 (UL and DL)</td>
<td>ongoing</td>
</tr>
<tr>
<td>Band 4 + Band 7</td>
<td>ongoing</td>
</tr>
<tr>
<td>Band 20 + Band 3</td>
<td>ongoing</td>
</tr>
<tr>
<td>Band 20 + Band 8</td>
<td>ongoing</td>
</tr>
<tr>
<td>Band 1 + Band 21</td>
<td>ongoing</td>
</tr>
<tr>
<td>Band 1 + Band 19</td>
<td>completed</td>
</tr>
<tr>
<td>Band 11 + Band 18</td>
<td>ongoing</td>
</tr>
<tr>
<td>Band 1 + Band 18</td>
<td>ongoing</td>
</tr>
<tr>
<td>Band 3 + Band 8</td>
<td>ongoing</td>
</tr>
<tr>
<td>Band 4 + Band 12</td>
<td>New</td>
</tr>
</tbody>
</table>

### Intraband

<table>
<thead>
<tr>
<th>Intraband</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Band 1 (intra-band CA)</td>
<td>Ongoing</td>
</tr>
<tr>
<td>Band 40 (intra-band CA)</td>
<td>Ongoing</td>
</tr>
<tr>
<td>Band 41 (intra-band CA)</td>
<td>Completed</td>
</tr>
<tr>
<td>Band 38 (intra-band CA)</td>
<td>ongoing</td>
</tr>
<tr>
<td>Band 7 (intra-band CA)</td>
<td>ongoing</td>
</tr>
<tr>
<td>Band 25 (intra-band CA, non contiguous)</td>
<td>ongoing</td>
</tr>
<tr>
<td>Band 3 (intra-band CA, non contiguous)</td>
<td>ongoing</td>
</tr>
<tr>
<td>Band 4 (intra-band CA, non contiguous)</td>
<td>new</td>
</tr>
<tr>
<td>Band 1 (intra-band CA, contiguous)</td>
<td>new</td>
</tr>
</tbody>
</table>

Source: 3GPP
## HSPA+ Multicarrier Band Combinations

<table>
<thead>
<tr>
<th>Combo</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Band 2 (4)</td>
<td>Completed</td>
</tr>
<tr>
<td>Band 1 (4)</td>
<td>In Process</td>
</tr>
<tr>
<td>Band 1 + Band 8 (2+2)</td>
<td>In Process</td>
</tr>
<tr>
<td>Band 1 + Band 3 (3+1)</td>
<td>In Process</td>
</tr>
<tr>
<td>Band 1 + Band 3 (2+1)</td>
<td>In Process</td>
</tr>
<tr>
<td>Band 5 (3)</td>
<td>In Process</td>
</tr>
<tr>
<td>Band 1 + Band 3 (2+2)</td>
<td>In Process</td>
</tr>
<tr>
<td>Band 1 + Band 11 (2+2)</td>
<td>In Process</td>
</tr>
<tr>
<td>Band 2 + Band 4 (3+1)</td>
<td>In Process</td>
</tr>
<tr>
<td>Band 9 (3)</td>
<td>In Process</td>
</tr>
<tr>
<td>Band 9 (4)</td>
<td>In Process</td>
</tr>
<tr>
<td>Band 2 + Band 5 (1+2)</td>
<td>In Process</td>
</tr>
<tr>
<td>Band 2 + Band 5 (1+1)</td>
<td>Completed</td>
</tr>
<tr>
<td>Band 1 + Band 11 (1+1)</td>
<td>Completed</td>
</tr>
<tr>
<td>Band 1 (3)</td>
<td>Completed</td>
</tr>
<tr>
<td>Band 1 + Band 5 (1+1, 2+1, 2+2)</td>
<td>Completed</td>
</tr>
<tr>
<td>Band 2 + Band 4 (1+1, 1+2, 2+1, 2+2)</td>
<td>Completed</td>
</tr>
<tr>
<td>Band 1 + Band 8 (1+1, 2+1, 3+1)</td>
<td>Completed</td>
</tr>
</tbody>
</table>

Source: 3GPP
Many Facets of Seamless Mobile Broadband

Integrated Global LTE Multimode Solutions

**Multimode**
- LTE FDD
- LTE TDD
- UMTS
- EV-DO
- CDMA 1X
- TD-SCDMA
- GSM/EDGE

**Carrier Aggregation**
(30+ configurations)
- 700/850/900
- 1500/1700/1900
- 2300/2600

**Multiband**
(Up to 40 bands)

**Integration**
**Coexistence**
**Interworking**

**Multi-Technology**
- Wi-Fi
- GNSS
- BT

**Seamless Interworking Across Broadest Set of Technologies and Bands**
Thank You

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