Building LTE Device Economies of Scale

Joe Lawrence
Vice President
CDG
November 15, 2012
Global industry body representing the interests of:

331 CDMA2000 and LTE operators in 121 countries as well as and their suppliers worldwide
Today, there are 331 CDMA2000 operators in 121 countries. More than 210 EV-DO operators; with more deployments planned. 14 LTE operators in 4 countries.

625M+ CDMA2000 subscribers worldwide as of December 2011
39M+ LTE subscribers worldwide November 2012

CDMA2000 operators are responsible for the majority of LTE’s initial growth.

Note: * Forecast
Sources: Informa WCIS+, Global Mobile Daily, CDG, Deutsche Bank, operator data

Source: IHS iSuppli Research, November 2012
Evolution Path

A roadmap that includes CDMA, LTE and Wi-Fi technologies

CDMA2000 Evolution Path

CDMA2000 1X

1xEV-DO Rel. 0

1xEV-DO Rev. A

Multicarrier EV-DO

H/W Upgrade Rev. B

DO Advanced

1X Advanced

1X Rev. F

OFDMA-based Technologies

LTE

LTE-A

Wi-Fi (802.11 a/b/g)

Wi-Fi (802.11 b/g/n)

Bridging the mutual interests of:

CDMA2000

LTE

Sources: CDG November 2012
CDG: LTE Initiatives

- eHRPD Interoperability
- Seamless Data Mobility
- Device RF Links
- System Determination
- Spectrum Assignments and Aggregation
- Device Procurement and Aggregation
- Inter-Standard Global Roaming
- Voice Service Continuity
CDMA and LTE in the USA

Up to 62 CDMA2000 operators
49 EV-DO Rev. A networks
8 LTE networks

184M+ CDMA2000 subscribers as of Jun 2011
More than 19.6M LTE subscribers as of November 2012

U.S. Market: Wireless Technology Market Share

- CDMA2000 1X/EV-DO
- GSM/UMTS/HSPA
- LTE

Sources: CDG, CTIA and Chetan Sharma, November 2012
CDMA2000/LTE Networks

14 CDMA operators commercially launched LTE, another 24 announced their plans

Commercial

Announced

Nearly 8 out 10 LTE subscribers worldwide use the services offered by the operators above.

Most of the other CDMA2000 operators worldwide do not yet have the requisite demand, spectrum or capital to deploy LTE.

Source: CDG, November 2012
The bulk of LTE subscriptions today are in the United States, Korea and Japan. Mass market economies of scale will be attained once China and India have fully deployed LTE.
LTE Spectrum Harmonization
### LTE Band Classes

So far, 28 FDD and 12 TDD bands have been defined for LTE ... more to come

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No fewer than 11 bands are expected to be used for LTE in Asia Pacific alone. All regions will see deployments in multiple bands.”

*Julian Bright, Senior Analyst, Networks, Informa*

LTE spectrum harmonization is needed to reduce the barriers to economies of scale
In the United States alone, operators have deployed or plan to deploy LTE in the:

- 700 MHz 3GPP bands (Band Classes 12, 13, 14, 17);
- 850 MHz cellular band (Band Class 5);
- Original PCS band (Band Class 2);
- PCS Block G (Band Class 25);
- AWS-1 band (Band Class 4);
- Potential AWS-4 band (Band Class 23);
- Original 800 MHz iDEN band (Band Class 26); and
- BRS band (Band Class 41)

A Block (transmitting at Channel 52 and receiving at Channel 57), B Block (transmitting at Channel 53 and receiving at Channel 58), and C Block (transmitting at Channel 54 and receiving at Channel 59) must occur in the face of high-power signals transmitted from the E Block (Channel 56) and TV Channel 51.3

The operative difference between Band 17 (which applies to the B and C Blocks) and Band 12 (which applies to the A, B, and C Blocks) is the filtering requirements that devices on each band must meet under 3GPP standards. Band 17 requires a narrower filter than does Band 12, in an effort to reduce the threat of interference from the E Block and Channel 51.5 The narrower Band 17 filter provides far more attenuation of E Block and Channel 51 signals than the Band 12 filter by using the two A Block frequencies (Channels 52 and 57) as de facto 6 MHz guard bands. Because Band 12 has no such guard bands, current filtering technology can provide virtually no attenuation of the E Block or Channel 51 signals.

Source: CDG, November 2012
# FDD-LTE Commercial Deployments

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**Notes:**
- 700 MHz: 5Ghz band.
- 800 MHz: 698-960 MHz
- 1500 MHz: 1700-2200 MHz
- 1600 MHz: 1800-1900 MHz
- 1700 MHz: 1900-2100 MHz
- 1800 MHz: 1900-2100 MHz
- 1900 MHz: 1900-2100 MHz
- 1900 G: 1900-2100 MHz
- 2100 MHz: 2100-2200 MHz
- 2600 MHz: 2600-2700 MHz
- 3500 MHz: 3500-3600 MHz

**Countries:**
- Australia
- Brazil
- Canada
- China
- Germany
- Denmark
- Finland
- Germany
- H.K.
- Japan
- Norway
- Philippines
- Poland
- Portugal
- Russia
- S. Arabia
- Singapore
- S. Korea
- Sweden
- U.K.
- USA
# TDD-LTE Commercial Deployments

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<td>Sweden</td>
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<td>U.K.</td>
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</table>

Source: CDG, November 2012
Solution: Use of Common LTE Bands

Today, the two dominant LTE frequency band assignments are 1800 MHz FDD (Band 3) and 2.5 GHz FDD (Band 7)

Use of the 1800 MHz and 2600 MHz bands accounts for 62% of all commercial LTE deployments today
**LTE Global Reach**

Multiple iPhone 5 SKUs to serve multiple markets

**A1428**
- AT&T
- **GSM/EDGE**
  - 850, 900, 1800, 1900 MHz
- **UMTS/HSPA+/DC-HSDPA**
  - 850, 900, 1900, 2100 MHz
- **LTE**
  - Bands 2, 4, 5 and 17

**A1429 (CDMA)**
- **CDMA2000 1X/1X Adv./EV-DO Rev. A/B**
  - 800, 1900, 2100 MHz
- **GSM/EDGE**
  - 850, 900, 1800, 1900 MHz
- **UMTS/HSPA+/DC-HSDPA**
  - 850, 900, 1900, 2100 MHz
- **LTE**
  - Bands 1, 3, 5, 13 and 25

**A1429 (GSM)**
- **GSM/EDGE**
  - 850, 900, 1800, 1900 MHz
- **UMTS/HSPA+/DC-HSDPA**
  - 850, 900, 1900, 2100 MHz
- **LTE**
  - Bands 1, 3 and 5 (13 & 25 unused)

**Notes:**
- Enabled up to five LTE band classes for the existing base of large LTE operators
- European 800 MHz and 2600 MHz bands are not supported yet
- Each LTE BC needs to be FCC certified, which may cost upwards of $100K each
Projected LTE Global Spectrum Usage

Economies of scales will gravitate to the four most common BCs

Source: Tolaga Mobile Market Explorer, 2012
**Preferred LTE Bands for Roaming**

Roaming is an important factor in selecting LTE frequency assignments

<table>
<thead>
<tr>
<th>North America</th>
<th>Latin America</th>
<th>Europe</th>
<th>APAC</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>3 (1800 MHz)</td>
<td>3</td>
</tr>
<tr>
<td>4 (AWS)</td>
<td>4</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>7 (2600 MHz)</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>12 (includes BC 17)</td>
<td>12</td>
<td></td>
<td></td>
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<tr>
<td>13 (VZW)</td>
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<tr>
<td>14 (Public Safety)</td>
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<td></td>
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<tr>
<td>17 (AT&amp;T)</td>
<td></td>
<td>20</td>
<td></td>
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<tr>
<td>25 (includes BC 2)</td>
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<td></td>
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<tr>
<td>26 (includes BC 5)</td>
<td></td>
<td></td>
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<tr>
<td><strong>APT (BC28, 700 MHz)</strong></td>
<td><strong>APT</strong></td>
<td><strong>APT</strong></td>
<td></td>
</tr>
<tr>
<td><strong>38 (TDD 2600 MHz)</strong></td>
<td><strong>APT (China)</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
LTE Devices
CDMA2000/LTE Smartphones
CDMA2000 1X, EV-DO Rev. A and LTE multimode devices

- Apple iPhone 5
- Coolpad Quattro
- HTC Droid Incredible
- HTC Evo 4G LTE
- HTC Titan
- HTC Rezound
- HTC Thunderbolt
- HTC One VX
- HTC One X
- HTC One X+
- HTC Vivid
- Huawei Asciva
- Huawei Ascend
- Huawei Transform
- LG Connect
- LG Escape
- LG Esteem
- LG Intuition
- LG Lucid
- LG Motion
- LG Nitro HD
- LG Optimus
- LG Revolution
- LG Spectrum
- LG Viper
- Motorola Atrix 4G
- Motorola Droid 3
- Motorola Droid Bionic
- Motorola Droid Razr
- Motorola Razr HD
- Motorola Razr M
- Motorola Razr Maxx
- Motorola Razr Maxx HD
- Motorola Photon Q
- Nokia Lumia 900
- Pantech Breakout
- Pantech Burst
- Pantech Flex
- Pantech Marauder
- Pantech Sky Vega
- Samsung Craft
- Samsung Droid Charge
- Samsung Focus 2
- Samsung Galaxy S Aviator
- Samsung Galaxy S II
- Samsung Galaxy S III
- Samsung Galaxy Attain
- Samsung Galaxy Exhilarate
- Samsung Galaxy Express
- Samsung Galaxy Indulge
- Samsung Galaxy Lightray
- Samsung Galaxy Note
- Samsung Galaxy Nexus
- Samsung Galaxy Rugby Pro
- Samsung Galaxy Victory 4G
- Samsung Stratosphere
- ZTE Anthem

Note: Not an all inclusive list
RF Front End Modules will boil down to three frequency ranges:

- 700 – 900 MHz
- 1700 – 1900 MHz
- 2100 – 2600 MHz

Source: Wireless Intelligence, December 2011
LTE Device Availability by Frequency (cont.)

Larger markets will drive greater device availability

Networks by Frequency, 1Q2012

- 700 MHz
- AWS
- 2100 MHz
- 2600 MHz
- 800 MHz
- 2300 MHz TDD
- 900 MHz
- 2600 MHz TDD (BC41)
- 1800 MHz
- 2600 MHz TDD (BC40)

Source: Informa Telecoms Media, GSA and CDG
LTE Device Aggregation
**LTE Purchasing Power**

Supply and demand plays an important role in creating economies of scale

<table>
<thead>
<tr>
<th>Type of Operator</th>
<th>Typical Purchase Volume</th>
<th>Smartphone Price Range</th>
<th>OEM Revenue Opportunity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tier 1</td>
<td>1-2M</td>
<td>$450-550</td>
<td>&gt; $450M</td>
</tr>
<tr>
<td>Tier 2</td>
<td>100-200K</td>
<td>$500-600</td>
<td>&gt; $50M</td>
</tr>
<tr>
<td>Tier 3-5</td>
<td>1-10K</td>
<td>$550-650</td>
<td>&gt; $0.5M</td>
</tr>
</tbody>
</table>

*Note: Hypothetical case, not actual numbers*

**Smaller operator purchasing power is limited by access to capital and device subsidies**
The Need for Device Aggregation

To Remain Competitive

To Create Economies of Scale

To Expand Your Product Portfolio

To Build Strength Through Synergy
Device Aggregation

Device aggregation with a single SKU creates economies of scale

- Increases production volumes
- Reduces development and test costs, while improving time-to-market

CDG facilitates aggregation efforts by leveraging its knowledge and relationships with operators, distributors and OEM/ODMs worldwide

- Has successfully executed multiple device aggregation efforts
- Gathers operator requirements and identifies available products
- Facilitates aggregated purchases using MoUs
- The terms and conditions of the master agreement are agreed to by all parties
- All commercial transactions are between the operator and the OEM
- All devices will be shipped directly to the operator via a distributor
Device Aggregation Process

What type of device do you want to aggregate?
- Select from categories

What devices are currently available?
- Within a price range

Select the device you want to aggregate

How many of these devices do you want?
- Within the price range
- Purchasers sign and submit MoU to CDG

Summation of the aggregated purchase volume
- Based on MoUs collected by CDG

Obtain Price from OEM based on aggregated volume
- OEM submits Pricing MoU to CDG
- Price is based on standard terms:
  - FOB Hong Kong
  - Payment terms
  - Warranty period
  - Spare part replacement rate
  - Delivery period

Price and standard terms are forwarded to Buyers
- CDG forwards OEM Pricing MoU to Buyers
- Buyers obtain a Supply Agreement from the OEM

OEM forwards Standard Supply Agreement to Buyers
- Appendices define the product, price, quantity, billing address, shipping address

Buyers issue Purchase Orders
- All modifications and customization requests are specified in the P.O.
- All devices are shipped by OEM directly to the Buyers
Wrap-up
A Well Connected Device

The challenge is to support all of the 3GPP and 3GPP2 frequency assignments

Devices that operate across multiple networks to deliver most services
4G connections will grow the fastest, but the overwhelming majority will be 3G

**2016 Global Connections, 8.21B**

- **UMTS-HSPA**: 5.54B
- **GSM/EDGE**: 1.15B
- **LTE**: 780M
- **CDMA**: 575M
- **TD-SCDMA**: 164M

**LTE** will account for 8% of total global connections

Sources: Informa Telecoms & Media, GSA, GSMA, Machina Research, Statistica and CDG
Thank You