The Digital Dividend
Technological Perspective

Geraldo Neto, Manager Government Affairs
Montevideo, June 1st 2012.

Fortune 500 Company
Celebrating more than 25 years of driving the evolution of wireless communications
Making wireless more personal, affordable and accessible to people everywhere
World's largest fabless semiconductor company, #1 in wireless
Member of the S&P 100 & 500 Indexes
Snapdragon Processors Are Complete
Built Smarter to Work Smarter

Qualcomm Designs, Integrates and Delivers all the Pieces
Bridging the Digital Divide in Emerging Regions

- **12%** PC Installed Base
- **5%** Fixed Internet Penetration
- **78%** Mobile Penetration

Source: Qualcomm data.
Connecting Places, People and Things

**Calling Places**
e.g. Calling home
"Are you there?"

**Connecting People**
e.g. Calling friends
"Where are you?"

**Internet in Your Pocket**
e.g. Informed Social Network
"What’s up?"

**Internet of Things**
e.g. Fridge tells you you are out of milk

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**Global Connectivity**

**Personal Mobile**

**Context-aware Services**

**Inflection points**

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**1000x Data Challenge**

Spectrum is key to solve it

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Source: Ericsson
Growth in Data Traffic

Mobile Data Traffic Growth

Until 2010–2020**

2010-2015

10-12x

2010–2020**

1000x

*Strategy Analytics 2011    ** DoCoMo, 11/2010

Mobile Data Traffic Demand

Example

BRAZIL NEEDS 1060 MHZ OF SPECTRUM UNTIL 2020

Source: Cisco Visual Networking Index, ITU, Anatel.
New Spectrum Bands are Needed

Spectrum Demand vs. Availability in Brazil (MHz)

All international studies (i.e. ITU, GSMA, Anatel) indicate the need for more spectrum for mobile services in Brazil.

IMT (3G/4G) Bands

<table>
<thead>
<tr>
<th>Frequency Band</th>
<th>Specific Band Pairing (MHz)</th>
<th>Common Names (not official names)</th>
</tr>
</thead>
<tbody>
<tr>
<td>450 MHz</td>
<td>450 - 470</td>
<td>450 MHz</td>
</tr>
<tr>
<td>700 MHz</td>
<td>698 – 862 (varies)</td>
<td>Various</td>
</tr>
<tr>
<td>800 MHz</td>
<td>824 - 849 / 869 - 894</td>
<td>800 MHz or cellular band</td>
</tr>
<tr>
<td>900 MHz</td>
<td>890 - 915 / 935 - 960</td>
<td>900 MHz or GSM 900</td>
</tr>
<tr>
<td>1700 MHz</td>
<td>1750 - 1780 / 1840 - 1870</td>
<td>Korean PCS band</td>
</tr>
<tr>
<td>1800 MHz or 1.8 GHz</td>
<td>1710 - 1785 / 1805 - 1880</td>
<td>DCS 1800 band</td>
</tr>
<tr>
<td>1900 MHz or 1.9 GHz</td>
<td>1850 - 1910 / 1930 - 1990</td>
<td>PCS band</td>
</tr>
<tr>
<td>2.1 GHz</td>
<td>1920 - 1980 / 2110 - 2170</td>
<td>UMTS band</td>
</tr>
<tr>
<td>1.7 GHz / 2.1 GHz</td>
<td>1710 - 1770 / 2110 - 2170</td>
<td>AWS Band</td>
</tr>
<tr>
<td>2.3 GHz</td>
<td>2300 - 2400</td>
<td></td>
</tr>
<tr>
<td>2.5 GHz</td>
<td>2500 - 2570 / 2620 - 2690</td>
<td>MMDS band</td>
</tr>
<tr>
<td>3.4 GHz</td>
<td>3400 – 3700 (varies)</td>
<td>WiMAX band</td>
</tr>
</tbody>
</table>
**40+ Global Radio Frequency Bands**

**US & Canada**
- UMTS (CDMA 850)
- UMTS/CDMA/LTE 1700
- UMTS/LTE 700
- TD-LTE 2600
- Extended AWS
- AWS 1500 (L-Band)
- AWS 2100 (S-Band)

**Europe**
- UMTS 2100
- UMTS 900
- LTE 2000
- LTE 800
- CDMA 450
- LTE 600

**China**
- UMTS/CDMA 2100
- CDMA 850
- CDMA 450
- TD-SCDMA 1900
- TD-SCDMA 2000
- LTE 1500
- LTE 800
- LTE 900
- TD-LTE 2500

**Japan**
- CDMA/UMTS 850
- UMTS/LTE 1700
- UMTS/LTE 1500
- LTE 1500
- LTE 800
- LTE 900
- TD-LTE 2500

**Latin America**
- CDMA 450
- UMTS/CDMA 850
- UMTS/CDMA 1900
- UMTS/CDMA/LTE 1700
- UMTS 2100
- UMTS 850
- LTE 2600
- LTE 1800
- LTE 900
- LTE 450

**MENA**
- UMTS/CDMA 2100
- UMTS 900
- UMTS 1800
- TD-LTE 2100

**India**
- CDMA 850
- UMTS 2100
- UMTS 900
- UMTS 1800
- TD-LTE 2300

**South Korea**
- UMTS/CDMA 850
- UMTS 2100
- UMTS 1900
- CDMA 1700
- LTE 850

**Australia**
- UMTS 2100
- UMTS 850
- UMTS 900
- LTE 2600

**Africa**
- UMTS 2100
- CDMA 450
- CDMA 800
- CDMA 1900
- UMTS 900
- UMTS 1800

**Limited number of bands in a device**

- As defined in 3GPP and 3GPP2
- Not exhaustive

**Band Plans Below 1 GHz**

**The band 700 MHz (proposed)**
- 698 MHz
- 2x45 MHz
- 806 MHz

**The band 850 MHz**
- 824 MHz
- 844 MHz
- 869 MHz
- 890 MHz
- 935 MHz

**The band 900 MHz**
- 889 MHz
- 915 MHz
- 925 MHz
- 960 MHz

**The band 800 MHz (DD1)**
- 791 MHz
- 821 MHz
- 832 MHz
- 862 MHz

**The band 850 MHz**
- 824 MHz
- 849 MHz
- 869 MHz
- 894 MHz

**190 MHz**
- APAC/Africa

**130 MHz**
- EME/Africa
- Americas

**130 MHz**
- = Downlink
- = Uplink
Digital Dividend – Pros and Cons of Band Plans

<table>
<thead>
<tr>
<th></th>
<th>APT</th>
<th>US</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pros</strong></td>
<td>Designed assuming the spectrum is clear of other users.</td>
<td>US band plan has the attraction in terms of equipment and device availability that it has been deployed in the USA.</td>
</tr>
<tr>
<td></td>
<td>Significant benefits from economies of scale (around 50% of world pop).</td>
<td>Better for those countries that prioritize releasing the band within a short timeline.</td>
</tr>
<tr>
<td></td>
<td>Maximum bandwidth availability (2x45MHz).</td>
<td>The US had to deal with legacy uses and public safety.</td>
</tr>
<tr>
<td><strong>Cons</strong></td>
<td>Despite India, New Zealand and Australia APT band plan implementation by Asian countries is still work in progress.</td>
<td>Less spectrum availability (2x30MHz) and fragmentation.</td>
</tr>
<tr>
<td></td>
<td>The availability of devices for this band will likely lag behind that of US band plan.</td>
<td>Device interoperability will be challenging between sub-bands.</td>
</tr>
</tbody>
</table>

Solutions for APT band Plan

- Qualcomm’s Radio Frequency (RF) chipset portfolio already provides support for the 698-806 MHz frequency range.
- LTE chipset solutions supporting the APT FDD frequency channel arrangement could be available as early as one year following the completion of standardization within 3GPP.
- Band 28 was approved at 3GPP RAN4 level this month and is expected to be approved at 3GPP RAN Plenary in June next month.
- The timeframes for commercial chipset and device availability will depend upon the availability of passive components (e.g., filters, duplexers) and market demand.
LTE: A Parallel Evolution Path to HSPA+

HSPA

Mobile Broadband

Next-Gen Performance

HSPA+ (Commercial)

10 MHz Dual-Carrier

Dual-Carrier Enhancements

20 MHz Multicarrier

Taking HSPA+ to the next level

HSPA+ Advanced

Leverages wider and unpaired spectrum

LTE (FDD and TDD Commercial)

Realizes full benefits of heterogeneous networks

LTE Advanced

DL: 1+ Gbps

UL: 375+ Mbps

(Up to 100 MHz)

LTE Voice Through Fallback to 3G

Initial Launches Data Cards

Initial Voice Solution LTE Data Handsets

Long Term Voice Solution LTE VoIP Handsets

3G coverage

LTE data only

Simultaneous VoIP and LTE data

Rely on 3G for Voice

Fallback to 3G

Circuit Switched Fallback (CSFB) to WCDMA

CS voice or 3G VoIP using SR-VCC

Note: Estimated commercial dates.
Superior Modem Performance

- Only Global 3G/4G Multimode
  - LTE/TD-LTE
  - TD-SCDMA
  - DC-HSPA+, HSPA
  - 1x R99
  - 1xDO Rev B
  - GERAN

- Simultaneous Voice and Data
  - First simultaneous CDMA voice and LTE data handset
  - First UMTS voice and LTE data handset

- Leading Technologies
  - Advanced receivers
  - 100 Mbps peak LTE rates
  - 42 Mbps peak 3G rates

Multimode Is Key for LTE Handsets

Source: Qualcomm data.

Leading in LTE Technology Development

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

- Second Generation
  - World’s First Mobile Platform (8960) with integrated LTE/3G Multimode
  - 7 modes supported: LTE FDD, LTE TDD, UMTS, EV-DO, CDMA 1x, TD-SCDMA, GSM/EDGE

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

All Multimode, All Bands, Performance Evolution

Source: Qualcomm data.
Snapshot on LTE Device Availability

Snapshot from GSA’s on LTE device availability on different bands

<table>
<thead>
<tr>
<th>LTE FDD</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>700 MHz</td>
<td>170 devices</td>
</tr>
<tr>
<td>800 MHz Band 20</td>
<td>72 devices</td>
</tr>
<tr>
<td>1800 MHz Band 3</td>
<td>75 devices</td>
</tr>
<tr>
<td>2600 MHz Band 7</td>
<td>94 devices</td>
</tr>
<tr>
<td>800/1800/2600 MHz</td>
<td>57 devices</td>
</tr>
<tr>
<td>AWS Band 4</td>
<td>72 devices</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>LTE TDD</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>2300 MHz Band 40</td>
<td>43 devices</td>
</tr>
<tr>
<td>2600 MHz Band 38</td>
<td>45 devices</td>
</tr>
<tr>
<td>2600 MHz Band 41</td>
<td>5 devices</td>
</tr>
</tbody>
</table>

Source: GSA (www.gsacom.com), April 2012

Small Cells Will Provide The Next Leap In Performance

Bring network closer to users and leverage Hetnets—add small cells—for next leap in performance

Different dimension of improvement: adding small cells like pico and femto and mitigate interference
Conclusions

- Mobile Broadband needs more spectrum to address data demand growth
- Regional and global spectrum harmonization will continue to be important, only a limited number of frequency bands in devices
- Smartphone expansion into new mobile segments is accelerating data traffic growth
- Snapdragon family is enabling smarter connected devices
- The 2G to 3G migration is important for a more efficient use of spectrum
- With larger frequency blocks for LTE, it is possible to boost data capacity
- It is necessary to bring network closer to the user — add femtocells

Gracias!

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