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Director, Government Affairs SEA&P

Re-farming 2G bands – ASEAN situation

ASEAN Spectrum Policy Forum (ASPF-5)
Workshop on re-farming 2G bands
March 18, 2015
Born Mobile™

- 28+ years of driving the evolution of wireless communications
- Making wireless more personal, affordable and accessible
- World's largest fabless semiconductor company
- S&P 100/ S&P 500/ Fortune 500
Outline

1. Background/Introduction
2. Meeting demand for mobile services
3. Re-farming existing bands
4. Allocating new bands
5. Maximizing new and existing band opportunity
6. Summary
Mobile ecosystem plays important role in Economic Growth

Job Creation from Mobile Industry (thousand jobs)

Wireless Matrix, Capital IQ, A.T. Kearney Analysis
Accelerating 3G/4G growth

3G/4G net additions surpassed 2G in Q2 2011

~ 2.4B

Q4 2013  Q4 2014  Q4 2015  Q4 2016  Q4 2017  Q4 2018

~ 4.4B

3G/4G Connections  2G  GSM Connections

~ 3.5B

~ 5.2B
Wireless Broadband Standards are evolving

- LTE
- LTE Advanced
- HSPA
- HSPA+
- HSPA+ Advanced
- WCDMA
- EV-DO
- EV-DO Rev. B
- DO Advanced
- 1X Advanced
- Wi-Fi
- 802.11 g
- 802.11 n
- 802.11 ac
- 802.11 ad
- 802.11 ah
Licensed spectrum is the foundation of mobile broadband
Mobile 3G/4G delivers reliable, high-speed internet access while on-the-go

**Predictable Performance**
*Exclusive Use*

Approved users (subscribers) only
Coordinate before/while transmitting data

**Seamless Mobility**
*Coordinated Network*

60 Watt Max Transmit Power
Low and High Spectrum Bands
700MHz to 2700 MHz
Short to very long ranges, from small to macro cells
Seamless access and seamless handoffs

Demanding applications
Hyper-dense environments

Anywhere you get a signal
While on-the-go
Spectrum Harmonization Matters

Brings down the cost of mobile devices

Enables international roaming

Reduces cross border interference

Figure 4: Average selling price for handsets (ASP)

Source: LECG analysis of data from Strategy Analytics and Yankee Group.
Existing Spectrum Harmonization Worldwide

Harmonization and global standards drive economies of scale

North America
- UMTS/CDMA AWS
- UMTS/CDMA1900
- UMTS/CDMA850
- LTE700
- LTE AWS
- LTE2600 (B41)
- LTE2000 (MSS S-Band)

Europe
- UMTS900/2100
- LTE800/1800
- LTE2600

MENA
- UMTS900/2100
- LTE800/1800/2600
- LTE2300

South America
- LTE700
- UMTS850/1800
- UMTS1900/2100
- LTE2600

SEA & P
- UMTS850/900
- LTE850/900
- UMTS2100
- LTE700/1800/2600
- LTE2300
Licensed Mobile Broadband Spectrum Resources (MHz)

- Asia Pacific Region

**Coverage Bands (<1GHz)**
- B28: 700 band: 2x45 MHz
- B5: 850 band: 2x25 MHz
- B27: extended 850 band: 2x17 MHz
- B26: extended 850 band: 2x35 MHz
- B8: 900 band: 2x35 MHz

**Capacity Bands (>1GHz)**
- B3: band: 2x75 MHz
- B1: 2100 band: 2x60 MHz
- B40: 2300 band: 100 MHz
- B7: 2600 band: 2x70 MHz with 50 MHz unpaired TDD
850/900 MHz

- Due to the overlap between the 850MHz band downlink and the 900MHz band uplink, there is possibility of inter-band interference
- Mitigation techniques, such as filtering and guard band, can help operators minimize potential harmful interference
- Qualcomm encourages consultation with the industry to determine the suitable filter and guard band arrangement at the band edge
- APT AWG Report 53 on Migration Strategy of GSM to Mobile Broadband provides guidance
- Harmonized allocation, in particularly with neighboring countries, could minimize potential for cross-border interference and greatly reduce coordination costs
Guard Band Requirement for Various Neighboring Technology Combinations

Contained in APT AWG Report 53:

<table>
<thead>
<tr>
<th>Technology in Band 5 (850 MHz band)</th>
<th>Technology in Band 8 (900 MHz band)</th>
<th>Suggested Edge-to-Edge Separation (Guard Band in MHz)</th>
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<tbody>
<tr>
<td>CDMA (1.23 MHz)</td>
<td>GSM (200 kHz)</td>
<td>1.6</td>
</tr>
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Assumptions
(a) At least 60dB isolation between Tx/Rx Antenna
(b) Tx Path has filter for out of band attenuation of around 50dB
(c) Rx Path has filter for out of band attenuation of around 35dB
(d) Edge to Edge Guard Band is defined as separation from upper edge of 850MHz carrier in Tx path to lower edge of 900MHz carrier in Rx path and does NOT include inherent guard band
Example: Malaysian and Indonesian 850/900 MHz arrangement

Key points of the arrangement:

- “The said band may be used in a manner whereby different technologies can co-exist within the same band thus allowing maximum utilization of the spectrum “
- GSM base station in-block transmissions should not exceed +61 dBm EIRP; and
- GSM mobile station transmission should not exceed 31 dBm EIRP.
- IMT Base Station in-block transmissions should not exceed +61 dBm/5MHz EIRP;
- On a case to case basis, higher EIRP value may be permitted if acceptable technical justification is provided; and
- IMT mobile station transmissions should not exceed +31dBm/5MHz
STATUS of Band 5: 850MHz

- Mature ecosystem for 3G in 850MHz – 43 3G networks deployed globally
- LTE is being deployed in this band. 486 devices available
- Example of live networks in APAC:
  - Telstra, Vodafone — Australia (3G)
  - Vodafone – Australia (LTE)
  - Bhutan Telecom - Bhutan (3G)
  - Smartone — Hong Kong (3G)
  - NTT DoCoMo – Japan (3G+LTE)
  - LG U PLUS & SK Telecom — Korea (LTE)
  - Telecom Malaysia – Malaysia (3G)
  - Extelcom – Philippines (3G)
  - Smart — Philippines (LTE)
  - CAT, True and DTAC — Thailand (3G)
  - Telecom NZ — New Zealand (3G)

Singapore taking account of band usage in Malaysia and Indonesia are looking at band planning options
STATUS of Band 8: 900MHz

- Mature ecosystem for 3G in 900MHz, widely deployed globally
- LTE is being deployed in 900MHz, with 486 devices available,
- Example live networks in the APAC region:
  - Vodafone — New Zealand (3G)
  - AIS — Thailand (3G) (LTE trial)
  - Celcom & Maxis — Malaysia (3G)
  - Telstra — Australia (LTE, trialing LTE-A)
  - Optus — Australia (3G)
  - CSL — Hong Kong (3G)
  - SMART - Philippines (3G)
  - Indosat — Indonesia (3G)
  - Telkomsel, XL Axiata — Indonesia (LTE)
  - KT Corp — South Korea (LTE)
  - Chunghwa Telecom, Taiwan Star — Taiwan (LTE)
STATUS of extended 850MHz (Band 26 and Band 27)

- 3GPP completed band standardization
- Already covered as IMT identification in ITU Radio Regulation No. 5.317A
- Harmonization efforts underway in APT Wireless Group
- Interest in band in Latin America and in APAC (e.g. Malaysia, Indonesia, Australia)
- Coexists with Band 5 and Band 28
700 MHz
Global Status

Source: Qualcomm, Jan. 2014.
Band 28 is allocated to mobile operators in: Argentina, Australia, Brazil, Chile, Ecuador, Fiji, Japan, Mexico, New Zealand, Panama, Papua New Guinea, Taiwan

Ecosystem is growing: 76 devices available from Apple, HTC, LG, Samsung, Sony, Alcatel, ZTE, Huawei, Motorola and others

8 commercial networks launched: Optus, Telstra, Vodafone NZ, Telecom NZ (Spark), FarEasTone, Taiwan Mobile, Asia Pacific Telecom, Digicel
**Options for sub 1 GHz spectrum arrangements in ASEAN**

<table>
<thead>
<tr>
<th>Option</th>
<th>Spectrum Details</th>
<th>Total MHz</th>
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<tbody>
<tr>
<td>Option 1: All Band 28, All Band 27, Partial Band 5 and All Band 8</td>
<td>703-748 45 758-803 45 807-824 17 824-835 11 852-880 17 880-915 11 915-925 35 925-960MHz 35</td>
<td>216</td>
</tr>
<tr>
<td>Option 3: All Band 28, Partial Band 26 and All Band 8</td>
<td>703-748 45 758-803 45 814-835 21 835-859 21 859-880 35 880-915 915 915-925 35 925-960MHz 35</td>
<td>202</td>
</tr>
<tr>
<td>Option 4: All Band 28, All Band 26 and Partial Band 8</td>
<td>703-748 45 758-803 45 814-849 35 849-859 35 859-894 21 894-915 915 915-939 21 939-960MHz</td>
<td>202</td>
</tr>
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1800 MHz, 2100 MHz, 2300 MHz, 2600 MHz

Bands >1 GHz are the basis for providing capacity

- **1800 MHz** is the most popular band for LTE
  - APAC deployments include: Australia, Hong Kong, Singapore, New Zealand, Malaysia
  - 158 FDD Networks
  - LTE ecosystem is well developed: 1141 devices available
- **2100 MHz** is a fundamental 3G band used in all countries
- **2300 MHz** is available on an exclusive basis in SEA&P countries:
  - Malaysia, Australia, New Zealand, Indonesia, Philippines, Hong Kong
  - 21 network deployments
  - LTE-TDD Device ecosystem developed with 696 devices available
- **2600 MHz** exclusively available in many SEA&P countries
  - Australia, New Zealand, Hong Kong, Singapore, Malaysia, Philippines
  - 91 network deployments
  - LTE-FDD ecosystem is established with 1022 devices available. LTE-TDD in some countries
National Spectrum Arrangements should support Carrier aggregation options

Carrier aggregation further enhances broadband experience

AGGREGATION ACROSS BANDS

LOW BAND
- 700 MHz
- 850 MHz
- 900 MHz

HIGH BAND
- 2.6 GHz
- 2.1 GHz
- 1800 MHz

AGGREGATED, FATTER DATA PIPE

MULTI-CARRIER HSPA+/LTE DEVICE

Higher Data Rates to All Users, More ‘Bursty’ Capacity

1 Additional spectrum bands and band combinations continuously defined in 3GPP. 2 For typical bursty applications and typical partial carrier load, Multi-Carrier supports more bursty application users.
Summary

Re-farming 2G bands increases efficiency and assists delivery of benefits on mobile

- Using harmonised bands for licensed mobile broadband maximizes opportunity
- There are ecosystems for 3G and LTE in the 850 and 900 MHz spectrum
- The 1800 MHz capacity band supports a large LTE ecosystem
- 700 MHz is an opportunity for LTE coverage
- Band 26 and 27 can provide for efficient <1 GHz spectrum use
Thank you

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Qualcomm is a leader in solutions for all types of spectrum

Technologies for licensed and unlicensed spectrum, with solutions to make the best use of both

**Licensed Spectrum**
Cleared spectrum for 3G/4G, **Exclusive use**

**Unlicensed Spectrum**
Multiple technologies (Wi-Fi), **Shared use**

**Mobile Broadband**

**Leadership solutions for opportunistic use of unlicensed spectrum**
Qualcomm is pioneering tighter interworking of 3G/4G and Wi-Fi, plus extending LTE Advanced to unlicensed spectrum for a unified network

**Wi-Fi leadership for local area access**
Qualcomm VIVE™ brings content and devices to life enabling a robust end-to-end 11ac ecosystem

**Mobile 3G/4G technology and performance leadership**
4th generation LTE solution with Qualcomm® Gobi™ LTE Advanced modem and RF solution

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