WIRELESS COMMUNICATIONS ASSOCIATION

4G Device Out of Band Emissions and Larger Channel Bandwidths

October, 2011

WCAI and Clearwire Positions

- **Growth of 4G services requires more throughput, capacity and efficient use of spectrum.**
  - Monthly tonnage on Clearwire network as grown by 3X over the past year.
  - Wider channel bandwidths allow more efficient use of spectrum, provide greater throughput and speeds to the end user.
- **Current FCC device emission masks are too restrictive to accommodate a broad family of mobile devices using large bandwidths and achieving high data rates.**
  - Multi-mode/multi-radio smartphone designs require reasonable tradeoffs between size, battery life and performance.

WCAI and Clearwire Positions

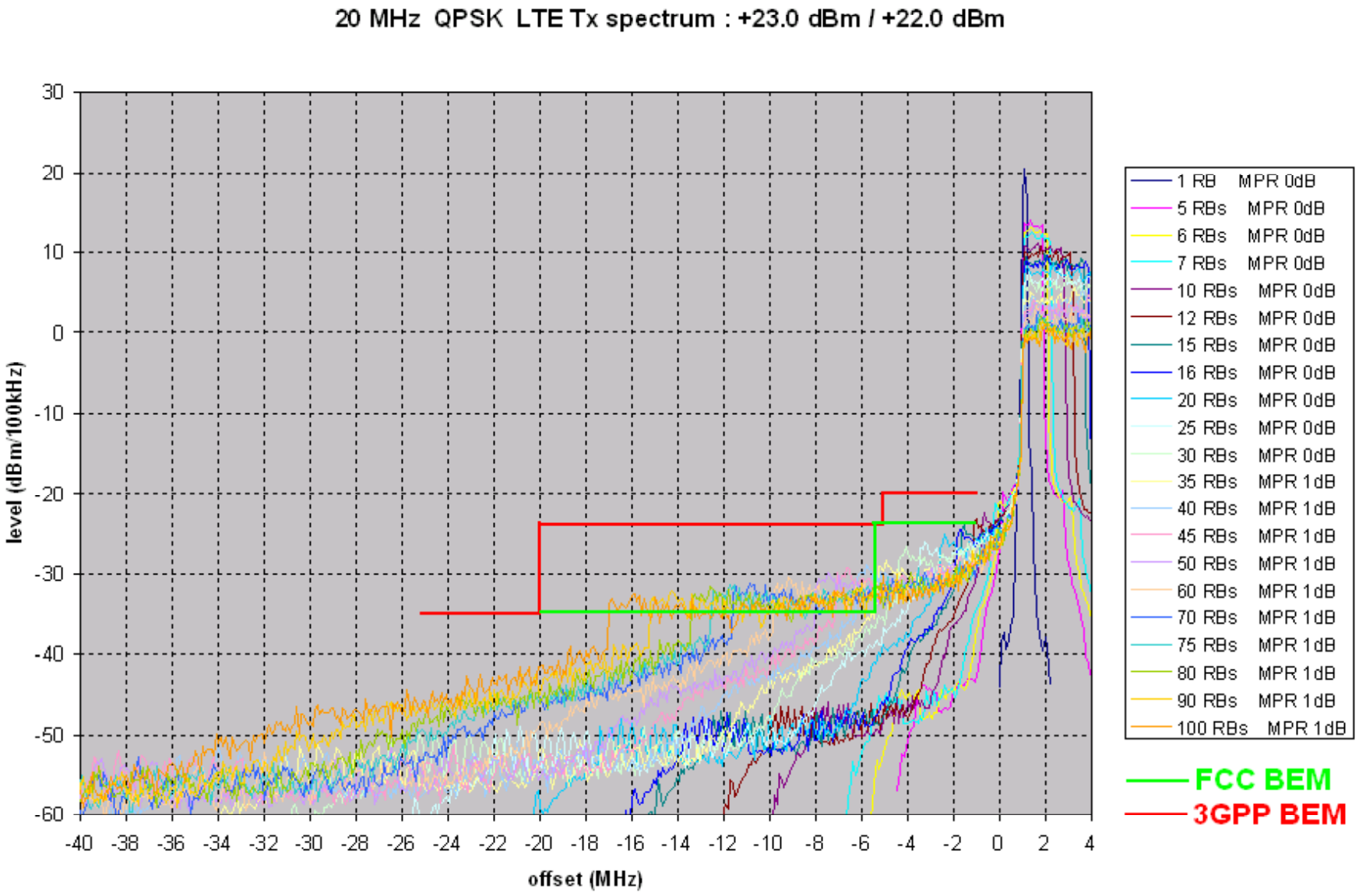
- **Actual operating characteristics of 4G systems yield much less potential for interference than outlined by the few dissenting commenters**

- **Global 3GPP standards were created by a majority of the world's leading network and device vendors and have properly addressed the tradeoffs between performance and interference potential in 4G systems**

Real World Interference Potential of 4G Networks

- **Mobile 4G devices will not typically be allocated all uplink bandwidth while operating at full power.**
  - SC-FDMA/OFDMA share the UL among multiple users in the manner of FDM and TDM
  - The bandwidth allocated for each mobile device is typically much narrower than the full channel bandwidth, and occurs for a fraction of the total frame duty cycle
  - To preserve battery life and minimize intra-system interference in 4G networks, mobile devices operate under stringent power control rules to minimize transmitted power
  - Mobile devices only operate at full power in cell edge regions but at the narrowest bandwidths in order to achieve maximum coverage.

Simulation of 20 MHz LTE Device UL Emissions



Real World Interference Potential of 4G Networks

- **The spectral emissions mask (SEM) of a 4G system is not the same as the instantaneous emissions expected from any one device.**
  - It is a composite mask of all different forms of instantaneous emissions that may occur. The actual emissions are a function of the power and number/location of the allocated frequency resources.
  - Consequently, the adjacent channel leakage ratio (ACLR) of 4G systems based on SC-FDMA/OFDMA is typically much less than represented by the SEM.
- **Consequently, for 4G systems, a relaxation in the SEM cannot be simply inferred as resulting in an equivalent increase in the potential risk of interference.**

Globalstar Concern: Interference to MSS

- **BRS1 operates today on a co-primary, co-channel basis with Globalstar and BAS Channel A10 without interference from devices.**
  - CLWR currently operates WiMAX and pre-WiMAX technologies in the 2496-2500 band and has not received ANY interference complaints.
- **Globalstar analyses are flawed as they apply worst case device operating conditions across a 4G network.**
  - Applying Globalstar's methodology and the current FCC mask results in required separation distances of 2 km for 2483.5-2490.5 MHz and 7 km 2490.5-2495 MHz. This suggest they cannot co-exist today.
  - Globalstar's analysis uses a very pessimistic free space path loss model to characterize mobile to mobile interference.
  - Typical 4G mobile devices use power control algorithms to minimize intra-system interference and maximize battery life.
  - Globalstar's operations are likely to be in rural areas.

EIBASS Concern: Interference to BAS A10 and A9

- **BRS1 operates today on a co-primary, co-channel basis with Globalstar and BAS Channel A10 without interference from devices.**
  - CLWR currently operates WiMAX and pre-WiMAX technologies in the 2496-2500 band and has not received interference complaints.
- **Probability of 4G mobile operating at full power in the immediate vicinity of an A10 or A9 receiver is unlikely.**
  - BAS receivers will typically be outdoors where 4G mobiles will not need to operate at full power.
- **Very few channel A10 facilities exist.**

IPWireless Concern: Interference Within the BRS/EBS Band

- **The potential for uncoordinated TDD interference exists within the band today and is highly improbable.**
  - The BRS/EBS band is designated for full flexible use.
  - 4G mobile device power control decreases the likelihood of intra- and inter-system interference and maximizes battery life.
  - Numerous 4G operators, network vendors and device/chipset vendors agree support WCAI's position. Motorola Mobility submitted a summary of LTE simulations by 3GPP showing interference is highly unlikely and hypothetical.
- **IPWireless does not consider best practices already created by WCAI and adopted by the BRS/EBS industry to promote coordination.**
- **IPWireless's reference to CEPT Report 19 is not applicable to 4G/IMT-Advanced systems using OFDMA technology and has not been adopted by any of the 4G standards organizations.**

wcainternational
WIRELESS COMMUNICATIONS ASSOCIATION

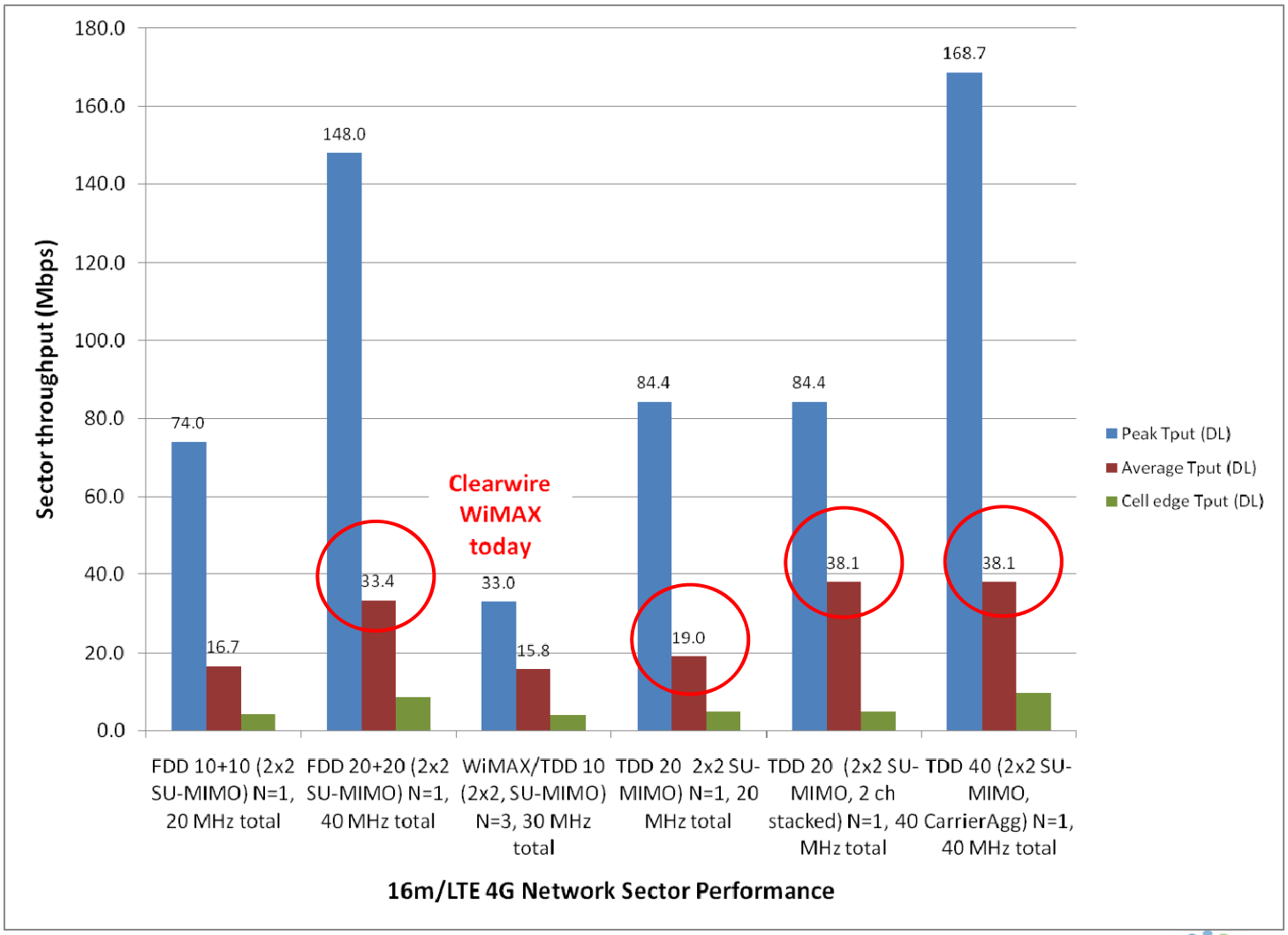
Northrup Grumman Concern: Interference Within the BRS/EBS Band

- Northrup Grumman System Corporation (NGSC) operates a public safety system in New York City on behalf of the Department of Information Technology and Telecommunications using the combined D2/D3 channel.
- CLWR also operates a WiMAX system in New York City that is adjacent in frequency.
- Due the close proximity and elevated base station antenna heights in NYC, there has been base station to base station interference.
  - Clearwire and NGSC have cooperated and applied filters when necessary to one or both operator's base stations to reduce interference.
  - No device to device interference has been reported and CLWR has deployed >550,000 devices in the NYC area.
- The propagation environment for base station to base station interference is completely different than mobile to mobile because of elevated antenna heights and line-of-sight conditions.

Reference Material

wcainternational
WIRELESS COMMUNICATIONS ASSOCIATION

Advantages of 20 MHz channels



wcainternational
WIRELESS COMMUNICATIONS ASSOCIATION

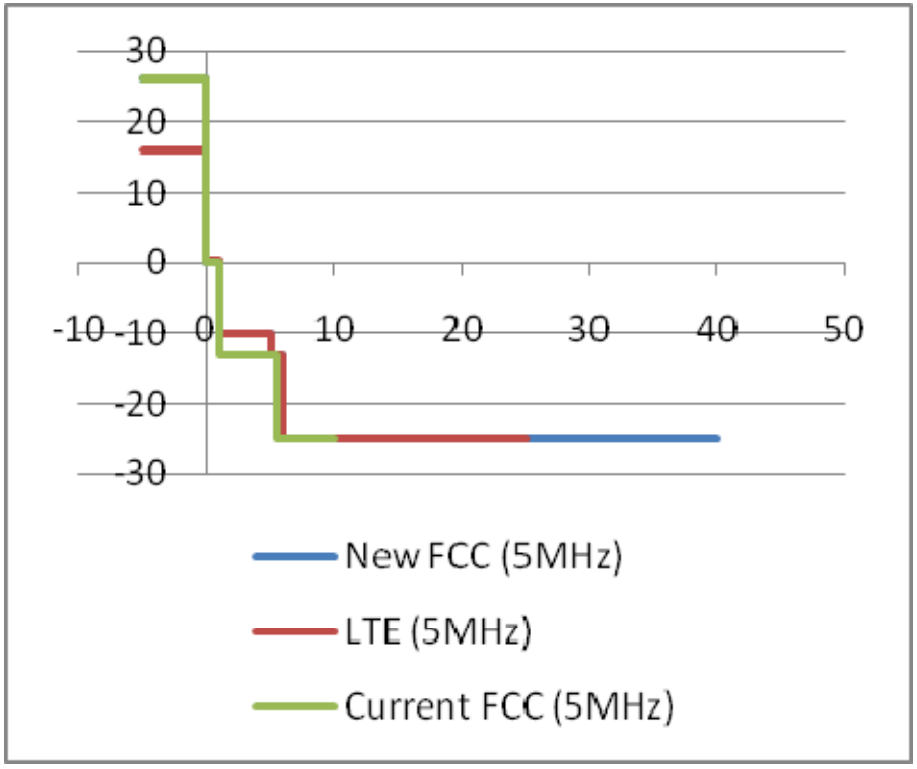
Current emissions mask challenges for devices

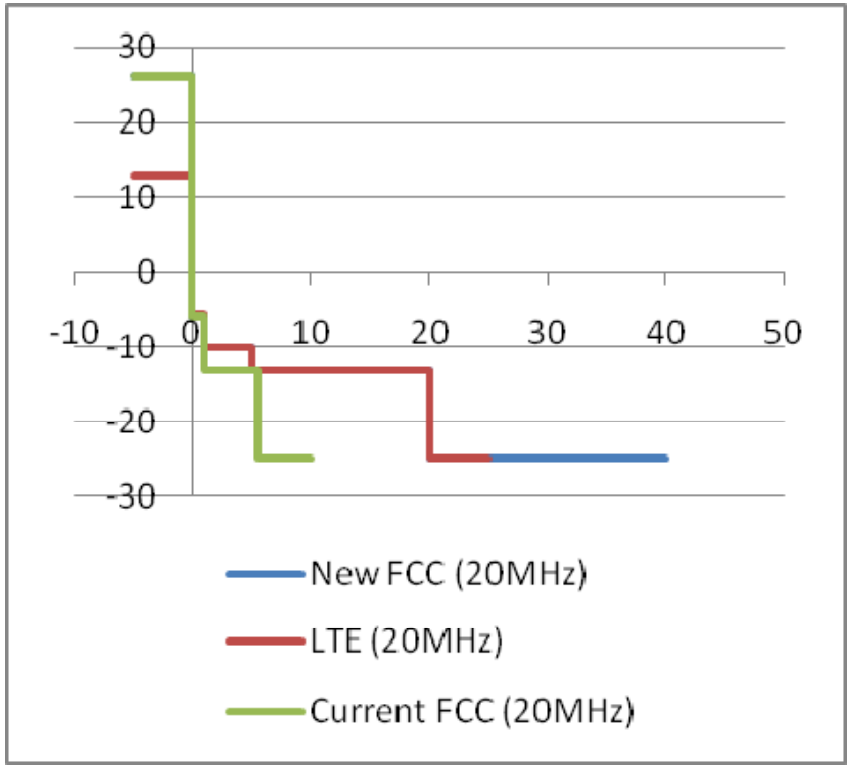
- **OOBE in the first 1 MHz is ok**: From an mobile station (MS) point of view, there is no problem with the values allowed by the current FCC rules. When 3GPP compliant devices are measured using FCC approach, they will align with the FCC -13 dBm limit (only slight 0.2dB difference, due to 3GPP spec using 30kHz measurement BW).

Frequency Block Size (MHz)	3GPP spec	FCC limit	3GPP spec with FCC measurement procedure
5	-15dBm/30kHz	-13dBm/50kHz	-12.8dBm/50kHz
10	-18dBm/30kHz	-13dBm/100kHz	-12.8dBm/100kHz
20	-21dBm/30Khz	-13dBm/200kHz	-12.8dBm/200kHz

- **From a MS point of view, the current challenges with the emissions mask are:**
  - The allowed emissions do not scale with bandwidth: the 55 + 10logP point is fixed at 5.5MHz
  - The 43 + 10logP point from 0 to 5.5MHz is 3dB more stringent than achievable in typical 4G systems that support 20MHz (i.e. 3GPP LTE)

OOBE masks


30
20
10
0
-10
-20
-30
-10
0
10
20
30
40
50
New FCC (5MHz)
LTE (5MHz)
Current FCC (5MHz)


30
20
10
0
-10
-20
-30
-10
0
10
20
30
40
50
New FCC (20MHz)
LTE (20MHz)
Current FCC (20MHz)

ACLR implications on interference

- ACLR determines the amount of power that is radiated in the first adjacent channel: In LTE this is a constant for all supported bandwidths

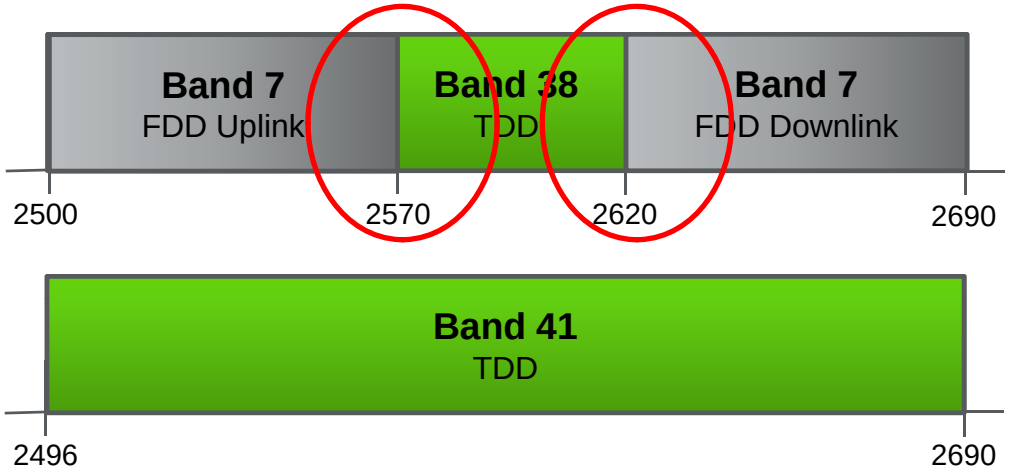
	Channel bandwidth / E-UTRA$_{ACLR1}$ / measurement bandwidth					
	1.4 MHz	**3.0 MHz**	**5 MHz**	**10 MHz**	**15 MHz**	**20 MHz**
E-UTRA$_{ACLR1}$	30 dB	30 dB	30 dB	30 dB	30 dB	30 dB
E-UTRA channel Measurement bandwidth	1.08 MHz	2.7 MHz	4.5 MHz	9.0 MHz	13.5 MHz	18 MHz
Adjacent channel centre frequency offset (in MHz)	+1.4 / -1.4	+3.0 / -3.0	+5 / -5	+10 / -10	+15 / -15	+20 / -20

Source: 3GPP TS36.101, Rel-8, section 6.6.2.3

- This means that as the channel bandwidth is doubled, the power spectral density of the emissions is halved in order to maintain the same ACLR
- The implication is that LTE compliant devices emit the same amount of power into the first adjacent channel irrespective of the bandwidth used
- Therefore changing the BRS/EBS emissions mask will not result in more interference from devices, it simply allows operation of wider bandwidth devices with different OOBE profile to be feasible

3GPP on FDD/TDD Coexistence

- 3GPP has defined 3 bands for 2.6 GHz, IMT-Extension spectrum:



ITU Option 1:
Band 7 (FDD) and Band 38 (TDD)
Europe centric

ITU Option 3:
Enabled by Band 41 (TDD)
USA/Asia centric

- 3GPP RAN4 group is discussing modifications related to UE emission behavior for devices operating at the inner edges of Band 7 and Band 38 (red circles above). These are specific to the FDD/TDD coexist interference, and are targeting uncoordinated operator deployments
- EU regulatory studies (ECC Report 131, CEPT 019, etc) – focused on 3G/UMTS with 5 MHz channels, not 4G/LTE/LTE-A with 20 MHz or greater channel bandwidth.
- For the rest of the 2.6 GHz bands (Band 7, 38, 41) (ie regions not included in red circles above), 3GPP specs remain exactly aligned to the WCAI proposal.
- FCC rules for the 2.6 GHz band have always assumed coordinated approach to interference, and have never mandated mechanisms for FDD/TDD coexistence. Such approaches are not necessary.