COALITION FOR 4G IN AMERICA

May 26, 2010

Via Electronic Filing

Marlene H. Dortch
Secretary
Federal Communications Commission
445 Twelfth Street, S.W.
Washington, DC 20554

Re: WT Docket No. 06-150; PS Docket No. 06-229; GN Docket No. 09-51; RM Docket No. 11592
Notice of *Ex Parte* Presentation

Dear Ms. Dortch:

On May 25, 2010, Doug Hyslop and Chris Helzer of Wireless Strategy, LLC; Carri Bennet of Bennet and Bennet on behalf of the Rural Telecommunications Group, Inc.; Michael Lazarus of Paul, Hastings, Janofsky & Walker LLP on behalf of MetroPCS Communications, Inc. and Triad 700, LLC; Charles Logan of Lawler, Metzger, Keeney & Logan, LLC on behalf of Access Spectrum, LLC; George Wheeler of Holland and Knight on behalf of United States Cellular Corporation; Kathleen Wallman of Wallman Consulting, LLC on behalf of Xanadoo Company; Paul Kolodzy of Kolodzy Consulting on behalf of Xanadoo Company; Lawrence R. Krevor, Richard Engelman and Trey Hanbury on behalf of Sprint Nextel Corporation; Christopher Wieczorek on behalf of T-Mobile USA, Inc.; and Kevin Joseph on behalf of Cellular South, Inc. (collectively, "4G Coalition Members") met with Pat Amodio, Yoon Chang, Jeff Cohen, David Furth, Behzad Ghaffari, Brian Hurley, Jacob Kurian, and Jennifer Manner of the Public Safety and Homeland Security Bureau; Walter Johnston of the Office of Engineering and Technology; and Leon Jackler, Won Kim, Paul Murray, Tom Peters, Joel Taubenblatt, Peter Trachtenberg, and Jordan Usdan of the Wireless Telecommunications Bureau. The 4G Coalition Members reviewed and discussed the attached *700 MHz Band Analysis* prepared by the technical consulting firm Wireless Strategy and filed with the Commission in the above-captioned dockets on May 10, 2010.

In addition to reviewing key elements of the Wireless Strategy study, the 4G Coalition identified a reference error on page eleven of the report. The original study referred to the out-of-band-emissions ("OOBE") level required to protect public safety narrowband operations as 69+10 log P; however, the actual OOBE level is 65+10logP. Use of the correct OOBE reference of 65+10logP favors the Wireless Strategy recommendation. At 65+10logP, even the standard emissions mask will meet the OOBE requirement and no block-specific filtering is required. A redline copy of the paper that reflects the proper OOBE rule and makes certain consequential corrections about the level of filtering necessary is attached.

Pursuant to section 1.1206(b) of the Commission's rules, this letter and the attachment are being submitted for inclusion in the public record in the above-referenced proceedings.

Sincerely,

/s/ Trey Hanbury

Trey Hanbury

Attachment

cc: Pat Amodio
Yoon Chang
Jeff Cohen
David Furth
Behzad Ghaffari
Brian Hurley
Leon Jackler
Walter Johnston
Won Kim
Jacob Kurian
Jennifer Manner
Paul Murray
Tom Peters
Joel Taubenblatt
Peter Trachtenberg
Jordan Usdan

700 MHz Band Analysis

May 6, 2010

the business of wireless technology

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I. Introduction

The 700 MHz band has reached a crucial juncture requiring further regulatory guidance. The possibility of multiple operating bands for 700 MHz threatens wireless competition, consumer flexibility, and the affordability of public safety wireless broadband devices, and is a marked departure from precedent in the US wireless industry. From the early days of cellular through later deployments in the PCS and AWS bands, devices have supported all blocks within the designated band, affording economy of scale for large and small operators alike. In addition, the balkanization of 700 MHz threatens the National Broadband Plan recommendation that Public Safety have the benefit of the entire 700 MHz to roam and the benefit of the economies of scale from having all like devices include the Public Safety band. The direction taken by the two largest operators at 700 MHz reverses this openness in device design, inhibits the ability of small operators to reach the marketplace, and threatens the National Broadband Plan's mandate for a national interoperable public safety network.

Comments in the record cite interference concerns as the driving factor behind the 700 MHz band fragmentation.[1] The analyses in sections III and IV demonstrate that the interference concerns may be handled through typical network planning and coordination measures, and do not require unusual block-specific filtering by the devices. As shown in section V, Device Design, two operating bands may fully cover all paired commercial 700 MHz spectrum and the Public Safety Broadband (PSBB) block: band 12 for lower A, B, and C and a proposed new band for upper C, D, A, and PSBB. This approach would greatly simplify compliance with the recommendation of the National Broadband Plan encouraging public safety device support of all commercial paired blocks in the 700 MHz band,[2] reducing the required number of duplexers from four to two. To maximize the device ecosystem, all commercial 700 MHz broadband devices operating in paired spectrum should support both Band 12 and the newly proposed Upper Band. Commission action is necessary to provide the lower and upper A block licensees, the future upper D block licensees, and the public safety community with a competitive footing in terms of device cost and variety.

700 MHz Band Ownership

AT&T and Verizon Wireless emerged from Auction 73 with the largest holdings of 700 MHz spectrum and contributed nearly 82% of the total auction revenue.[3] Verizon Wireless owns the upper C Block within the continental United States, along with significant holdings in the lower A Block (147.9

[1] Motorola ex parte February 8, 2010; Comments of Verizon Wireless, March 31, 2010; Comments of Motorola, Inc., March 31, 2010; Comments of AT&T Inc., March 31, 2010, RM-11592.

[2] "The FCC should explore other ways to encourage the deployment of public safety devices that transmit across the entire broadband portion of the 700 MHz band (i.e., Band 12, Band 13, Band 14 and Band 17)." p. 316, *Connecting America: The National Broadband Plan*.

[3] DA 08-595, Report No. AUC-08-73-I (Auction 73), "Auction of 700 MHz Band Licenses Closes", Attachment D. Also http://www.wirelessstrategy.com/700auction.html

million POPs) and B Block (46.3 million POPs). Prior to the auction, AT&T had purchased much of the lower C Block from other license holders, and emerged from the auction with the winning bid for most of the lower B block licenses (175.8 million POPs). Both operators have announced plans to deploy 3GPP Long Term Evolution (LTE) technology in their respective blocks, with the first markets planned for launch in 2010 and 2011.

The remaining licenses in Auction 73 went to 99 bidders constituting a mix of smaller wireless operators and new entrants to wireless. Although bidding for the large markets was dominated by AT&T and Verizon Wireless, the licenses won by the 99 bidders were largely in the lower A block and covered a sizable portion of the country, promising to invigorate competition in the 700 MHz band.

Threat to Wireless Competition

An essential requirement to sustain competition by smaller operators is the availability of low-cost devices. Device costs are lowered through scale; a critical mass of device volume must be reached to achieve low price points and interest multiple device manufacturers in developing equipment for a given band. The initial band selections by AT&T and Verizon Wireless remove the benefit of scale from the lower and upper A block operators, the future D block operator(s), and PSBB operators. Based on the filtering selections of AT&T and Verizon Wireless, unique device designs must be developed for the lower and upper A blocks and for the D Block and PSBB (Band 14), significantly reducing commonality of device components and increasing costs.

Threat to Consumer Flexibility

Under the currently defined operating bands, 700 MHz devices built for AT&T will only work on systems deployed in the lower B and C blocks, and 700 MHz devices built for Verizon Wireless will only work on the upper C block. Consumers purchasing devices from these operators would be locked into their systems. If lower A block and upper A and D block competitors were running systems in the same geography, a consumer would need to purchase separate devices to work on either of their systems. Consumer flexibility will be significantly restricted unless action is taken to ensure that all commercial devices operating in paired spectrum are capable of supporting all paired broadband allocations at 700 MHz.

Threat to Affordability of Public Safety Devices

The fragmented band plans at 700 MHz pose similar scale issues to device development for the PSBB spectrum. Rather than leveraging the wide array of devices developed for the commercial upper C block, the public safety community must work with device manufacturers to tailor devices for Band 14. If public safety's network goals include multiple roaming options, coverage redundancy, and scalable capacity, then public safety devices should include support for the lower A, B, and C blocks as well as the upper C, A, D and PSBB blocks. The current 700 MHz operating bands would require a minimum of four transmitter-receiver chains, significantly increasing device complexity. Implementing four chains requires not only four duplexers, but also multiple components such as LNAs, mixers, and up-converters. Moreover, Qualcomm has stated [4] that their current chipset portfolio supports only two 3G/4G

[4] Comments of Qualcomm Incorporated, March 31, 2010, RM-11592.

transmitter-receiver chains below 1 GHz. The public safety device goal stated in the National Broadband Plan is not achievable using Qualcomm's current chipset and the current operating bands. The unique device design and the low volume of public safety devices sold annually will result in high unit costs as experienced in the trunked radio world today, a significant cost penalty relative to the commercial sector.

When the D Block is commercially auctioned, the commonality of Band 14 could provide some scale to the public safety community. However, the D block operator(s) will face a similar obstacle of developing devices for a new band while struggling to overcome the disadvantage of a three-year lag relative to AT&T and Verizon Wireless in deploying nationwide coverage[5].

Public safety's interests would be better served if all commercial 700 MHz broadband devices supported the PSBB block. Such an approach would provide the public safety community with lower-cost devices driven by the combined scale of the commercial, paired block operators, and deliver the added benefit of multiple roaming partners for the PSBB devices. During construction of the nationwide public safety system, the public safety community could make use of the commercial 700 MHz networks through roaming arrangements. And in the event of capacity or coverage issues within the PSBB system, the PSBB devices could readily roll over to the commercial bands.

Analyses provided herein demonstrate that such an approach is feasible and cost-effective. Accordingly, the Commission should require all devices sold in the commercial, paired 700 MHz blocks must support the operating bands of Band12 and the New Upper Band described below.

II. 700 MHz Devices

As the LTE standard evolved within 3GPP, four band plans for 700 MHz were introduced. Verizon Wireless has selected 3GPP Band 13, which covers the upper C block[6]. Verizon notes in the record their decision to hold in reserve their significant license ownership in the lower A block[7]. AT&T is targeting Band 17[8] for LTE devices, which covers the lower B and C blocks, but excludes the lower A block, where AT&T owns no spectrum.

[5] The auction value of the upper D block would increase significantly through enforcement of a common banding approach with the upper C block.

[6] Bands 13 and 14 were included in Table 5.2-1 E-UTRA Frequency Bands, p. 10, 3GPP TS 36.101 v8.1.0 (2008-03).

[7] "Given that Verizon Wireless does not plan to deploy its Lower A Block spectrum in the near term, it makes no sense for it (or its 4G customers) to bear the burden of additional cost associated with including that band in its initial LTE devices…", p. 11, Comments of Verizon Wireless, RM-11592, March 31, 2010.

[8] Bands 12 and 17 were introduced in Table 5.5-1 E-UTRA Operating Bands, p. 14, 3GPP TS 36.101 v8.7.0 (2008-09).

The selection of operating bands by the two large incumbents has prompted a petition for rulemaking by lower A block owners, citing difficulties in obtaining devices.[9] The A Block licensees state that device manufacturers are focused on Bands 13 and 17 to the exclusion of the other spectrum blocks in the 700 MHz band.

Comments by manufacturers confirm the issue of a limited number of bands supported in devices developed for AT&T and Verizon Wireless.[10] Although currently available device chipsets support the entire 700 MHz band, in the case of Qualcomm’s RTR8600 multi-mode chipset, the current number of 3G or 4G low-frequency bands which may be supported within a device is limited to two.[11] A low-frequency band is defined as a sub-1 GHz operating band such as 900 MHz, cellular, or 700 MHz. The device manufacturers select filters to support specific bands, and given this chipset limitation of low-frequency band paths, the device manufacturer must prioritize its 700 MHz support to the one or two bands of interest to the wireless operator. For their 700 MHz launch devices, AT&T and Verizon Wireless are targeting multi-mode and multi-band devices which may serve on 3G cellular systems in areas where 700 MHz coverage is not yet operational, leaving one low-frequency band for 700 MHz support. Without regulatory intervention, devices built for AT&T and Verizon Wireless will only support their individual spectrum holdings at 700 MHz; the remaining paired blocks will not be supported by the devices.

As a result, the licensees in Bands 12, 14, and the upper A block cannot leverage the mainstream, high-volume device ecosystems driven by AT&T and Verizon Wireless, imposing a significant cost penalty on both the smaller US wireless commercial operators and the public safety community.

III. Lower Band Analysis

The FCC band plan for the 700 MHz band is shown in Figure 1. The 3GPP-recommended device transmit and receive directions are indicated by the arrows above the blocks, with an “up” arrow denoting device transmit and a “down” arrow denoting device receive. The Band 12 and Band 17 boundaries are illustrated.

[9] Comments of Cellular South Inc., September 30, 2009, GN Docket Nos. 09-157 and 09-51; Comments – NBP Public Notice #26, GN Docket Nos. 09-47, 09-51, 09-137; DA 10-278, *Wireless Telecommunications Bureau Seeks Comment on Petition for Rulemaking Regarding 700 MHz Band Mobile Equipment Design and Procurement Practices*, RM-11592.

[10] Motorola ex parte February 8, 2010, RM-11592.

[11] p. 5, Comments of Qualcomm Incorporated, March 31, 2010, RM-11592.

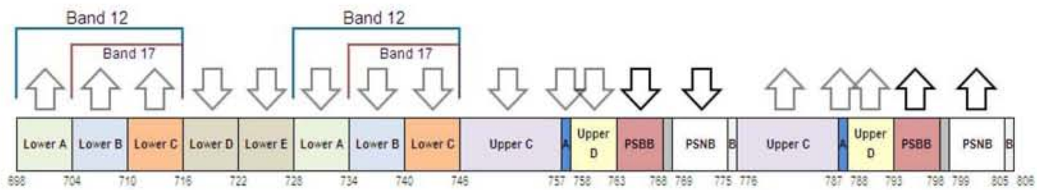

Figure 1: Lower 700 MHz Band with Bands 12 and 17

The black arrows above the Public Safety blocks indicate the direction mandated by the FCC. The blocks licensed in Auction 73 were allocated as “flexible use”, meaning any block could be used for transmit or receive. The 3GPP recommended directions minimize the number of transitions between transmit and receive, which minimizes the interference boundaries and simplifies filter and device component design.

In the lower 700 MHz band, three 6 MHz blocks of spectrum from 728 to 746 MHz are paired with three similar blocks at 698 to 716 MHz, forming the lower A, B and C blocks. Two unpaired 6 MHz blocks, D and E, are located between the A, B and C blocks at 716-728 MHz. The lower D and E blocks are suitable for high-power broadcast applications, allocated with a maximum ERP of 50 kW. Qualcomm’s MediaFLO technology is an example of a typical service which may be employed in the D and E blocks.

The lower band has three potential sources of interference which may impact device filter design: the lower A block boundary with DTV Channel 51 at 698 MHz; the lower C block boundary with the lower D block at 716 MHz; and the lower E block boundary with the lower A block at 728 MHz.

Lower A Block Boundary with DTV Channel 51 at 698 MHz

In the 700 MHz band, the FCC requires licensees to provide co-channel and adjacent-channel protection to the TV/DTV contours. With the completion of the digital TV transition, the last remaining DTV channel requiring protection is Channel 51, adjacent to the lower A block device transmit. Per section 27.60, the A block licensee must protect the broadcast contour of the DTV station by ensuring the adjacent channel desired signal-to-undesired signal (D/U) ratio is met[12]. This D/U ratio limits the radiated power within the A block near the service contour of the television station. The second and third adjacent blocks, B and C, are not required to observe a minimum separation distance from, or meet an adjacent channel D/U ratio to, the Channel 51 contour. [13] Instead, the FCC regulations applying to the A, B and C blocks are the maximum transmit power defined in 27.50 and the OOBE criteria of 43 + 10 log P applied to all commercial blocks at 700 MHz.

[12] 47CFR 27.60 (a) (2) “The minimum D/U ratio for adjacent channel stations is 0 dB at the hypothetical Grade B contour (64 dBuV/m) (88.5 kilometers (55 miles)) of the TV station or -23 dB at the equivalent Grade B contour (41 dBuV/m) (88.5 kilometers (55 miles)) of the DTV station.”

[13] 47CFR 27.60 (b) (2) (ii) (D) “(e.g., a base station may be operating within TV Channel 62 and the mobiles within TV Channel 67, in which case the TV channels 61, 62, 63, 66, 67, and 68 must be protected).” The regulations do not specify further protection to second-adjacent channel 64, for instance.

The FCC rules provide several approaches under which an A block licensee may meet the protection criteria to the DTV Channel 51 service contour:

- Maintain a minimum distance from the DTV station contour[14];
- Provide an engineering study demonstrating adherence to the D/U ratio;
- Obtain written concurrence from the TV/DTV station. [15]

The rules provide clear options for the A block licensee to protect the channel 51 contour without applying stringent filtering to the device front end. It would be illogical for A block licensees to sacrifice the majority of their spectrum as guard band when other means are available to control the interference, such as distance separation. Furthermore, since the lower B and C blocks are not adjacent to Channel 51, the adjacent channel D/U ratios do not apply to those blocks. The regulations imply that DTV receiver filtering is expected to handle strong transmit signals in the second adjacent channel, provided that the OOBE criteria of 43 + 10 log P is met. Additional guard band near 698 MHz is not required to protect channel 51 receivers.

The Channel 51 transmissions are high-power broadcast signals which may interfere with reception in the lower A, B, and C blocks. However, when applying the 3GPP recommended device transmit direction to 698-716 MHz, the interference becomes a base station-to-base station interference scenario. The device receive band has 30 MHz of separation from Channel 51, providing significant attenuation of the broadcast transmission. Therefore, the Channel 51 transmissions do not impact the device receive filter design.

The base station-to-base station interference scenario may be handled through traditional operator coordination measures such as base station location selection, antenna downtilt, sector orientation, and base station filtering. An example demonstrating the effectiveness of these network coordination techniques is the 3GPP approach at the 716 MHz boundary. The situation is nearly identical – a high-power broadcast signal (D block) is immediately adjacent to the cellular-style UE transmit block (C block), yet no guard band is required.

Given the device transmit direction within 698-716 MHz, the multiple approaches for A block licensees to protect the DTV station contour, and the parallel situation at 716 MHz, the boundary at 698 MHz does not require unusual filtering sacrificing the A block as guard band.

Lower D Block Boundary with Lower C Block at 716 MHz

At this boundary, device transmissions in the lower C block reside adjacent to the high-power broadcast transmissions in the lower D block. There are two interference scenarios at this boundary. The

[14] While network operators do not control mobile locations explicitly, the network coverage area where the device may transmit can be controlled such that the A block device will not operate in a geography where the DTV station contour D/U ratio would not be met.

[15] 47CFR 27.60 (a) (1) (i) – (iv).

first scenario is the D block impact to the C block, which is similar to the Channel 51-to-A block impact above where the D block may interfere with C block base station receive. This is a base-to-base interference scenario, handled through base station location, sector orientation, antenna downtilt, and base station filtering, and does not impact device filter design.

The second interference scenario involves the C block device transmission interfering with the D block device reception. This is a mobile-to-mobile interference case similar to the A block situation where the device transmit is adjacent to Channel 51 device receive.

These two interference scenarios are an inherent function of the 716 MHz boundary where transmit operations are adjacent-channel to receive operations. These scenarios remain identical regardless of whether Band 12 or Band 17 is adopted. No unusual filtering requirements are specified by 3GPP at the 716 MHz boundary.

Lower E Block Boundary with Lower A Block at 728 MHz

The final boundary in the lower band is at 728 MHz. Motorola states a concern that the high-power base station transmissions in the D and E blocks may interfere with the device reception in the lower A, B and C blocks[16]. To handle the interference, Motorola recommended using the A block as guard band[17].

Given the 3GPP recommendations for transmit direction, the entire range from 716 through 776 MHz is harmonized as base station downlink transmission. The out-of-band emissions applicable to the A, B and C blocks are identical throughout that spectrum range. The main regulatory difference for the lower D and E blocks is the higher permitted ERP of 50 kW. The interference mechanism which may result from this higher base station transmit power is device receiver overload. A device attempting to receive a low desired signal will increase its front-end gain to maximize its receiver sensitivity. If a strong signal is present in a nearby channel, the device front-end may be overloaded or de-sensitized by the strong signal. In the case of the 728 MHz boundary, the potential for receiver overload is a near-far interference problem. If an A, B or C block device closely approaches the D or E block transmitter, and the desired A, B or C block signal is weak, then interference may result. However, network operators may easily plan their base station deployment to eliminate this interference issue by placing A, B or C block base stations in the vicinity of the D and E block transmitters. The broadband devices will receive a strong desired signal in this area and lower the device front-end gain, improving blocking performance. This is a normal design situation, and a common industry practice. Co-location or near-location of base stations successfully avoids this interference mechanism by limiting the extremes of signal strengths between the two systems.

[16] Motorola ex parte February 8, 2010, p. 8, RM-11592.

[17] 3GPP TSG RAN WG4 (Radio) Meeting #47, R4-081108, “TS36.101: Lower 700 MHz Band 15”, Motorola contribution, p. 2 section 2c.

With a broadcast deployment strategy, the D and E block licensees are incented to install as few sites as possible to achieve their coverage targets. The near-far situation with respect to the lower A, B and C blocks is easily handled through near-location of base stations to the D and E block transmitters. No modifications to device filtering are required to protect device reception. Standard network coordination mechanisms are sufficient.

The review of the lower band boundaries demonstrates no need for filtering more stringent than operating band 12. Band class 17 is not required from an interference perspective. The US 700 MHz deployments in the lower band should be using UE Band Class 12.

IV. Upper Band Analysis

In the upper 700 MHz band, the blocks currently consist of a paired 11+11 MHz upper C block, two paired 1+1 MHz blocks (A and B), the upper D paired block (5+5 MHz), the PSBB paired block (5+5 MHz), the public safety narrowband spectrum (6+6 MHz), and 1+1 MHz of guard band between the PSBB and PSNB allocations. The Coalition for 4G in America has proposed that the Commission combine the upper A and D blocks and auction them as a combined block.[18] The operating bands applicable to the upper 700 MHz band are shown in figure 2.

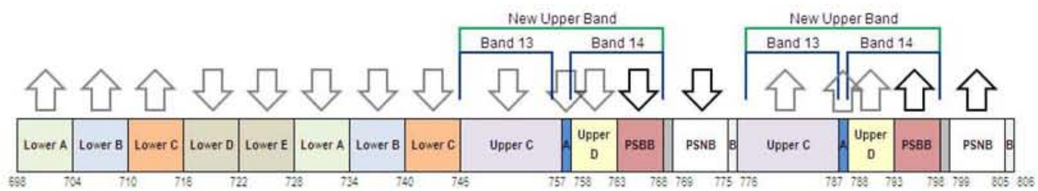

Figure 2: Upper 700 MHz Band and Bands 13, 14, and New Upper Band

Bands 13 and 14 are close to each other but separated per the 700 MHz band plan. However, the following analysis shows that a single band covering 13, 14, and the Upper A block, referred to as the New Upper Band in Figure 2, can meet OOBE requirements.

The interference scenario in the upper 700 MHz block consists of additional emissions protection for the public safety spectrum.

The FCC rules state that the public safety narrowband (PSNB) channels must be protected at their edge by a more stringent OOBE requirement than the commercial blocks. The commercial block OOBE requirement is for 43 + 10 log P with a 100 kHz measurement bandwidth. For simplicity, this

[18] Coalition for 4G in America ex partes, Jan. 6, 2010 and April 28, 2010, WT Docket No. 06-150.

translates to a power level of -3 dBm/MHz[19]. The tighter FCC requirements into the PSNB spectrum are 76 + 10 log P for base stations and 65 + 10 log P for mobiles and portables, with a measurement bandwidth of 6.25 kHz. Normalizing these levels to 1 MHz, the OOBE protection criteria becomes -13 dBm/MHz for mobiles[20] and -24 dBm/MHz for base stations.

The base station filtering may be tailored for an individual operator, employing tighter filtering than that of the entire band. Filtering is often block-specific at the base station to meet OOBE requirements to adjacent blocks. Therefore, since we are analyzing the feasibility of widening the block support for the UE, and the node B is under operator discretion, we will focus on the -13 dBm/MHz requirement for mobiles.

From the 3GPP specifications, the minimum required emissions mask for an LTE UE, normalized to 1 MHz measurement bandwidth, is -13 dBm/MHz as shown in Table 1 below, using signaling option NS-06[21]. Therefore, the LTE UE emissions mask will comply with the FCC OOBE protection criteria to the public safety block simply by complying with the 3GPP minimum specifications for transmitter performance.

	Spectrum emission limit (dBm)/ Channel bandwidth				
Δf_{OOB} (MHz)	1.4 MHz	3.0 MHz	5 MHz	10 MHz	Measurement bandwidth
± 0-0.1	-13	-13	-15	-18	30 kHz
± 0.1-1	-13	-13	-13	-13	100 kHz
± 1-2.5	-13	-13	-13	-13	1 MHz
± 2.5-5	-25	-13	-13	-13	1 MHz
± 5-6		-25	-13	-13	1 MHz
± 6-10			-25	-13	1 MHz
± 10-15				-25	1 MHz

Table 1: LTE UE Emissions Mask (3GPP TS 36.101)

As demonstrated above, the OOBE requirements into the public safety spectrum may be met with the standard emissions mask, and does not require block-specific filtering. The C block licensee would not be placed at a disadvantage if required to use the proposed New Upper Band.

[19] OOBE of 43 + 10 log P, with P in W, reduces to -43 dBW for the measurement bandwidth of interest, 100 kHz. Converting the measurement to dBm yields -13 dBm/100 kHz. For ready comparison to the 3GPP spectrum mask tables, the OOBE level is further adjusted for a 1 MHz measurement bandwidth, or -3 dBm/MHz.

[20] The increased protection from device emissions to public safety may be calculated as (65 + 10 log P) = -35 dBm/6.25 kHz. Converting the bandwidth to 1 MHz yields -13 dBm/MHz.

[21] P. 36 Table 6.6.2.2.3-1: Additional requirements, signaled value NS-06. 3GPP TS 36.101 v9.3.0 (2010-03).

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V. Device Design

The recommendations in sections III and IV increase the amount of spectrum covered by the operating bands and reduce the spacing, or gap, between the transmit and receive passbands. The proposed Lower and Upper operating bands are shown in figure 3.

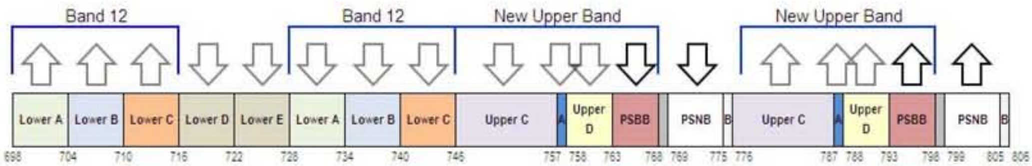

Figure 3: Upper and Lower 700 MHz Bands

The duplexer performance depends on the duplex gap and the size of the passbands. Too narrow of a spacing between the transmit and receive blocks may increase the insertion loss or reduce the isolation between passbands. The effectiveness of the duplexer design is approximated by the ratio of the duplex gap size to the passband size[22]. A comparison of the insertion loss, isolation, and duplexer ratio for Avago duplexers[23] for several 3GPP bands is provided in Table 2.

						Insertion Loss (dB)				Isolation (dB)			
						UE Rx Band		UE Tx Band		UE Rx Band		UE Tx Band	
Avago Part Number	Frequency Band	Frequency Range (Rx/Tx, MHz)	Passband (MHz)	Duplex Gap (MHz)	Ratio	Typical	Maximum	Typical	Maximum	Minimum	Typical	Minimum	Typical
ACMD-7602	Band I	1920-1980/2110-2170	60	130	2.17	1.1	2	1.1	1.6	53	61	41	52
ACMD-7409	Band II (US PCS)	1850-1910/1930-1990	60	20	0.33	1.5	3.5	1.1	3	52	56	43	48
ACMD-7403	Band II (US PCS)	1850-1910/1930-1990	60	20	0.33	1.3	3	1	2.1	52	59	40	49
ACMD-7606	Band VIII	880-915/925-960	35	10	0.29	2.2	3	2.2	2.7	45	55	44	56
N/A	Band XII	698-716/728-746	18	10	0.56	1.3	3	1.1	2.1	52	59	40	49
N/A	New Upper Band	746-768/777-798	22/21	9	0.43	1.3	3	1.1	2.1	52	59	40	49

Table 2: 700 MHz Band Duplexer Performance

The first four rows of Table 2 summarize the published specifications of Avago duplexers for 3GPP bands I, II and VIII. The Band I duplexer is for the 2100 MHz UMTS band. The large duplex gap provides exceptional performance in terms of low insertion loss[24] (1.1 dB typical) and isolation[25]. Band

[22] A steeper filter rolloff requires a higher order filter which is often more complex or more expensive. However, the "steepness" of rolloff is measured in relation to the pass band's width or filter's cutoff frequency, using metrics such as shape factor or dB/decade. For example, the shape factor is the ratio of the width of the transition region and pass band to the width of the pass band. The ratio used above is the shape factor minus one.

[23] Avago film bulk acoustic resonator (FBAR) duplexer specifications as downloaded from their web site at http://www.avagotech.com/pages/en/rf_for_mobile_wlan_mmw/fbar_filters/duplexers/umts_band_duplexer/

[24] Insertion loss quantifies the amount of signal attenuated as it passes through the filter. Higher insertion loss means more signal is attenuated by the filter, which reduces the coverage range.

[25] Isolation refers to the amount of attenuation from one passband to the other, an important metric for technologies requiring simultaneous transmit and receive in the same device, such as UMTS and FDD LTE. Isolation ensures that the device transmission does not interfere with reception.

II, the US PCS band, separates two 60 MHz passbands with a 20 MHz duplex gap. The ratio is less favorable than Band I, but the performance is still acceptable.[26] Band VIII is noteworthy as being a low-frequency band with a 10 MHz duplex gap. The passbands are narrower than the PCS band, but the ratio is less favorable, at 0.29 versus 0.33. The insertion loss for Band VIII is slightly less favorable than the 2100 MHz and PCS bands.

The last two rows in Table 2 provide the passband and duplex gap information for the 3GPP band 12 and New Upper Band duplexers. The shaded duplexer specifications are extrapolations from the performance of the other bands. The duplex gap to passband ratios are more favorable than the ratio for the PCS band, indicating that the performance of the proposed duplexers would exceed that of 3GPP Band VIII and be similar or better than the US PCS band.

In short, the duplex gaps for band 12 and the upper band proposal are well within the current state of the art for duplexer design. Sufficient isolation between transmit and receive will be achieved, and the filter insertion loss impact on coverage range will be comparable to other bands.

Verizon Wireless raised a device design concern that requiring a 700 MHz device to support all paired 700 MHz blocks automatically requires the device to support all air interface technologies:

> "For example, if a 700 A Block licensee chooses WiMAX, it would need devices that use WiMAX as the air interface. But under the Alliance's proposal, that device would also need to include the ability to use LTE on the A Block or C-Block spectrum."[27]

Verizon misconstrues the intent of the Alliance request, which was "to require that all mobile units for the 700 MHz band be capable of operating over all frequencies in the band[28]." A device may be capable of operating over all frequencies in a band without supporting all air interface technologies. For example, today AT&T sells devices which operate throughout the PCS band and support GSM and/or UMTS technologies. Verizon Wireless sells devices which operate throughout the PCS band and support CDMA 1x and 1xEVDO technologies. Neither operator's devices currently support the other's technologies, yet the devices are capable of operating over all frequencies in the band.

[26] Although not reflected in the chart above, it is noteworthy that the FCC has assigned new licenses in the PCS G Block that reduce the duplexer gap to 15 MHz; moreover, the FCC has allocated, though not yet assigned, additional spectrum for mobile broadband use in the PCS H Block that would further reduce the available duplexer gap to 10 MHz. The incremental decrease in the PCS duplexer gap reflects technical improvements that have occurred since the PCS bands were first assigned.

[27] Comments of Verizon Wireless, March 31, 2010, RM-11592.

[28] *700 MHz Block A Good Faith Purchaser Alliance Petition for Rulemaking Regarding the Need for 700 MHz Mobile Equipment to be Capable of Operating on All Paired Commercial 700 MHz Frequency Blocks*, filed Sept. 29, 2009 (Petition), at iii, 12.

With this understanding, a 700 MHz device adhering to the petition's request is not required to support multiple air interface technologies. The device must simply provide the capability of operating over the paired frequency blocks in terms of the filtering supported.

VI. Upper A Block

Return of Upper A Block

The upper A block lies in the center of the newly proposed Upper Band filtering scheme. With 1+1 MHz, the bandwidth is insufficient to deploy an LTE carrier. As previously stated, the Coalition for 4G in America has proposed a return of the spectrum to the Commission, in exchange for compensation to the incumbent licensees [29]. This proposal should be granted, with the upper A spectrum combined with the upper D block to form a 6+6 MHz block for auction.

VII. Conclusions

Lower 700 MHz Band

Mandating paired spectrum device support for band 12 will increase competition in the 700 MHz band and improve the value and utilization of spectrum. As demonstrated above, an LTE band 12 duplexer is feasible with current duplexer technology and provides similar performance and interference protection as other bands. The interference mechanisms between lower D and lower C are the same as between Channel 51 and lower A; therefore, there is no reason to require 6 MHz of guard band on one boundary but not the other. Channel 51 must be protected as per the FCC rules, but the A block licensees have a variety of means to provide the protection other than through a device filtering approach that relegates the A block to guard band. To sustain competition, the A block licensees must gain access to device scale with the corresponding lower costs. Further, if public safety is to achieve roaming, priority access, and economies of scale, the lower A block must be included in device designs supported by the lower B and C licensees.

Upper 700 MHz Band

Mandating device support across the Upper Band paired commercial blocks and PSBB spectrum will benefit public safety and increase the value of D block spectrum. As demonstrated above, the new Upper Band filtering would support all regulations regarding OOBE and would not cause interference beyond the normal network coordination situations. For LTE deployments, the new Upper Band duplexer design is well within the current state of the art and the filtering requirements are consistent with other 3GPP standard operating bands. Requiring support of a common band for the Upper 700 MHz blocks will lower the cost of PSBB devices and simplify implementation of PSBB roaming onto the upper C and

[29] Coalition for 4G in America ex partes, Jan. 6, 2010 and April 28, 2010, WT Docket No. 06-150; Access Spectrum ex parte, March 5, 2010, WT Docket Nos. 96-86 and 06-150, and PS Docket 06-229.

D blocks. The new operating band would likely increase D Block auction revenues as the bidders will not have to factor a device premium into their business plan.

Commission Action Requested

The FCC should act to mandate commercial broadband device support across the band 12 paired blocks and the upper band commercial and PSBB blocks to increase competition, benefit public safety, maximize spectrum usage, and further the goals of the national broadband plan. Specifically, the Commission should consider the following recommendations:

- All commercial devices operating in 700 MHz paired spectrum should support the lower A, B and C blocks and the upper C, A, D and PSBB blocks;
- The upper A block should be returned to the Commission and combined with the upper D block for auction[30].

[30] Coalition for 4G in America ex parte, April 28, 2010, WT Docket No. 06-150, PS Docket No. 06-229, GN Docket No. 09-51.